# SECTION 21 05 00-COMMON WORK RESULTS FOR FIRE SUPPRESSION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This section supplements all sections in this division, including pipe, fittings, valves, and connections for sprinkler standpipe and fire hose combination sprinkler and standpipe systems.

### 1.2 REFERENCES

A. General: Comply with appropriate standards.

1. American Society of Mechanical Engineers: ASME.
2. American Society for Testing and Materials: ASTM.
3. American Welding Society: AWS.
4. American Water Works Association: AWWA.
5. National Fire Protection Association: NFPA.
6. Underwriter Laboratories, Inc.: U.L.
7. Factory Mutual Standards: FM.
8. Los Angeles Department of Building and Safety: LADBS.
9. Los Angeles Fire Department: LAFD.

### 1.3 SUBMITTALS

A. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections. Submit data and shop drawings to indicate pipe materials, fittings, accessories, equipment and methods of installation.

B. Manufacturer’s Installation Instructions: Submit installation for all system components.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

D. Project Record Documents: Record actual locations of components and tag numbering.

E. Operation and Maintenance Data: Submit spare parts lists, exploded assembly views and recommended maintenance intervals.

### 1.4 WARRANTY

A. Furnish one-year minimum.

## PART 2 – PRODUCTS

### 2.1 VALVES

A. Gate Valves:

1. Up to and including 2 inches: Bronze body and trim, rising stem, hand wheel, solid wedge or disc, threaded ends.
2. Over 2 inches: Iron body, bronze trim, rising stem pre-grooved for mounting tamper switch, hand wheel, OS&Y, solid bronze or cast iron wedge, flanged, grooved ends.
3. Over 4 inches: Iron body, bronze trim, non-rising stem with bolted bonnet, solid bronze wedge, flanged ends.

B. Globe or Angle Valves:

1. Up to and including 2 inches: Bronze body, bronze trim, rising stem and hand wheel, inside screw, renewable rubber disc, threaded ends, with back seating capacity.
2. Over 2 inches: Iron body, bronze trim, rising stem, hand wheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

C. Ball Valves:

1. Up to and including 2 inches: Bronze two piece body, brass, chrome plated bronze, or stainless steel ball, teflon seats and stuffing box ring, lever handle, threaded ends.
2. Over 2 inches: Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle or gear drive hand wheel for sizes 10 inches and over, flanged.

D. Butterfly Valves:

1. Up to and Including 2 Inches Bronze Body: Stainless steel disc, resilient replaceable seat, threaded or grooved ends, extended neck, hand wheel and gear drive and integral indicating device, and built-in tamper proof switch rated 10 amp at 115 volt AC.
2. Over 2 Inches Cast or Ductile Iron Body: Cast or ductile iron, chrome or nickel plated ductile iron or aluminum bronze disc, resilient replaceable EPDM seat, wafer, lug, or grooved ends. With extended neck, hand wheel and gear drive and integral indicating device external tamper switch rated 10 amp at 115 volt AC.

E. Check Valves:

1. Up to and including 2 inches: Bronze body and swing disc, rubber seat, threaded ends.
2. Over 2 inches: Iron body, bronze trim, swing check with rubber disc, renewable disc and seat, flanged ends.
3. 4 inches and over: Iron body, bronze disc with stainless steel spring, resilient seal, threaded, wafer, or flanged ends.

F. Drain Valves:

1. Compression Stop: Bronze with hose thread nipple and cap.
2. Ball Valve: Brass with cap and chain, ¾ inch hose thread.

## 2.2 MATERIALS

A. Electrical

1. All electrical components furnished or installed under Fire Suppression shall be in complete compliance with the Electrical Specifications.
2. Wiring Diagrams. A wiring diagram of work not in Fire Suppression but necessary to operate equipment shown in this section shall be submitted for review as a shop drawing.

B. Equipment Identification.

1. Provide as required under “Identification”.

C. Access to Equipment.

1. All valves, control devices, equipment, specialties, etc. shall be located for easy access for operation, repair and maintenance. If items are concealed, provide access doors of size required for easy access to the items. Provide access doors as required.

## 2.3 BURIED PIPING

A. Ductile Iron Pipe, Class 350, AWWA C151, grooved ends.

1. Steel Fittings: ASME B16.5, steel flanges and fittings.
2. Ductile Iron Joints: ANSI/AWWA C-606.
3. Ductile Iron Coupling Housings: ASTM A-536, Grade 65-45-12.
4. Install piping with double-layer half over-lap 10 mil polyethylene tape.

## 2.4 ABOVE GROUND PIPING

A. Steel Pipe: ASTM A135/135M UL listed, threadable, light wall; or ASME B36.10; Schedule 10 or 40 black steel.

1. Steel Fittings: ASME B16.5, steel flanges and fittings; ASME B16.11, forged steel socket welded and threaded.
2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings; or ASME B16.4, threaded fittings.
3. Malleable Iron Fittings: ASME B16.3, threaded fittings ASTM B47. Mechanical Grooved Couplings: Ductile iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers per ANSI/AWWA C-606; ASTM A-536 Grade 65-45-12.

## 2.5 PIPE HANGERS AND SUPPORTS

A. Per specification requirements.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Verify excavations are to required grade, dry, and not over-excavated.

B. Verify adequacies of all site utilities and points-of-connection for existing buildings and/or structures.

### 3.2 PREPARATION

A. Remove scale and foreign material, from inside and outside, before assembly.

B. Prepare piping connections to sprinkler heads and as required.

### 3.3 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

B. Install piping to conserve building space, to not interfere with use of space and other work.

C. Group piping whenever practical at common elevations.

D. Install pipe sleeve at piping penetrations through footings partitions, walls, and floors. Seal pipe and sleeve penetrations to maintain fire resistance equivalent to fire separation.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Heads, piping, hangers and supports where exposed to corrosive ambient air conditions shall be prime coated.

G. Pipe Hangers and Supports:

1. Install in accordance with NFPA 13 and NFPA 14.
2. Install hangers to with minimum 1/2 inch space between finished covering and adjacent work.
3. Place hangers within 12 inches of each horizontal elbow.
4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
6. Where installing several pipes in parallel and at same elevation, provide multiple or trapeze hangers.
7. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

H. Slope piping and arrange systems to drain at low points. Install eccentric reducers to maintain top of pipe level.

I. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

J. Do not penetrate building structural members without approval of LAWA.

K. Where more than one piping system material is specified, install compatible system components and joints. Install flanges, union, and couplings at locations requiring servicing.

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

M. Install valves with stems upright or horizontal, not inverted. Remove protective coatings after installation.

N. Install gate or butterfly valves for shut-off or isolating service.

O. Install drain valves at main shut-off valves, low points of piping and apparatus.

P. Where inserts are omitted, drill through concrete slab from below and install through-bolt with recessed square steel plate and nut above or flush with top of recessed into and grouted flush with slab.

## 3.4 INTERFACE WITH OTHER PRODUCTS

A. Inserts:

1. Install inserts for placement in concrete forms.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Install hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

## 3.5 CLEANING

A. Clean entire system after other construction is complete.

END OF SECTION 21 05 00

# SECTION 21 05 16-EXPANSION FITTINGS AND LOOPS FOR FIRE-SUPPRESSION PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Flexible pipe connectors.
2. Expansion joints.
3. Expansion compensators.
4. Pipe alignment guides.
5. Swivel joints.
6. Pipe anchors.

### 1.2 REFERENCES

A. General: Comply with appropriate standards.

1. American Society of Mechanical Engineers: ASME.
2. American Welding Society: AWS.
3. National Fire Protection Association: NFPA.
4. Underwriters' Laboratories: U.L.
5. Los Angeles Department of Building and Safety: LADBS.

### 1.3 DESIGN REQUIREMENTS

A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

B. Expansion Compensation Design Criteria:

1. Installation Temperature: 50 degrees F.
2. Fire Protection System Temperature: 75 degrees F.
3. Safety Factor: 20 percent.

### 1.4 SUBMITTALS

A. Submit data on all materials.

B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints. Drawings shall be sealed by a registered professional engineer. Include information for piping expansion compensation in shop drawings for all fire suppression piping system as needed.

C. Product Data:

1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

D. Design Data: Indicate criteria and show calculations. Submit sizing methods calculations sealed by a registered professional engineer.

E. Manufacturer's Installation Instructions: Submit special procedures.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Welders' Certificate: Include welders' certification of compliance with AWS D1.1.

H. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.

I. Operation and Maintenance Data: submit adjustment instructions.

## 1.5 WARRANTY

A. Furnish five year manufacturer warranty for leak free performance of packed expansion joints.

# PART 2 - PRODUCTS

## 2.1 FLEXIBLE PIPE CONNECTORS

A. Manufacturers:

**1. Mason Ind.**
**2. Vibrex-Sausse.**
**3. Metraflex.**

B. Steel Piping:

1. Inner Hose: Carbon Steel, Stainless Steel or Bronze.
2. Exterior Sleeve: Double braided stainless steel or bronze.
3. Pressure Rating: 200 psig WOG and 250 degrees F.
4. Joint: As specified in piping section.
5. Size: Use pipe-sized units.
6. Maximum offset: 1 inch on each side of installed center line.

C. Copper Piping:

1. Inner Hose: Bronze
2. Exterior Sleeve: Braided bronze.
3. Pressure Rating: 200 psig WOG and 250 degrees F.

4. Joint: As specified in piping section.
5. Size: Use pipe sized units
6. Maximum offset: 1 inch on each side of installed center line

## 2.2 EXPANSION JOINTS

A. Manufacturers:

**1. Mason Ind.**
**2. Vibrex-Sausse.**
**3. Metraflex.**

B. Stainless Steel Bellows Type:

1. Pressure Rating: 200 psig WOG and 250 degrees F.
2. Maximum Compression: 1-3/4 inch.
3. Maximum Extension: 1/4 inch.
4. Joint: As specified in piping section.
5. Size: Use pipe sized units
6. Application: Steel piping 3 inch and smaller.

C. External Ring Controlled Stainless Steel Bellows Type:

1. Pressure Rating: 225 psig and 70 degrees F.
2. Maximum Compression: 1-1/4 inch.
3. Maximum Extension: 5/16 inch.
4. Maximum Offset: 5/16 inch.
5. Joint: As specified in piping system.
6. Size: Use pipe sized units
7. Accessories: Internal flow liner.
8. Application: Steel piping 3 inch and larger.

D. Double Sphere, Elbow or Flexible Compensators:

1. Body: Teflon or Neoprene and nylon.
2. Working Pressure: 225 psi.
3. Maximum Temperature: 80 degrees F.
4. Maximum Compression: 1-1/8 inch.
5. Maximum Elongation: 7/8 inch.
6. Maximum Offset: 7/8 inch.
7. Maximum Angular Movement: 30 degrees.
8. Joint: As specified in piping system.
9. Size: Use pipe sized units.
10. Accessories: Control rods or Control cables.
11. Application: Steel piping 2 inch and larger.

E. Two-ply Bronze Bellows Type:

1. Construction: Bronze with anti-torque device, limit stops, internal guides.

2. Pressure Rating: 200 psi WOG and 250 degrees F.
3. Maximum Compression: 1-3/4 inch.
4. Maximum Extension: 1/4 inch.
5. Joint: As specified in piping section.
6. Size: Use pipe sized units
7. Application: Copper piping.

F. Copper with Packed Sliding Sleeve:

1. Maximum Temperature: 250 degrees F.
2. Joint: As specified in piping section.
3. Size: Use pipe sized units
4. Copper or steel piping 2 inches and larger.
5. Application: Copper or steel piping 2 inch and larger.

G. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.

H. Swivel Joints: Fabricated steel Bronze Ductile Iron Cast steel body, double ball bearing race, field lubricated, with rubber (Buna-N) O-ring seals.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.

B. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

C. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.

D. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints as required.

E. Provide grooved piping systems with minimum one joint per inch pipe diameter instead of flexible connector supported by vibration isolation. Grooved piping systems need not be anchored.

## 3.2 MANUFACTURER'S FIELD SERVICES

A. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION 21 05 16

# SECTION 21 12 00-FIRE-SUPPRESSION STANDPIPES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes entire standpipe system from fire department connection to fire hose connection.

### 1.2 REFERENCES

A. General: Comply with appropriate standards.

1. American Society of Mechanical Engineers: ASME.
2. American Society for Testing and Materials: ASTM.
3. American Welding Society: AWS.
4. American Water Works Association: AWWA.
5. National Fire Protection Association: NFPA.
6. Underwriter Laboratories, Inc.: U.L.
7. Factory Mutual Standards: FM.
8. Los Angeles Department of Building and Safety: LADBS.
9. Los Angeles Fire Department: LAFD.

### 1.3 SUBMITTALS

A. Submit data on all materials, including manufacturers' installation instructions.

B. Shop Drawings: Indicate supports, components, accessories, and sizes.

C. Product Data: Submit manufacturer's catalog sheet for equipment indicating rough-in size, finish, and accessories.

D. Field Test Reports: Indicate compliance with specified performance.

E. Manufacturer's Installation Instructions: Submit with product data.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Operation and Maintenance Data: Submit spare parts lists, exploded assembly views and recommended maintenance intervals.

### 1.4 WARRANTY

A. Provide one-year minimum.

## PART 2 - PRODUCTS

### 2.1 FIRE HOSE CABINETS

A. Manufacturers:

1. **Potter-Roemer.**
2. **Larsen.**
3. **American Fire Hose & Cabinets.**

B. Hose Cabinets:

1. Style: Recessed, Semi-recessed, or Surface mounted. Fire rated when installed in fire rated assemblies.
2. Tub: 20 gauge thick steel with 18 gauge steel frame, prepared for pipe and accessory rough in.
3. Door: 20 gage thick steel, flush, or glazed, with 1/4 inch thick wired glass full panel, hinged, positive latch device.
4. Finish: Prime Coated or Enameled.

C. Hose Rack: Steel; with polished chrome finish; swivel or stationary type with pins and water stop.

D. Hose: 1 inch or 1-1/2 inch diameter; mildew and rot-resistant.

E. Nozzle: Chrome plated brass combination fog, straight stream, and adjustable shut-off.

### 2.2 VALVES

A. Manufacturers:

1. **Clow.**
2. **Nibco.**
3. **Viking.**

B. Hose Station Valve: Angle type, brass or chrome plated finish, 1-1/2 inch nominal size, with automatic ball drip.

C. Hose Connection Valve: Angle type; brass or chrome plated finish; 2-1/2 inch size, thread to match fire department hardware, 300 psi working pressure, with threaded cap and chain of chrome plated finish.

D. Pressure reducing Valve: Angle or Straight away type; brass finish with inner hydraulic controls. 1-1/2 inch size, fire department thread, 400 psi inlet pressure, with threaded cap and chain of chrome plated finish.

E. Hose Connection Valve Cabinets:

1. Style: Recessed, Semi-recessed, or Surface mounted. Fire rated when installed in fire rated assemblies.
2. Tub: 20 gauge thick steel with 18 gauge steel frame, prepared for pipe and accessory rough in.
3. Door: 20 gauge thick steel, flush, or glazed, with 1/4 inch thick wired glass full panel, hinged, positive latch device.
4. Finish: Prime Coated or Enameled.

## 2.3 FIRE DEPARTMENT CONNECTION

A. Type: Flush mounted wall type with brass or chrome plated finish. Free standing type shall be with ductile iron pedestal with red enamel finish.

B. Outlets: Two-way with fire department thread size. Threaded dust cap and chain of matching material and finish.

C. Drain: 3/4 inch automatic drip, outside connected to approved receptor.

D. Label: "Standpipe - Fire Department Connection".

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Verify blocking in place for cabinet installation.

## 3.2 INSTALLATION

A. Install cabinets plumb and level. Secure to adjacent surfaces.

B. Install hose station valve in cabinet at 60 inches above floor. Install hose-connection valve under hose station valve and not closer than 4 inches from side or bottom of cabinet.

C. Connect standpipe system to water source ahead of domestic water connection.

D. Where static pressure exceeds 100 psi but is less than 100 psi at any hose station, furnish pressure orifice disc in discharge of hose station valve to prevent pressure on hose exceeding 90 psi.

E. Install two way fire department outlet on roof.

## 3.3 CLEANING

A. Flush entire system of foreign matter.

END OF SECTION 21 12 00

# SECTION 21 13 13-WET-PIPE SPRINKLER SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes wet-pipe sprinkler system, system design, installation, and certification.

### 1.2 REFERENCES

A. General: Comply with appropriate standards.

1. American Society of Mechanical Engineers: ASME.
2. American Society for Testing and Materials: ASTM.
3. American Welding Society: AWS.
4. American Water Works Association: AWWA.
5. National Fire Protection Association: NFPA.
6. Underwriter Laboratories, Inc.: U.L.
7. Factory Mutual Standards: FM.
8. Los Angeles Department of Building and Safety: LADBS.
9. Los Angeles Fire Department: LAFD.

### 1.3 SCHEDULES

A. System Hazard Areas: Per NFPA 13.

### 1.4 SUBMITTALS

A. Submit data on all materials including manufacturers' installation instructions.

B. Shop Drawings: Indicate complete layout of all system components, including: coordinated sprinkler locations, detailed pipe layout, hangers and supports, components, accessories and system controls.

C. Samples: Submit two of each style of sprinkler specified.

D. Design Data: Submit signed and sealed design calculations.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Operation and Maintenance Data: Submit components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

## 1.5 WARRANTY

A. Provide one-year minimum.

## 1.6 EXTRA MATERIALS

A. Furnish extra sprinklers.

B. Furnish suitable wrenches for each sprinkler type.

C. Furnish metal storage cabinet in location designated by facility representative.

# PART 2 - PRODUCTS

## 2.1 SPRINKLERS

A. Manufacturers:

**1. Viking.**
**2. Reliable.**
**3. Grinnell.**

B. Suspended Ceiling Type:

1. Type: Standard, Semi-recessed, Recessed, or Concealed pendant type with matching adjustable semi-recessed escutcheon plate.
2. Construction: All bass frame with metal Belleville spring seal, Teflon coated, brass or chrome finish.
3. Escutcheon Plate Finish: Chrome plated.
4. Fusible Link: Glass bulb type, temperature rated for specific area hazard.

C. Exposed Area Type:

1. Type: Standard upright type, with guard.
2. Factory applied corrosion-resistant coating.
3. Fusible Link: Glass bulb type, temperature rated for specific area hazard.

D. Side wall Type:

1. Type: Standard, Semi-recessed, or Recessed horizontal side wall type with matching adjustable escutcheon plate and guard.
2. Construction: All bass frame with metal Belleville spring seal, Teflon coated, brass or chrome finish.
3. Escutcheon Plate Finish: Brass. Chrome plated. Enamel, color as selected.
4. Fusible Link: Glass bulb type temperature rated for specific area hazard.

E. Guards: Finish to match sprinkler finish.

## 2.2 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm or electric alarm, with pressure retard chamber and variable pressure trim; test and drain valve; strainer and gages.

B. Water Motor Alarm: Hydraulically operated impeller type alarm with aluminum alloy red enameled gong and motor housing, nylon bearings, and inlet strainer.

C. Electric Alarm: Electrically operated red enameled gong with pressure alarm switch.

D. Water Flow Switch: Vane or paddle type switch with u-bolt mounting, horizontal or vertical, with adjustable alarm delay-0-120 second range.

E. Fire Department Connections:

1. Type: Flush mounted wall type with chrome plated finish or free standing type with ductile iron pedestal with red enamel finish.
2. Outlets: Two-way with fire department thread size. Threaded dust-cap and chain of matching material and finish.
3. Drain: 3/4 inch min. automatic drip.
4. Label: "Sprinkler - Fire Department Connection"

## 2.3 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Controls: Supervisory switches, Water Level Supervisory Switches, Tank Temperature Supervisory Switches, Room Temperature Supervisory Switches.

B. Disconnect Switch: Factory mount in control panel and/or on equipment.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install buried shut-off valves in valve box, furnish post indicator as required.

B. Install and/or indicate location of approved double check valve assembly at sprinkler system water source connection and fire department connection.

C. Install outside alarm-gong on building wall.

D. Place pipe runs to minimize obstruction to other work.

E. Install piping in concealed spaces above finished ceilings.

F. Locate sprinklers in coordination with architectural reflected ceiling plan.

G. Install and connect to existing fire pump system as required.

H. Install guards on sprinklers.

I. Hydrostatically test entire system.

J. Under the direction of L.A.F.D. Inspector of Record and LAWA.

## 3.2 INTERFACE WITH OTHER PRODUCTS

A. Verify signal devices are installed and connected to fire alarm system.

## 3.3 CLEANING

A. Flush entire piping system of foreign matter.

## 3.4 PROTECTION OF INSTALLED CONSTRUCTION

A. Apply masking tape or paper cover to protect concealed sprinklers, cover plates, and sprinkler escutcheons not receiving field paint finish. Remove after painting. Replace painted sprinklers with new.

END OF SECTION 21 13 13

# SECTION 21 13 16-PRE-ACTION/DRY-PIPE SPRINKLER SYSTEMS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes dry-pipe sprinkler system, system design, installation, and certification.

### 1.2 REFERENCES

A. General: Comply with appropriate standards.

1. American Society of Mechanical Engineers: ASME.
2. American Society for Testing and Materials: ASTM.
3. American Welding Society: AWS.
4. American Water Works Association: AWWA.
5. National Fire Protection Association: NFPA.
6. Underwriter Laboratories, Inc.: U.L.
7. Factory Mutual Standards: FM.
8. Los Angeles Department of Building and Safety: LADBS.
9. Los Angeles Fire Department: LAFD.

### 1.3 SUBMITTALS

A. Submit data on all materials, including manufacturers' installation instructions.

B. Shop Drawings: Indicate complete layout of all systems, including: coordinated sprinkler locations, detailed pipe layout, hangers and supports, components, accessories and system controls.

C. Product Data: Submit data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

D. Samples: Submit two of each style of sprinkler specified.

E. Design Data: Submit signed and sealed design calculations.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Operation and Maintenance Data: Submit components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

H. System Hazard Areas: Per NFPA 13.

## 1.4 WARRANTY

A. Provide one-year minimum.

## 1.5 EXTRA MATERIALS

A. Furnish extra sprinklers.

B. Furnish suitable wrenches for each sprinkler type.

C. Furnish metal storage cabinet in location designated by facility representative.

# PART 2 - PRODUCTS

## 2.1 SPRINKLERS

A. Manufacturers:

**1. Viking.**
**2. Reliable.**
**3. Grinnell.**

B. Suspended Ceiling Type:

1. Type: Standard, Semi-recessed, Recessed, or Concealed pendant type with matching adjustable semi-recessed escutcheon plate.
2. Construction: All brass frame with metal Belleville spring seal, Teflon coated, brass or chrome finish.
3. Escutcheon Plate Finish: Chrome plated.
4. Fusible Link: Glass bulb type, temperature rated for specific area hazard.

C. Exposed Area Type:

1. Type: Standard upright type, with guard.
2. Factory applied corrosion-resistant coating.
3. Fusible Link: Glass bulb type, temperature rated for specific area hazard.

D. Side wall Type:

1. Type: Standard, Semi-recessed, or Recessed horizontal side wall type with matching adjustable escutcheon plate and guard.
2. Construction: All brass frame with metal Belleville spring seal, Teflon coated, brass or chrome finish.
3. Escutcheon Plate Finish: Brass. Chrome plated. Enamel, color as selected.
4. Fusible Link: Glass bulb type temperature rated for specific area hazard.

E. Dry Sprinklers:

1. Type: Standard, upright or side wall with matching plate.
2. Construction: All brass frame with metal Belleville spring seal, Teflon coated, brass or chrome plated.
3. Fusible solder link type, temperature rated for use.

F. Guards: Finish to match sprinkler finish.

## 2.2 PIPING SPECIALTIES

A. Dry Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm and/or electric alarm, with accelerator, test and drain.

B. Water Motor Alarm: Hydraulically operated impeller type alarm with aluminum alloy red enameled gong and motor housing, nylon bearings, and inlet strainer.

C. Electric Alarm: Electrically operated red enameled gong with pressure alarm switch.

D. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts.

E. Air Compressor: Shall be single unit type/electric motor driven with air maintenance device, 1/3 H.P. 120/1/60 minimum.

F. Fire Department Connections:

1. Type: Flush mounted wall type with chrome plated finish or free standing type with ductile iron pedestal red enamel finish.
2. Outlets: Two way with thread size to suit fire department hardware; threaded dust cap and chain of matching material and finish.
3. Drain: 3/4 inch min. automatic drip.
4. Label: "Sprinkler - Fire Department Connection"

## 2.3 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Controls: Supervisory switches, Water Level Supervisory Switches, Tank Temperature Supervisory Switches, Room Temperature Supervisory Switches.

B. Disconnect Switch: Factory mount in control panel on equipment.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install buried shut-off valves in valve box furnish post indicator as required.

B. Install and/or indicate location of approved double check valve assembly at sprinkler system water source connection and fire department connection.

C. Install outside alarm-gong on building wall.

D. Place pipe runs to minimize obstruction to other work.

E. Install piping in concealed spaces above finished ceilings.

F. Locate sprinklers in coordination with architectural reflected ceiling plan.

G. Install and connect to existing fire pump system as required.

H. Install guards on sprinklers.

I. Hydrostatically test entire system.

J. Under the direction of L.A.F.D. Inspector of Record and LAWA Facility Representative.

## 3.2 INTERFACE WITH OTHER PRODUCTS

A. Verify signal devices are installed and connected to fire alarm system.

## 3.3 CLEANING

A. Flush entire piping system of foreign matter.

## 3.4 PROTECTION OF INSTALLED CONSTRUCTION

A. Apply masking tape or paper cover to protect concealed sprinklers, cover plates, and sprinkler escutcheons not receiving field paint finish. Remove after painting. Replace painted sprinklers with new.

END OF SECTION 21 13 16

# SECTION 21 22 00-CLEAN AGENT FIRE SUPPRESSION SYSTEM

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes design, installation and certification of Clean Agent Fire Suppression Systems Addressable Detection.

### 1.2 REFERENCES

A. General: Comply with appropriate standards.

1. American Society of Mechanical Engineers: ASME.
2. American Society for Testing and Materials: ASTM.
3. American Welding Society: AWS.
4. American Water Works Association: AWWA.
5. National Fire Protection Association: NFPA.
6. Underwriter Laboratories, Inc.: U.L.
7. Factory Mutual Standards: FM.
8. City of Los Angeles Plumbing Code: LAPC.

### 1.3 SUBMITTALS

A. Submit data on all materials, including manufacturers' installation instructions.

B. Shop Drawings: Indicate complete layout of all system components, including: coordinated nozzle locations, detailed pipe layout, hangers and supports, required components, accessories and system controls.

C. Design Data: Submit signed and sealed design calculations for the complete system, including battery stand-by power calculations for the control panel and the battery stand-by power supply.

D. Provide Manufacturers Certificate.

### 1.4 WARRANTY

A. All System components furnished under this contract shall be guaranteed against defect in design, material and workmanship for the full warranty time which is standard with the manufacturer and/or supplier, but in no case less than one year.

## 1.5 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. Deliver extra materials to LAWA.

1. Detection Devices: Not less than 10 percent of amount of each type installed.
2. Audible Devices: Not less than 10 percent of amount of each size and type installed.
3. Visual Devices: Not less than 10 percent of amount of each type installed.

# PART 2 - PRODUCTS

## 2.1 INTEGRATED FIRE SUPPRESSION SYSTEMS

A. Manufacturers:

**1. Fike Corp.**
**2. Ansul.**
**3. Viking.**

## 2.2 PERFORMANCE REQUIREMENTS

A. Design clean-agent extinguishing system and obtain approval from authorities having jurisdiction. Design system for Class A, B, or C fires as appropriate for areas being protected and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.

B. The system shall be complete in all ways necessary for a functional, UL listed and/or FM approved, clean agent suppression system. It shall include: All mechanical and electrical installation, all detection and control equipment, agent storage containers, clean agent, nozzles, pipe and fittings, manual release and abort stations, audible and visual alarm devices, auxiliary devices and controls, shutdowns, alarm interface, caution/advisory signs, functional checkout testing, and training.

C. Performance Requirements (Agent): Per manufacturer’s data.

D. Performance Requirements (Detection): Per manufacturer’s data.

E. System Operating Sequence: As described by manufacturer.

## 2.3 PIPING MATERALS

A. Steel Pipe: ASTM A 53, Type S, Grade B or ASTM A 106, Grade B; Schedule 40, or Schedule 80, seamless steel pipe.

1. Threaded Fittings:

a. Malleable-Iron Fittings: ASME B16.3, Class 300.
b. Flanges and Flanged Fittings: ASME B16.5, Class 300, unless Class 600 is indicated.

2. Grooved-End Fittings: FMG approved and NRTL listed, ASTM A47 malleable iron or ASTM A 536 ductile iron, with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

## 2.4 VALVES

A. General: Brass; suitable for intended operation.

B. Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.

## 2.5 EXTINGUISHING-AGENT CONTAINERS

A. Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.

1. Finish: Red and white enamel or epoxy paint.
2. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.
3. Each cylinder shall have a low-pressure switch to provide visual and electrical supervision of the container pressure. The low-pressure switch shall be wired to the control panel to provide an audible and visual “Trouble” alarm in the even the container pressure drops below 272 psi.
4. Each cylinder shall be fitted with a liquid level device to determine the clean agent quantity without removing the cylinder from its mounting bracket, disconnecting the distribution piping, or removing the clean agent system from service. (35 lb. and 60 lb. cylinders are excluded).

## 2.6 FIRE-EXTINGUISHING CLEAN AGENT

A. Manufacturers:

**1. Fike Corporation.**
**2. Ansul.**
**3. Viking.**

B. Clean Agent: HFC-125, pentafluoroethane or HFC-227ea, heptafluoropropane.

## 2.7 DISCHARGE NOZZLES

A. Equipment manufacturer's standard one-piece brass or aluminum alloy of type, discharge pattern, and capacity required for application.

1. Deflector plates shall be used with the nozzles when sensitive ceiling tiles must be protected.
2. A maximum nozzle flow rate of 17 lbs./sec shall be designed for all areas with false ceilings or delicate operations. Higher flow rates may dislodge objects, which could damage or affect equipment and/or process.

## 2.8 FIRE SUPPRESSION RELEASING CONTROL PANEL

A. Control panel and its components shall be listed and approved type.

B. The addressable control panel shall be UL listed and Factory Mutual Global (FMG) approved for use as a local fire alarm system, and/or releasing clean agent, deluge and pre-action sprinkler fire suppression systems.

C. Control panels shall be capable of networking with similar panels to allow for internal and external NOC communications.

D. Power Requirements: 120-Vac; with electrical contacts as described in manufacturers data.

E. The control-panel shall include the following features:

1. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.
2. Automatic switchover to standby power at loss of primary power.
3. Storage container, low-pressure indicator.
4. Service disconnect to interrupt system operation for maintenance with visual status indication on the control panel.

F. Standby Power: Lead-acid or nickel-cadmium batteries with capacity to operate system for 24 hours and alarm for minimum of 5 minutes. Include automatic battery charger, with varying charging rate between trickle and high depending on battery voltage that is capable of maintaining batteries fully charged.

## 2.9 DETECTION DEVICES

A. These shall include ionization detectors and remote air-sampling detector system. Including air-sampling pipe network, a laser-based photoelectric detector, a sample transport fan, and a control unit.

## 2.10 MANUAL STATIONS WITH DIGITAL COUNTDOWN TIMER

A. General Description: A manual release shall also consist of a digital countdown timer and abort switch combined as one unit.

B. Manual Release: "AGENT RELEASE" caption, and red finish. Unit shall have a metal housing with a dual action release configuration to prevent accidental system discharge.

C. Abort Switch: "ABORT" caption, momentary contact, with yellow button.

D. Countdown Timer: The countdown timer provides a digital readout, indicating the number of seconds remaining until the clean agent discharges. There shall be a label stating "Seconds Remaining to Discharge" at the digital readout.

E. Each manual release and abort station shall include a contact monitor module to provide for a custom message and device location at the control panel.

## 2.11 SWITCHES

A. Listed and approved type, 120-Vac or low voltage compatible with controls. Include contacts for connection to control panel.

1. Low-Agent Pressure Switches: Pneumatic operation.
2. Door Closers: Magnetic retaining and release device or electrical interlock to cause the door operator to drive the door closed.

## 2.12 ALARM DEVICES

A. Low voltage, and surface mounting, unless otherwise indicated.

B. Bell: Minimum 6-inch diameter.

C. Horns: 90 to 94 dBA.

D. Strobe Lights: Translucent lens, with "AGENT" or similar caption.

## 2.13 AUXILIARY PANELS

A. Maintenance By-Pass Switch/Panel: Shall be located adjacent to the clean agent releasing control panel. The maintenance by-pass switch/panel shall have a key-switch which, when operated, will place the clean agent control panel in a "TEST" mode without affecting the detection system.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with hazard-area leakage requirements, installation tolerances, and other conditions affecting work performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Verification of existing conditions before starting work.

## 3.2 PIPING APPLICATIONS

A. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.

B. Fitting Working Pressure: 620 psig minimum.

C. Flanged Joints: Class 300 minimum.

D. NPS 2 and Smaller: ASTM B 88, Type L, ASTM B 88M, Type B, copper tube; copper, solder-joint fittings; and brazed joints.

E. NPS 2 and Smaller: Schedule 40, steel pipe; malleable-iron threaded fittings; and threaded joints.

F. NPS 2-1/2 and NPS 3: ASTM B 88, Type L, ASTM B 88M, Type B, copper tube; copper, solder-joint fittings; and brazed joints.

G. NPS 2-1/2 and NPS 3: Schedule 40, steel pipe; forged-steel welding fittings; and welded joints.

H. NPS 2-1/2 and NPS 3: Schedule 40, steel pipe; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.

I. Retain one of two paragraphs below.

J. NPS 4 and Larger: Schedule 40, steel pipe; steel, grooved-end fittings; keyed couplings; and grooved joints.

K. NPS 4 and Larger: Schedule 40, steel pipe; forged-steel welding fittings; and welded joints.

L. Piping between Storage Containers and Orifice Union:

1. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
2. Fittings Working Pressure: 2175 psig minimum.
3. Flanged Joints: Class 600 minimum.
4. All sizes: Schedule 80, steel pipe; forged-steel welding fittings; and welded joints.

M. Piping Downstream from Orifice Union:

1. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
2. Fittings Working Pressure: 1000 psig minimum.
3. Flanged Joints: Class 300 minimum.
4. All sizes: Schedule 40, steel pipe; forged-steel welding fittings; and welded joints.

## 3.3 CLEAN-AGENT EXTINGUISHING PIPING INSTALLATION

A. Install clean-agent extinguishing piping and other components level and plumb.

B. Install pipe and fittings, valves, and discharge nozzles as required.

C. Support piping shall include required seismic restraints.

## 3.4 CONNECTIONS

A. Install control panels, detection system components, alarms, and accessories, complying with requirements of NFPA 2001, Section “Detection, Actuation, and Control Systems”, as required for supervised system application.

B. Install piping adjacent to extinguishing-agent containers to allow service and maintenance.

C. Connect electrical devices to control panel and for interfacing to building’s fire alarm system.

## 3.5 LABELING AND SIGNS

A. Provide as required.

## 3.6 DEMONSTRATION

A. Train LAWA’s maintenance personnel to adjust, operate, and maintain clean-agent extinguishing systems.

END OF SECTION 21 22 00

# SECTION 22 05 00-COMMON WORK RESULTS FOR PLUMBING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section supplements all Sections of this Division and shall apply to all phases of Work specified or required to provide for the complete installation of plumbing systems. The intent of this Specification is to provide a complete plumbing system.

> **NOTE:** Noise and vibration control measures shall be incorporated into the plumbing design, including resilient support for plumbing lines, flexible connections for pipe work, selection of moderate plumbing fluid velocities and vibration isolation for the pumps.

### 1.2 REFERENCES

A. General: Comply with Appropriate Standards

1. American National Standards Institute: ANSI
2. American Society of Mechanical Engineers: ASME
3. American Society of Sanitary Engineering: ASSE
4. ASTM International: American Society of Testing and Materials: ASTM
5. American Welding Society: AWS
6. American Water Works Association: AWWS
7. Manufacturers Standardization Society of the Valve and Fittings Industry: MSS
8. National Electrical Manufacturers Association: NEMA
9. Plumbing and Drainage Institute: PDI
10. Underwriters Laboratories Inc.: U.L.
11. American society of Mechanical Engineers: ASME
12. California Energy Commission: C.E.C.
13. National Fire Protection Association: NFPA
14. Canadian Standards Association: CSA
15. Factory Mutual Standards: FM
16. American gas Association: AGA
17. California State Fire Marshal Regulations: CSFM
18. National Sanitation Foundation: NSF
19. International Association of Plumbing & Mechanical Officials: IAPMO
20. Cast Iron Soil Pipe Institute: CISPI
21. Los Angeles City Disabled Access Division: LAC-DAV
22. Los Angeles Plumbing Code: LAPC
23. Los Angeles Department of Building and Safety: LADBS
24. Los Angeles Fire Department: LAFD.

## 1.3 SUBMITTALS

A. Submit data on pipe materials, fittings, accessories, and equipment.

B. Manufacturer's Installation Instructions: Submit installation instructions for pumps, valves and accessories.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

## 1.4 ENVIRONMENT REQUIREMENTS

A. Do not install underground piping when bedding is wet.

## 1.5 WARRANTY

A. Furnish one year minimum.

## 1.6 JOB CONDITIONS

A. Existing Conditions:

1. Existing Pipe Lines.

a. If any existing water, gas, or other pipes and appurtenances are encountered which interfere with the proper installation of new Work and which will not be used in connection with new Work, or existing systems, close such pipe in a proper manner, and if necessary, move or remove the pipes as directed by LAWA.

b. Where existing Work is to be modified, it shall be done in conformance with the Specifications. Materials used shall be same as existing unless otherwise specified.

# PART 2 - PRODUCTS

## 2.1 MATERIALS

A. Electrical.

1. All electrical components furnished or installed under the Plumbing Division shall be in complete compliance with the Electrical Specifications.
2. Wiring Diagrams. A wiring diagram of Work not in the Plumbing Division but necessary to put equipment shown in the Plumbing Division, and shall be submitted for review as a shop drawing.

B. Equipment Identification.

1. Provide as required.

C. Access to Equipment.

1. All valves, control devices, equipment, specialties, etc. shall be located for easy access for operation, repair and maintenance. If items are concealed, provide access doors of size required for easy access to the items. Provide access doors per specification.

D. List of Materials and Equipment

1. All items of material and equipment required by this section shall bear the approval of the LAWA prior to the start of any work.

**NOTE:** Restrooms shall be provided with a pipe chase with 30" min. wide door.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Verify excavations are to required grade, dry, and not over-excavated.

B. Verify adequacies of all site utilities and points-of-connection for existing buildings and/or structures prior to bid and start of work.

END OF SECTION 22 05 00

**SECTION 22 05 00-COMMON WORK RESULTS FOR PLUMBING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

A. This Section supplements all Sections of this Division and shall apply to all phases of Work specified or required to provide for the complete installation of plumbing systems. The intent of this Specification is to provide a complete plumbing system.

**NOTE:** Noise and vibration control measures shall be incorporated into the plumbing design, including resilient support for plumbing lines, flexible connections for pipe work, selection of moderate plumbing fluid velocities and vibration isolation for the pumps.

**1.2 REFERENCES**

A. General: Comply with Appropriate Standards

1. American National Standards Institute: ANSI
2. American Society of Mechanical Engineers: ASME
3. American Society of Sanitary Engineering: ASSE
4. ASTM International: American Society of Testing and Materials: ASTM
5. American Welding Society: AWS
6. American Water Works Association: AWWS
7. Manufacturers Standardization Society of the Valve and Fittings Industry: MSS
8. National Electrical Manufacturers Association: NEMA
9. Plumbing and Drainage Institute: PDI
10. Underwriters Laboratories Inc.: U.L.
11. American society of Mechanical Engineers: ASME
12. California Energy Commission: C.E.C.
13. National Fire Protection Association: NFPA
14. Canadian Standards Association: CSA
15. Factory Mutual Standards: FM
16. American gas Association: AGA
17. California State Fire Marshal Regulations: CSFM
18. National Sanitation Foundation: NSF
19. International Association of Plumbing & Mechanical Officials: IAPMO
20. Cast Iron Soil Pipe Institute: CISPI
21. Los Angeles City Disabled Access Division: LAC-DAV
22. Los Angeles Plumbing Code: LAPC
23. Los Angeles Department of Building and Safety: LADBS
24. Los Angeles Fire Department: LAFD.

**1.3 SUBMITTALS**

A. Submit data on pipe materials, fittings, accessories, and equipment.

B. Manufacturer's Installation Instructions: Submit installation instructions for pumps, valves and accessories.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

### 1.4 ENVIRONMENT REQUIREMENTS

A. Do not install underground piping when bedding is wet.

### 1.5 WARRANTY

A. Furnish one year minimum.

### 1.6 JOB CONDITIONS

A. Existing Conditions:

1. Existing Pipe Lines.

a. If any existing water, gas, or other pipes and appurtenances are encountered which interfere with the proper installation of new Work and which will not be used in connection with new Work, or existing systems, close such pipe in a proper manner, and if necessary, move or remove the pipes as directed by LAWA.
b. Where existing Work is to be modified, it shall be done in conformance with the Specifications. Materials used shall be same as existing unless otherwise specified.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Electrical.

1. All electrical components furnished or installed under the Plumbing Division shall be in complete compliance with the Electrical Specifications.
2. Wiring Diagrams. A wiring diagram of Work not in the Plumbing Division but necessary to put equipment shown in the Plumbing Division, and shall be submitted for review as a shop drawing.

B. Equipment Identification.

1. Provide as required.

C. Access to Equipment.

1. All valves, control devices, equipment, specialties, etc. shall be located for easy access for operation, repair and maintenance. If items are concealed, provide access doors of size required for easy access to the items. Provide access doors per specification.

**NOTE:** Restrooms shall be provided with a pipe chase with 30" min. wide door. Plumbing service chase shall have a minimum clearance of 18" from point of access to and behind all plumbing fixtures. Access to plumbing chase from inside restrooms will be avoided.

D. List of Materials and Equipment

1. All items of material and equipment required by this section shall bear the approval of the LAWA prior to the start of any work.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Verify excavations are to required grade, dry, and not over-excavated.

B. Verify adequacies of all site utilities and points-of-connection for existing buildings and/or structures prior to bid and start of work.

END OF SECTION 22 05 00

# SECTION 22 05 16-EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Flexible pipe connectors.
2. Expansion joints.
3. Expansion compensators.
4. Pipe alignment guides.
5. Swivel joints.
6. Pipe anchors.

### 1.2 REFERENCES

A. General: Comply with appropriate standards.

1. American Society of Mechanical Engineers: ASME.
2. American Welding Society: AWS D1.1.
3. Los Angeles Department of Building and Safety: LADBS.

### 1.3 DESIGN REQUIREMENTS

A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

B. Expansion Compensation Design Criteria:

1. Installation Temperature: 50 degrees F.
2. Domestic Hot Water: 140 degrees F.

### 1.4 SUBMITTALS

A. Submit data on all materials.

B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints. Submit shop drawings sealed by a registered professional engineer.

C. Product Data:

1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per

assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.

2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

D. Design Data: Indicate criteria and show calculations. Submit sizing methods calculations sealed by a registered professional engineer.

E. Manufacturer's Installation Instructions: Submit special procedures.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Welders' Certificate: Provide welders' certificate.

H. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.

I. Operation and Maintenance Data: Submit adjustment instructions.

## 1.5 WARRANTY

A. Provide one-year minimum.

B. Furnish five year manufacturer warranty for leak free performance of packed expansion joints.

# PART 2 - PRODUCTS

## 2.1 FLEXIBLE PIPE CONNECTORS

A. Manufacturers:

**1. Mason Ind.**
**2. Vibrex-Sausse.**
**3. Metraflex.**

B. Steel Piping:

1. Inner Hose: Carbon Steel Stainless Steel Bronze.
2. Exterior Sleeve: Double braided stainless steel bronze.
3. Pressure Rating: 200 psig WOG and 250 degrees F.
4. Joint: As specified for pipe joints.
5. Size: Use pipe-sized units.
6. Maximum offset: 3/4 inch on each side of installed center line.

C. Copper Piping:

1. Inner Hose: Bronze.
2. Exterior Sleeve: Braided bronze.
3. Pressure Rating: 125 psig and 250 degrees F.

4. Joint: As specified for pipe joints.
5. Size: Use pipe sized units.
6. Maximum offset: 3/4 inch on each side of installed center line.

## 2.2 EXPANSION JOINTS

A. Manufacturers:

**1. Mason Ind.**
**2. Vibrex-Sausse.**
**3. Metraflex.**

B. Stainless Steel Bellows Type:

1. Pressure Rating: 125 psig and 250 degrees F.
2. Maximum Compression: 1-3/4 inch.
3. Maximum Extension: 1/4 inch.
4. Joint: As specified in piping section.
5. Size: Use pipe sized units.
6. Application: Steel piping 3 inch and smaller.

C. External Ring Controlled Stainless Steel Bellows Type:

1. Pressure Rating: 125 psig and 250 degrees F.
2. Maximum Compression: 1-1/4 inch.
3. Maximum Extension: 5/16 inch.
4. Maximum Offset: 5/16 inch.
5. Joint: As specified in piping system.
6. Size: Use pipe sized units.
7. Accessories: Internal flow liner.
8. Application: Steel piping 3 inch and larger.

D. Single or Double Sphere, Elbow or Flexible Compensators:

1. Body: Teflon or Neoprene and nylon.
2. Working Pressure: 125 psi.
3. Maximum Temperature: 150 degrees F.
4. Maximum Compression: 1-1/8 inch.
5. Maximum Elongation: 7/8 inch.
6. Maximum Offset: 7/8 inch.
7. Maximum Angular Movement: 30 degrees.
8. Joint: As specified in piping system.
9. Size: Use pipe sized units.
10. Accessories: Control rods or Control cables.
11. Application: Steel piping 2 inch and larger.

E. Two-ply Bronze Bellows Type:

1. Construction: Bronze with anti-torque device, limit stops, internal guides.

2. Pressure Rating: 125 psig WOG and 250 degrees F.
3. Maximum Compression: 1-3/4 inch.
4. Maximum Extension: 1/4 inch.
5. Joint: Soldered as specified in piping system.
6. Size: Use pipe sized units.
7. Application: Copper piping.

F. Low Pressure Compensators with two-ply Bronze Bellows:

1. Working Pressure: 80 psig.
2. Maximum Temperatures: 250 degrees F.
3. Maximum Compression: 1/2 inch.
4. Maximum Extension: 5/32 inch.
5. Joint: As specified in piping system.
6. Size: Use pipe sized units.
7. Application: Copper or steel piping 2 inch and smaller.

G. Copper with Packed Sliding Sleeve:

1. Maximum Temperature: 250 degrees F.
2. Joint: As specified in piping section.
3. Size: Use pipe sized units.
4. Copper or steel piping 2 inches and larger.
5. Application: Copper or steel piping 2 inch and larger.

H. Rubber Expansion Joints: ASTM F 1123, fabric-reinforced rubber with external control rods and complying with FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

1. Manufacturers:

   a. Flex-Weld, Inc.
   b. Mason Industries.
   c. Metraflex, Inc.

2. Arch Type: Single or multiple arches.
3. Spherical Type: Single or multiple spheres.

   a. Minimum Pressure and Temperature Ratings for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.
   b. Minimum Pressure and Temperature Ratings for NPS 5 and NPS 6: 140 psig at 200 deg F.

4. Material: EPDM.
5. End Connections: Full-faced, integral, steel flanges with steel retaining rings.
6. Equal to Mason Industries Vibraflex.

## 2.3 ACCESSORIES

A. Pipe Alignment Guides and Anchors: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel with weld down or bolt down anchor base.

B. Swivel Joints: Fabricated steel, Bronze, Ductile Iron or Cast steel body, double ball bearing race, field lubricated, with rubber or (Buna-N) o-ring seals.

## 2.4 MATERIALS FOR ANCHORS

A. Steel Shapes and Plates: ASTM A 36/A 36M.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Expansion Anchors

1. Smooth wall, non-self-drilling internal plug expansion type anchors constructed of AISC 12L14 steel and zinc plated in accordance with Fed. Spec. QQ-A-325 type 1, Class 3.
2. Do not exceed 1/4 of average values for a specific anchor size using 2000 PSIG concrete only, for maximum working loads.
3. Locate spacing and install anchors in accordance with the manufacturer's recommendations.
4. Expansion anchors shall be U.L listed.

E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.

1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
3. Washer and Nut: Zinc-coated steel.

F. Concrete: Portland cement mix, 3000 psi minimum.

G. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 EXPANSION-JOINT INSTALLATION

A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

B. Install expansion joints of sizes matching size of piping in which they are installed.

C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

D. Provide cast iron test tee expansion joints every 150 feet on vertical drainage and vent lines and where noted or required.

### 3.2 PIPE BEND AND LOOP INSTALLATION

A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Attach pipe bends and loops to anchors.

1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

### 3.3 SWING CONNECTIONS

A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

B. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

### 3.4 ALIGNMENT-GUIDE INSTALLATION

A. Install guides on piping adjoining pipe expansion fittings and loops.

B. Attach guides to pipe and secure to building structure.

## 3.5 ANCHOR INSTALLATION

A. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints are indicated.

E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

## 3.6 MANUFACTURER'S FIELD SERVICES

A. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION 22 05 16

# SECTION 22 05 23-GENERAL-DUTY VALVES FOR PLUMBING PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Gate valves.
2. Globe valves.
3. Ball valves.
4. Plug valves.
5. Butterfly valves.
6. Check valves.
7. Chainwheels.

### 1.2 REFERENCES

A. General: Comply with Appropriate Standards

1. American National Standards Institute: ANSI
2. American Society of Mechanical Engineers: ASME
3. American Society of Sanitary Engineering: ASSE
4. ASTM International: American Society of Testing and Materials: ASTM
5. American Welding Society: AWS
6. American Water Works Association: AWWS
7. Manufacturers Standardization Society of the Valve and Fittings Industry: MSS
8. National Electrical Manufacturers Association: NEMA
9. Plumbing and Drainage Institute: PDI
10. Underwriters Laboratories Inc.: U.L.
11. American Society of Mechanical Engineers – ASME
12. California Energy Commission – C.E.C.
13. National Fire Protection Association – NFPA
14. Canadian Standards Association - CSA
15. Factory Mutual Standards – FM
16. American gas Association – AGA
17. California State Fire Marshal Regulations – CSFM
18. National Sanitation Foundation – NSF
19. International Association of Plumbing & Mechanical Officials – IAPMO
20. Cast Iron Soil Pipe Institute – CISPI
21. Los Angeles City Disabled Access Division – LAC-DAV
22. Los Angeles Plumbing Code - LAPC
23. Los Angeles Department of Building and Safety – LADBS

## 1.3 SUBMITTALS

A. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.

## 1.4 QUALITY ASSURANCE

A. For drinking water service, provide valves complying with NSF 61 State of California AB 1953 and C.P.C. latest approved edition.

## 1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not install valves underground when bedding is wet.

## 1.6 WARRANTY

A. Furnish five year manufacturer warranty for valves excluding packing.

## 1.7 EXTRA MATERIALS

A. Furnish two packing kits for each size valve.

## PART 2 – PRODUCTS

**NOTE:** As much as possible, all valves should be from one manufacturer.

## 2.1 GATE VALVES

A. Manufacturers:

1. **Nibco.**
2. **Crane.**
3. **Milwaukee.**

B. 2 inches and Smaller: MSS-SP-80 Class 125, bronze body, bronze trim, union bonnet, non-rising stem, hand-wheel, inside screw, solid wedge disc, alloy seat rings, threaded, soldered or press-fit ends.

C. 2-1/2 inches and Larger: MSSP-SP-80 Class 125, cast iron body, bronze trim, bolted bonnet, non-rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

D. Class 150, NRS, Ductile-Iron Gate Valves:

1. Manufacturers:

**a. Nibco.**
**b. Crane.**
**c. Powell.**

2. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 285 psig.
c. Body Material: ASTM A 395, ductile iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

E. Class 150, OS&Y, Ductile-Iron Gate Valves:

1. Manufacturers:

**a. Nibco.**
**b. Crane.**
**c. Powell.**

2. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 285 psig.
c. Body Material: ASTM A 395, ductile iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

## 2.2 GLOBE VALVES

A. Manufacturers:

**1. Crane.**
**2. Milwaukee.**
3. **Nibco**.

B. 2 inches and Smaller: MSS SP 80, Class 125, bronze body, bronze trim, threaded bonnet, hand wheel, Buna-N composition disc, solder or threaded ends.

C. 2-1/2 inches and Larger: MSS SP 85, Class 125, cast iron body, bronze trim, hand wheel, outside screw and yoke, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

D. Class 125, Iron Globe Valves:

1. Manufacturers:

**a. Nibco.**
**b. Crane.**
**c. Powell.**

2. Description:

a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

E. Class 150, Iron Globe Valves:

1. Manufacturers:

**a. Nibco.**
**b. Crane.**
**c. Powell.**

2. Description:

a. Standard: MSS SP-85, Type I.
b. CWP Rating: 285 psig.
c. Body Material: ASTM A 395, ductile iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

## 2.3 BALL VALVES

A. Manufacturers:

**1. Milwaukee.**
**2. Crane.**
**3. Nibco.**

B. 2 inches and Smaller: 400 psi WOG two piece bronze body, chrome plated brass ball, full port, teflon seats, blow-out proof stem, threaded, soldered or press-fit ends with union, lever handle.

C. 2 inches and Smaller: Class 150, bronze, two piece body, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, threaded, soldered or press-fit ends with union, lever handle.

D. 2 inches and Smaller: Class 150, bronze, three piece body, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, threaded, soldered or press-fit ends, lever handle.

E. Class 150, Full-Port Stainless Steel Three-Piece Ball Valves:

1. Description:

a. Threaded or socket-weld up to 2-inches, with locking mechanism.
b. WOG Rating: 1000 psig.
c. Body Design: Split body.
d. Body Material: Stainless steel ASTM A-351, grade CF8M.
e. Seats: PTFE.
f. Stem: Stainless steel ASTM A-276, Type 316.
g. Ball: Stainless steel, ASTM A-351, GRADE CF8M.
h. Port: Full.

F. Flanged Class 150, split body, full bore, stainless steel ball valve.

1. Description:

a. Flanged 2-1/2-inch up to 6-inch, with locking mechanism.
b. Split body, full bore.
c. Body Material: Stainless steel A-351 grade CF8M.
d. Seats: Virgin Teflon.
e. Stem: A-276, 316SS.
f. Ball: Stainless steel A-351 grade CF8M.
g. Port: Full.

## 2.4 PLUG VALVES

A. Manufacturers:

**1. Nordstrom.**
**2. Dezurik.**
**3. Crane.**

B. 2 inches and Smaller: MSS SP 78, Class 300, cast iron construction, round port, full pipe area, pressure lubricated, teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench.

C. 2-1/2 inches and Larger: MSS SP 78, Class 300, cast iron construction, round port, full pipe area, pressure lubricated, teflon packing, flanged ends. Furnish wrench-operated or worm gear-operated.

## 2.5 BUTTERFLY VALVES

A. Manufacturers:

**1. Milwaukee.**
**2. Crane.**
**3. Nibco.**

B. 2-1/2 inches and Larger: Class 150.

1. Body: Cast or ductile iron, wafer lug or grooved ends, stainless steel stem, extended neck.
2. Disc: Nickel-plated ductile iron or Elastomer coated ductile iron.
3. Seat: Resilient replaceable EPDM.
4. Handle and Operator: 10 position lever handle. Furnish gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

## 2.6 CHECK VALVES

A. Horizontal Swing Check Valves:

1. Manufacturers:

**a. Milwaukee.**
**b. Crane.**
**c. Nibco.**

2. 2 inches and Smaller: Class 150, bronze body and cap, bronze seat, Buna-N disc, solder or threaded ends.
3. 2-1/2 inches and Larger: Class 125, cast iron body, bolted cap, bronze or cast iron disc, renewable disc seal and seat, flanged ends.
4. 2-1/2 inches and Larger: Class 125, cast iron body, bronze swing disc, flanged ends, outside lever and weight.

B. Spring Loaded Check Valves:

1. Manufacturers:

**a. Milwaukee.**
**b. Crane.**
**c. Nibco.**

2. 2 inches and Smaller: Class 250, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat, solder or threaded ends.
3. 2-1/2 inches and Larger: Class 250, wafer style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends.

## 2.7 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to ball valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

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

B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Install valves with clearance for installation of insulation and allowing access.

D. Provide access where valves and fittings are not accessible.

## 3.2 VALVE APPLICATIONS

A. Install shutoff and drain valves at required locations.

B. Install ball butterfly or gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install 3/4 inch gate ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

D. Install butterfly or globe valves for throttling, bypass, or manual flow control services.

E. Install spring loaded check valves on discharge side of all water pumps.

F. Install check valves on discharge of all pumps.

G. Install lug end butterfly valves adjacent to equipment when functioning to isolate equipment.

## 3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball or gate valves.
2. Throttling Service: Globe or angle valves.
3. Pump-Discharge Check Valves:

    a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
    b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, resilient-seat check valves.
    c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

## 3.4 DOMESTIC, HOT AND COLD WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 150, nonmetallic disc.
3. Ball Valves: Three piece, full port, bronze with stainless-steel trim.
4. Bronze Lift Check Valves: Class 125, nonmetallic TFE disc.
5. Bronze Swing Check Valves: Class 150, nonmetallic TFE disc.
6. Bronze Gate Valves: Class 150, RS.
7. Bronze Globe Valves: Class 150, nonmetallic disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Angle Valves: Class 125.
3. Steel Ball Valves: Class 150, full-port.

4. Ductile-Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
5. Ductile-Iron, Grooved-End Butterfly Valves: 300 CWP.
6. High-Performance Butterfly Valves: Class 150, 285 CWP.
7. Iron Swing Check Valves: Class 125, metal seats.
8. Iron Swing Check Valves with Closure Control: Class 125, lever and weight.
9. Iron, Center-Guided Check Valves: Class 125, globe, resilient seat.
10. Iron Gate Valves: Class 125, OS&Y.
11. Iron Globe Valves: Class 125.

## 3.5 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Three piece, full port, bronze with stainless-steel trim.
3. Bronze Swing Check Valves: Class 125, nonmetallic disc.
4. Bronze Gate Valves: Class 150, RS.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Steel Ball Valves: Class 150, full port.
3. Iron Swing Check Valves: Class 125, metal seats.
4. Iron Swing Check Valves with Closure Control: Class 125, lever and weight.
5. Iron Gate Valves: Class 125, OS&Y.
6. Lubricated Plug Valves: Class 125, regular gland, threaded or flanged.

END OF SECTION 22 05 23

# SECTION 22 05 29-HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Sleeves.
6. Mechanical sleeve seals.
7. Formed steel channel.
8. Firestopping relating to plumbing work.
9. Firestopping accessories.
10. Equipment bases and supports.
11. Metal framing system.
12. Fastener systems.
13. Pipe stand fabrication.
14. Pipe positioning systems.

### 1.2 REFERENCES

A. General: Comply with Appropriate Standards.

1. American Society of Mechanical Engineers: ASME
2. American Society of Testing and Materials: ASTM
3. American Welding Society: AWS
4. Factory Mutual Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation: FM
5. Manufacturers Standardization Society of the Valve and Fittings Industry: MSS
6. Underwriters Laboratories Inc.: UL
7. Los Angeles Plumbing Code - LAPC
8. Los Angeles Department of Building and Safety - LADBS

### 1.3 SUBMITTALS

A. Submit Data on all materials.

B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and details of trapeze hangers.

C. Product Data:

1. Submit manufacturers catalog data including load capacities.
2. Submit Manufacturers preparation and installation instructions.
3. Submit Manufacturers Certificate to verify all products meet or exceed specified requirements.

D. Operation and Maintenance Data: Submit spare parts list, exploded assembly views and recommended maintenance intervals.

## 1.4 ENVIRONMENTAL REQUIREMENTS

A. Review environmental conditions affecting products on site prior to installation.

B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.

C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

D. Provide ventilation in areas subject to corrosive ambient air conditions.

## 1.5 WARRANTY

A. Provide one-year minimum.

# PART 2 - PRODUCTS

## 2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:

**1. B-Line.**
**2. Tolco.**
**3. PHD Manufacturing, Inc.**

B. Plumbing Piping – Drainage, Waste, Vent and Storm:

1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
2. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
4. Wall Support: Welded steel bracket and wrought steel clamp.
5. Vertical Support: Steel riser clamp.
6. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
7. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.

C. Plumbing Piping - Water:

1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
2. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
3. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
6. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
7. Wall Support for Pipe Sizes 4 inches and Smaller: Welded steel bracket and wrought steel clamp.
8. Wall Support for Pipe Sizes 5 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
9. Vertical Support: Steel riser clamp.
10. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
11. Floor Support for Pipe Sizes 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
12. Floor Support for Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
13. Copper Pipe Support: Copper-plated, Carbon-steel ring.

## 2.2 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

## 2.3 INSERTS

A. Manufacturers:

**1. B-Line.**
**2. Tolco.**
**3. Hilti.**

B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

## 2.4 FLASHING

A. Metal Flashing: 26 gage thick galvanized steel.

B. Metal Counterflashing: 22 gage thick galvanized steel.

C. Lead Flashing:

1. Waterproofing: 5 lb./sq. ft sheet lead.
2. Soundproofing: 1 lb./sq. ft sheet lead.

D. Flexible Flashing: 47 mil thick sheet; compatible with roofing.

E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

## 2.5 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sealant: Listed and approved type.

## 2.6 MECHANICAL SLEEVE SEALS

A. Manufacturers:

1. **Thunderline Link-Seal, Inc.**
2. **NMP Corporation Model.**

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

## 2.7 FORMED STEEL CHANNEL

A. Manufacturers:

1. **B-Line.**
2. **Tolco.**
3. **Unistrut.**

## 2.8 FIRESTOPPING

A. Manufacturers:

1. **Dow Corning.**
2. **Hilti.**
3. **3M.**

B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.

## 2.9 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Type as required.

C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

D. General:

1. Furnish UL listed products or products tested by independent testing laboratory.
2. Select products with rating not less than rating of wall or floor being penetrated.

E. Non-Rated Surfaces:

1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

## 2.10 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

**1. B-Line.**
**2. Tolco.**
**3. Unistrut.**

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

## 2.11 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

**a. B-Line.**
**b. Hilti.**
**c. Powers Fasteners.**

2. Expansion Anchors:

    a. Smooth wall, non-self-drilling internal plug expansion type anchors constructed of AISC 12L14 steel and zinc plated in accordance with Fed. Spec. QQ-A-325 type 1, Class 3.
    b. Do not exceed 1/4 of average values for a specific anchor size using 2000 PSIG concrete only, for maximum working loads.
    c. Locate spacing and install anchors in accordance with the manufacturer's recommendations.
    d. Expansion anchors shall be U.L. listed.

## 2.12 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Manufacturers:

    **a. ERICO/Michigan Hanger Co.**
    **b. MIRO Industries.**

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers:

    **a. MIRO Industries.**

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:

    **a. ERICO/Michigan Hanger Co.**
    **b. MIRO Industries.**
    **c. Portable Pipe Hangers.**

2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

## 2.13 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Manufacturers:

1. **C & S Mfg. Corp.**
2. **HOLDRITE Corp.; Hubbard Enterprises.**
3. **Samco Stamping, Inc.**

## 2.14 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

B. Verify openings are ready to receive firestopping.

## 3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Install backing damming materials to arrest liquid material leakage.

D. Obtain permission from LAWA before drilling or cutting structural members.

## 3.3 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

    a. Inserts shall be steel, slotted type and factory-painted.

        1) Single rod shall be equal to Anvil International Fig. 281.
        2) Multi-rod shall be with end caps and closure strips.
        3) Clip form nails flush with inserts.
        4) Maximum loading including pipe, contents and covering shall not exceed 75% of rated insert capability.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
16. Supports from Steel Decks:

    a. Support piping from steel deck with metal deck ceiling bolt.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include

auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.
b. Vertical (MSS Type 55): Mounted vertically.
c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

## 3.4 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.

F. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

N. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

O. Suspended Horizontal Piping:

1. Support piping independently from structure using heavy iron-hinged type hangers.
2. Provide electroplated solid-band hangers for 2-inch and smaller pipe.
3. Provide trapeze hangers of angles, angles bolted back-to-back, or channels to parallel lines of piping.
4. Provide wall brackets for wall-supported piping, and furnish pipe saddles for floor-mounted piping.
5. Provide supports with recommended lining for glass piping.
6. Provide supports with copper lining for uninsulated copper piping.
7. Suspend piping from inserts, using beam clamps with retaining clamp or locknut, steel fish plates, cantilever brackets or other accepted means.
8. Suspend piping by rods with double nuts.
9. Provide additional steel framing as required and accepted where overhead construction does not permit fastening hanger rods in required locations.
10. Support branch fixture water piping in chases with copper-plated metal brackets, secured to studs.

## 3.5 EQUIPMENT SUPPORTS

A. Mount on or support from accepted foundations and supports, all noted equipment and related piping.

B. Size, locate, and install noise and vibration isolation equipment in accordance with manufacturer's recommendations and after review.

C. Select noise and vibration isolation equipment for lowest operating speed of equipment to be isolated.

D. Ensure that lateral motion under equipment at start-up, shut-down or when unbalanced is no more than a maximum of 1/4 inch.

E. Provide corrosion resistant mounting systems when exposed to the elements and other corrosive environments. Provide hot dip galvanized metal parts of mountings (except springs and hardware). Provide cadmium-plated and neoprene-coated springs and cadmium-plated nuts and bolts.

F. Correct noise and vibration problems due to faulty equipment or poor workmanship, as directed, without additional charge to LAWA.

G. Steel Spring Type:

1. Utilize bare stable springs without restraints.
2. Provide spring with diameter not less than 80% of loaded operating height of spring.
3. Design ends of spring so that they remain parallel during and after springs are loaded to their minimum specified deflections.
4. Provide springs with 50% travel from operating deflection before reaching solid height.
5. Provide spring mounts with 1/4 inch thick waffled neoprene acoustical pad bonded to underside of base plate.

H. Provide resiliently mounted equipment bases raised to operating height with a minimum of 2 inch of clearance at bottom of base prior to installing equipment.

1. Temporarily support bases on 2-inch thick (minimum) spacer blocks.
2. Adjust mountings to transfer load from spacer blocks to mountings; remove spacer blocks after equipment installation, but immediately prior to operation.

I. Concrete inertia blocks with adequate reinforcing steel will be provided under General Construction Work.

J. Neoprene-In-Shear Isolation Rails: Furnish for horizontal pumps, air compressors, and vacuum pumps when supplied with fractional horsepower motors.

1. Provide top structural iron channel rails with tapped holes to accept machinery foundation bolts supported by properly loaded and located double deflection neoprene-in-shear mountings, equal to Type DNR - M.I.I.
2. Provide mountings with 3/8 inch minimum static deflection and bolt holes for anchoring onto foundation equal to Type DNR - M.I.I.

K. Neoprene-In-Shear Supported Concrete Inertia Bases: Provide for horizontal pumps, jockey pumps, air compressors, and vacuum pumps when supplied with one horsepower to three horsepower motors.

L. Provide a minimum 6-inch thick concrete inertia block supported by double deflection neoprene-in-shear mountings, equal to Type ND - M.I.I., with form as noted for foundations. Bolt and grout equipment to concrete base. Provide minimum static deflection of 1 inch.

M. Spring-Supported, Factory-Fabricated Inertia Bases: Provide for horizontal pumps (except fire pumps), bottom-supported vertical booster pumps, jockey pumps, rotary air compressors and vacuum pumps with five horsepower and larger motors.

1. Provide concrete inertia block with factory-fabricated steel structural perimeter frame, set on roofing paper, with equipment anchor bolt templates and mounting brackets supplied by vibration control manufacturer.
2. Provide and locate under brackets, spring supports with a minimum static deflection of 1 inch and with leveling device to raise entire isolation base 2 inch above foundation.
3. Provide minimum thickness required for concrete inertia bases as follows:

a. Motor Size 5 hp to 15 hp: 6 inch.
b. Motor Size 20 hp to 50 hp: 8 inch.
c. Motor Size 60 hp to 100 hp: 10 inch.
d. Motor Size Over 100 hp: 12 inch.

N. Spring supported factory fabricated structural steel bases: Provide for vertical booster pumps suspended from floor slab above and through penetration.

1. Provide equipment rigidly bolted to spring supported reinforced structural base and isolated from suitable framed structural supports erected from floor slab.
2. Provide reinforced structural steel base constructed with structural members having depth of section not less than 1/12 span between spring mountings and supplied by vibration control manufacturer.
3. Provide a framed base to permit removal of any pump mounted on structural base.
4. Provide structural supports erected from floor slab, sized and framed to accept spring mountings and supported loads.
5. Piping in projected area of isolated structural pump base may be rigidly supported from isolated pump base.
6. Provide spring mountings designed so that they are capable of supporting equipment at fixed elevation during installation, and adjusted to provide operating clearance in mountings of 1/4 inch.

O. Center of gravity (C.G.) mounted spring inertia blocks:

1. Equipment and its driving motor shall be integrally mounted on spring-supported concrete inertia blocks.
2. Provide inertia blocks sized to provide sufficient mass so that dynamic movement of equipment block assembly will be less than 1/16 inch peak-to-peak at any connection flange. Form shall be as noted for foundations.
3. Provide blocks and spring mountings arranged to accomplish dynamically symmetrical system with respect to total C.G. of spring assembly in all three major axes.
4. Provide steel spring mountings consisting of bare stable springs arranged in pendulum configuration with built-in adjustable side snubbers, leveling device and 1/4 inch thick neoprene acoustical base pad.
5. Provide mountings with a minimum static deflection corresponding to isolation efficiency of 90% at lowest equipment operating speed.

## 3.6 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

## 3.7 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

## 3.8 FIELD QUALITY CONTROL

A. All tests shall be in accordance with city of Los Angeles and Inspector of Record.

END OF SECTION 22 05 29

# SECTION 22 05 48-VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Inertia bases.
2. Vibration isolators.
3. Flexible Connectors.
4. Seismic Restraint Devices.

### 1.2 REFERENCES

A. Comply with appropriate standards.

1. American National Standards Institute: ANSI
2. ANSI S1.4 - Sound Level Meters.
3. ANSI S1.8 - Reference Quantities for Acoustical Levels.
4. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of Noise Sources.
5. Air-Conditioning and Refrigeration Institute: ARI
6. American Society of Heating, Refrigerating: ASHRAE
7. Los Angeles Building Code: LABC
8. ISAT
9. Los Angeles Department of Building and Safety: LADBS.

### 1.3 PERFORMANCE REQUIREMENTS

A. Provide vibration isolation on motor driven equipment over 0.5 hp, plus connected piping.

B. Provide minimum static deflection of isolators for equipment as recommended by manufacturer.

C. Consider upper floor locations critical unless otherwise indicated.

D. Use concrete inertia bases for motors in excess of 40 hp and on base mounted pumps over 10 hp.

E. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.

F. Maintain room maximum sound levels, in Noise Criteria (NC) as defined by ANSI S1.8.

## 1.4 SUBMITTALS

A. Submit data on all materials.

B. Shop Drawings: Indicate equipment bases and locate vibration isolators, with static and dynamic load on each. Indicate assembly, material, thickness, dimensional data, pressure losses, acoustical performance, layout, and connection details for sound attenuation products fabricated for this project.

C. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials and dimensional data.

D. Design Data: Submit calculations indicating maximum room sound levels are not exceeded.

E. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions.

F. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.

G. Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.

## 1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of hangers including attachment points.

## 1.6 WARRANTY

A. Provide one year minimum.

# PART 2 - PRODUCTS

## 2.1 INERTIA BASES

A. Manufacturers:

1. **Mason Ind.**
2. **Amber/Booth Co.**
3. **Vibration Mountings & Control, Inc.**

B. Structural Bases:

1. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.
2. Construction: Welded structural steel with gusset brackets, supporting equipment and motor with motor slide rails.

C. Concrete Inertia Bases:

1. Mass: Minimum of 1.5 times weight of isolated equipment.
2. Construction: Structured steel channel perimeter frame, with gusset brackets and anchor bolts, reinforced as required.
3. Connecting Point: Reinforced to connect isolators and snubbers to base.
4. Concrete: Reinforced 3,000 psi concrete minimum.
5. Minimum thickness shall be:

| Motor Size | | Minimum Thickness | |
|---|---|---|---|
| (hp) | (kW) | (in) | (mm) |
| 5-15 | (4-11) | 6 | (150) |
| 20-50 | (15-37) | 8 | (200) |
| 60-75 | (45-55) | 10 | (250) |
| 100-250 | (75-190) | 12 | (300) |
| 300-500 | (220-375) | 18 | (350) |

## 2.2 VIBRATION ISOLATORS

A. Manufacturers:

**1. Mason Industries.**
**2. Amber/Booth Company, Inc.**
**3. Vibration Mountings & Controls, Inc.**

B. Vibration Isolator Types:

1. Type A: Spring isolators shall incorporate the following:

a. Minimum diameter of 0.8 of the loaded operating height.
b. Corrosion resistance where exposed to corrosive environment with:

1) Springs cadmium plated or electro-galvanized.
2) Hardware cadmium plated.
3) All other metal parts hot-dip galvanized.

c. Reserve deflection (from loaded to solid height) of 50 percent of rated deflection.

d. Minimum 1/4 inch thick neoprene acoustical base pad on underside, unless designated otherwise.
e. Designed and installed so that ends of springs remain parallel and all springs installed with adjustment bolts.
f. Non-resonant with equipment forcing frequencies or support structure natural frequencies.
g. Spring isolators to be Mason Type SLF, or as approved.
h. This isolator must be accompanied by seismic isolator Type II.

2. Type B: Spring isolators shall be same as Type A, except:

a. Provide built-in vertical limit stops with minimum 1/4 inch clearance under normal operation.
b. Tapped holes in top plate for bolting to equipment when subject to wind load.
c. Capable of supporting equipment at a fixed elevation during equipment erection. Installed and operating heights shall be identical.
d. Adjustable and removable spring pack with separate neoprene pad isolation.
e. Housing shall be designed to accept 1 G of acceleration.
f. Mason Type SLR.

3. Type C: Spring hanger rod isolators shall incorporate the following:

a. Spring element seated on a steel washer within a neoprene cup incorporating a rod isolation bushing.
b. Steel retainer box encasing the spring and neoprene cup.
c. Requires seismic restraint Type III.
d. Mason Type HS.

4. Type E: Elastomer hanger rod isolators shall be incorporate the following:

a. Molded unit type neoprene element with projecting bushing lining rod clearance hole.
b. Neoprene element shall be minimum 1-3/4 inch thick.
c. Steel retainer box encasing neoprene mounting.
d. Clearance between mounting hanger rod and neoprene bushing shall be minimum of 1/8 inch.
e. Requires seismic restraint Type III.
f. Mason Type HD.

5. Type F: Combination spring/elastomer hanger rod isolators to incorporate the following:

a. Spring and neoprene isolator elements in a steel box retainer. Neoprene of double deflection type. Single deflection is unacceptable. Spring seated in a neoprene cup with extended rod bushing.
b. Characteristics of spring and neoprene as describe in Type A and Type E isolators.
c. Requires seismic restraint Type III.
d. Mason Type 30N.

6. Type G: Pad type elastomer mountings to incorporate the following:

a. 0.750 inch minimum thickness.
b. 50 psi maximum loading.
c. Ribbed or waffled design.
d. 0.10 inch deflection per pad thickness.
e. 1/16 inch galvanized steel plate between multiple layers or pad thickness.
f. Suitable bearing plate to distribute load.
g. Mason Type Super W.

7. Type H: Pad type elastomer mountings to incorporate the following:

a. Laminate canvas duck and neoprene.
b. Maximum loading 1000 psi.
c. Suitable bearing plate to distribute load.
d. Minimum thickness, 1/2 inch.
e. Mason Type HL.

8. Type J: Rail type spring isolators:

a. Rail type spring isolators shall provide steel members of sufficient strength to prevent flexure with equipment operation.
b. Springs shall be the same as Type A with seismic restraint Type II or seismic restraint Type I or IV isolation.
c. Mason Type ICS.

9. Type K: Pipe anchors:

a. Vibration isolator manufacturer shall provide an all directional acoustical pipe anchor, consisting of a telescopic arrangement of two sizes of steel tubing separated by a minimum half inch thickness of heavy duty neoprene and duck or neoprene isolation material.
b. Vertical restraints shall be provided by similar material arranged to prevent vertical travel in either direction.
c. Allowable loads on the isolation material shall not exceed 500 psi and the design shall be balanced for equal resistance in any direction.
d. Mason Type ADA.

## 2.3 FLEXIBLE CONNECTORS

A. Elastomer Type FC-1:

1. Manufactured of nylon tire cord and EPDM both molded and cured with hydraulic presses.
2. Straight connectors shall have two spheres reinforced with a molded-in external ductile iron ring between spheres.
3. Elbow shall be long radius reducing type.
4. Rated 250 psi at 170 degrees F dropping in a straight line to 170 psi at 250 degrees F for sizes 1-1/2 inch to 12 inch elbows. Elbows shall be rated no less than 90 percent of straight connections.

5. Sizes 10 inches to 12 inches to employ control cables with neoprene end fittings isolated from anchor plates by means of 1/2 inch bridge bearing neoprene bushings.
6. Minimum safety factor, 4 to 1 at maximum pressure ratings.
7. Submittals shall include test reports.
8. Mason Type MFTNC Superflex.

B. Flexible Stainless Hose, Type FC-2:

1. Braided flexible metal hose.
2. 2 inch pipe size and smaller with male nipple fittings.
3. 2-1/2 inch and larger pipe size with fixed steel flanges.
4. Suitable for operating pressure with 4 to 1 minimum safety factor.
5. Length as required.
6. Mason Type BSS.

## 2.4 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers:

**1. Mason Industries.**
**2. Amber/Booth Company, Inc.**
**3. Mason Industries.**
**4. Vibration Mountings & Controls, Inc.**

B. Type B-1: Integral Structural Steel Base

1. Reinforced, as required, to prevent base flexure at start up and misalignment of drive and driven units. Centrifugal fan bases complete with motor slide rails. Drilled for drive and driven unit mounting template.
2. Mason Type M, WF.

C. Type B 2: Concrete Inertia Base

1. Concrete inertia bases shall be formed in a structural steel perimeter base, reinforced as required to prevent flexure, misalignment of drive and driven unit or stress transferal into equipment. The base shall be complete with motor slide rails, pump base elbow supports, and complete with height saving brackets, reinforcing, equipment bolting provisions and isolators.
2. Minimum thickness of the inertia base shall be according to the following tabulation:

| Motor Size | | Minimum Thickness | |
|---|---|---|---|
| (hp) | (kW) | (in) | (mm) |
| 5-15 | (4-11) | 6 | (150) |
| 20-50 | (15-37) | 8 | (200) |
| 60-75 | (45-55) | 10 | (250) |
| 100-250 | (75-190) | 12 | (300) |
| 300-500 | (220-375) | 18 | (350) |

3. Mason Type K, BMK.

## 2.5 SEISMIC RESTRAINT DEVICES

A. Type I: Spring Incorporating Seismic Restraint

1. Shall comply with general characteristics of spring isolators.
2. Shall have vertical restraints and are capable of supporting equipment at fixed elevation during equipment erection. Vertical restraint shall be separate from equipment load support.
3. Shall incorporate seismic snubbing restraint in all directions at specified acceleration loadings.
4. System to be field bolted to structure with minimum capability to withstand external forces of 1.5.
5. Mason Type SSLR.

B. Type II: Stationary Seismic Restraint

1. Each corner or side seismic restraint shall incorporate minimum 5/8" thick pad limit stops. Restraints shall be made of plate, structural members or square metal tubing in a welded assembly, incorporating resilient pads. Angle bumpers are not acceptable. System to be field bolted to deck with 1.0 g acceleration capacity.
2. Seismic spring mountings as described above are an acceptable alternative providing all seismic loading requirements are met.
3. Mason Industries Type Z 1011, Type Z 1225.

C. Type III: Cable Seismic Restraint,

1. Metal cable type with approved end fastening devices to equipment and structure. System to be field bolted to deck or overhead structural members or deck with aircraft cable and clamps as per ISAT guidelines.

D. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

E. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

F. Restraint Cables: ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

G. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

H. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

I. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

J. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

K. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

L. Adhesive Anchor Bolts: Adhesive anchor bolts are not permitted where seismic restraint is required. Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

## 2.6 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install isolation for motor driven equipment.

B. Bases:

1. Set steel bases for 1 inch clearance between housekeeping pad and base.
2. Set concrete inertia bases for 2 inch clearance between housekeeping pad and base.

C. Adjust equipment level.

D. Install spring hangers without binding.

E. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

F. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

G. Provide pairs of horizontal limit springs on fans with more than 6.0 inch static pressure, and on hanger supported, horizontally mounted axial fans.

H. Provide resiliently mounted equipment and piping with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.05 inch maximum clearance. Provide other snubbers with clearance between 0.15 inch and 0.25 inch.

I. Support piping connections to isolated equipment resiliently as follows:

1. Up to 4 inch Diameter: First three points of support.
2. 5 to 8 inch Diameter: First four points of support.
3. 10 inch Diameter and Over: First six points of support.
4. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

## 3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

## 3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. Install seismic snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inches.

3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.
4. All equipment whether isolated or not, shall be bolted to structure to allow for minimum 1/2 G of acceleration. Bolt points and diameter of inserts shall be submitted and verified as part of the contractor's submission for each piece of equipment and certified by a licensed civil or structural engineer.
5. All structurally suspended overhead equipment isolated or non-isolated shall be four point independently braced within Type III seismic restraining system.
6. Where base anchoring is insufficient to resist seismic forces, supplementary restraining such as seismic restraint system Type III shall be used above systems center of gravity to suitably resist "G" force levels. Vertically mounted tanks may require this additional restraint.
7. All anchor bolts and tie-ins to structure shall be designed for a 1.5 importance factor to meet the California Building Code.

B. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet at turns of more than 4 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.
4. Install Seismic Restraining System Type III: Taut for overhead suspended non-isolated equipment, piping and slack with 1/2 inch cable deflection for isolated systems.
5. Seismically restrain all piping with Type III restraining system in accordance with guideline as outlined below.
6. Seismic restraints are not required for the following (this does not apply to any life safety or high hazard equipment):

    a. Gas piping less than 1 inch I.D.
    b. Piping in Boiler and Mechanical Equipment rooms less than 1-1/4 inch I.D.
    c. All other piping less than 2-1/2 I.D.
    d. All piping suspended by individual hangers 12 inches in length or less from the top of the pipe to the bottom of the support for the hanger.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

H. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

## 3.4 SEISMIC RESTRAINTS FOR NON-ISOLATED EQUIPMENT

A. All ceiling suspended piping not excluded by diameter or distance required from support: Seismic Restraint type III.

B. All ceiling mounted equipment: Seismic Restraint Type III.

C. All floor mounted equipment, including but not limited to tanks, domestic water heaters, etc.: Seismic Restraint Type V.

## 3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements for piping flexible connections.

## 3.6 FIELD QUALITY CONTROL

A. Inspect isolated equipment after installation and submit report. Include static deflections.

B. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to plumbing equipment rooms, duct and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.

C. Furnish services of testing agency to take noise measurement. Use meters meeting requirements of ANSI S1.4.

## 3.7 PLUMBING VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

A. Supported or Suspended Equipment:

1. Pads:

   a. Material: Neoprene.
   b. Thickness: ½".

2. Component Importance Factor: 1.5.
3. Component Response Modification Factor: 1.5.
4. Component Amplification Factor: 2.5.

| Type of Equipment | Below Grade | | Above Grade | |
|---|---|---|---|---|
| | **Isolation Type** | **Deflection** | **Isolation Type** | **Deflection** |
| Heat Exchangers | D | 0.4 inch | B and Base Type B-1 | 1 inch |
| Pumps up to 15 HP | D-J | 0.4 inch | B or SR Type I and Base Type J | 1 inch |
| All Piping | Type I and SR Type III | 1 inch | Type I and SR Type III | 2 inches |
| Piping Flexible Connectors for Pumps | FC-1 | -- | FC-1 | -- |

END OF SECTION 22 05 48

# SECTION 22 05 53-IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.
8. Warning Signs and Labels.
9. Warning Tag.

### 1.2 REFERENCES

A. American Society of Mechanical Engineers: ASME

1. ASME A13.1 - Scheme for the Identification of Piping Systems.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturers catalog literature for each product required.

B. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

## PART 2 - PRODUCTS

### 2.1 NAMEPLATES

A. Manufacturers:

**1. Craftmark Identification Systems.**
**2. Safety Sign Co.**
**3. Seton Identification Products.**
**4. Kolbi.**

B. Product Description: Laminated three-layer plastic with engraved white letters on blue contrasting background color.

1. Plastic Labels for Equipment:

    a. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
    b. Letter Color: White.
    c. Background Color: Blue.
    d. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
    e. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
    f. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
    g. Fasteners: Stainless-steel rivets or self-tapping screws.
    h. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Metal Labels for Equipment:

1. Material and Thickness: Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

## 2.2 TAGS

A. Plastic Tags:

1. Manufacturers:

    **a. Seton.**
    **b. Brady.**
    **c. Kolbi.**

2. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 2 inches square.

B. Metal Tags:

1. Manufacturers:

    **a. Seton.**
    **b. Brady.**

c. **Kolbi.**

2. Stainless steel, 0.025” min. thickness and having predrilled holes or stamped roles for attachment hardware, with stamped or engraved letters; tag size minimum 2 inches square with finished edges.

## 2.3 STENCILS

A. Manufacturers:

**1. Seton.**
**2. Brady.**
**3. Kolbi.**

B. Stencils: With clean cut symbols and letters of following size:

1. Up to 2 inches Outside Diameter of Insulation or Pipe: 3/4 inch high letters.
2. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1 ¼ inch high letters.
3. Over 6 inches Outside Diameter of Insulation or Pipe: 2 1/2 inches inches high letters.
4. 10 inch and above of insulation or pipe: 3 ½ inches high letters.
5. Equipment: 1-3/4 inches high letters.

C. Stencil Paint: Semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

## 2.4 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers:

1. Manufacturers:

**a. Seton.**
**b. Brady.**
**c. Kolbi.**

2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

C. Plastic Tape Pipe Markers:

1. Manufacturers:

**a. Seton.**
**b. Brady.**
**c. Kolbi.**

2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

D. Plastic Underground Pipe Markers:

1. Manufacturers:

**a. Seton.**
**b. Brady.**
**c. Kolbi.**

2. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

## 2.5 CEILING TACKS

A. Manufacturers:

**1. Seton.**
**2. Brady.**
**3. Kolbi.**

B. Description: Steel with 3/4 inch diameter color-coded head.

C. Color code as follows:

1. Plumbing valves: Green.

## 2.6 LABELS

A. Manufacturers:

**1. Seton.**
**2. Brady.**
**3. Kolbi.**

B. Description: Stainless steel, size 2 ½ x 3/4 inches, adhesive backed with printed identification and bar code.

## 2.7 LOCKOUT DEVICES

A. Lockout Hasps:

1. Manufacturers:

**a. Seton.**
**b. Brady.**
**c. Kolbi.**

2. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

B. Valve Lockout Devices:

1. Manufacturers:

**a. Seton.**
**b. Brady.**
**c. Kolbi.**

2. Steel device preventing access to valve operator, accepting lock shackle.

## 2.8 WARNING SIGNS & LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.9 WARNING TAG

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Apply stencil painting.

B. Install identifying devices after completion of coverings and painting.

C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

E. Install tags using corrosion resistant chain. Number tags consecutively by location.

F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

G. Identify water heaters, pumps, tanks, and water treatment devices with stencil painting. Identify in-line pumps and other small devices with tags.

H. Identify control panels and major control components outside panels with plastic nameplates.

I. Identify valves in main and branch piping with tags.

J. Identify piping, concealed or exposed, with plastic tape pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

K. Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

### 3.2 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 10 feet along each run.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
8. Where removable ceiling tiles are provided, install buttons, tabs, or markers to identify location of concealed work and/or valves.

C. Pipe Label Color Schedule:

1. Domestic Water Piping:

a. Background Color: Blue.
b. Letter Color: White.

2. Sanitary Waste and Storm Drainage Piping:

a. Background Color: Yellow.
b. Letter Color: Black.

## 3.3 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Cold Water: 2 inches, round.
b. Hot Water: 2 inches, round.

2. Valve-Tag Color:

a. Cold Water: Blue.
b. Hot Water: Red.

3. Letter Color:

a. Cold Water: White.
b. Hot Water: White.

## 3.4 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 22 05 53

# SECTION 22 07 00-PLUMBING INSULATION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Plumbing piping insulation, jackets and accessories.
2. Plumbing equipment insulation, jackets and accessories.

### 1.2 REFERENCES

A. Comply with appropriate standards

1. ASTM International: ASTM
2. California Plumbing Code: CPC
3. Los Angeles Plumbing Code: LAPC
4. Los Angeles Department of Building and Safety: LADBS
5. Americans with Disabilities Act: ADA
6. City of Los Angeles – Disabled Access: DA

    a. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
    b. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
    c. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
    d. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
    e. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
    f. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
    g. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
    h. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
    i. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
    j. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
    k. ASTM C578 - Standard Specification, Cellular Polystyrene Thermal Insulation.
    l. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
    m. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.

n. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
o. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
p. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
q. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
r. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
s. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
t. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
u. ASTM E84.
v. ASTM E223.

## 1.3 SUBMITTALS

A. Product Data: Submit product description, thermal characteristics and list of materials and thickness and jackets for each service, and location.

B. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

D. LEED Submittal:

1. Product data for cedit EQ4.1: For adhesives and sealants, including printed statement of VOC content.

## 1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by LAWA. Use materials indicated for the completed Work.

1. Piping Mockups:

   a. One 10-foot section of NPS 2 straight pipe.
   b. One each of a 90-degree threaded, welded, and flanged elbow.
   c. One each of a threaded, welded, and flanged tee fitting.
   d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
   e. Four support hangers including hanger shield and insert.
   f. One threaded strainer and one flanged strainer with removable portion of insulation.
   g. One threaded reducer and one welded reducer.
   h. One pressure temperature tap.
   i. One mechanical coupling.

2. Equipment Mockups: One tank or vessel.
3. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
4. Notify LAWA seven days in advance of dates and times when mockups will be constructed.
5. Obtain LAWA's approval of mockups before starting insulation application.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless LAWA specifically approves such deviations in writing.
7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
8. Demolish and remove mockups when directed.

## 1.5 WARRANTY

A. Furnish one-year minimum.

B. Furnish five year manufacturer warranty for man made fiber.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURER

A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:

1. **CertainTeed.**
2. **Johns Manville.**
3. **Owens-Corning.**

## 2.2 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

B. TYPE P-2: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.

C. TYPE P-3: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket. Conform to ASTM C795 for application on Austenitic stainless steel.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: 0 to 650 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

D. TYPE P-4: ASTM C612; semi-rigid, fibrous glass board noncombustible. Conform to ASTM C795 for application on Austenitic stainless steel.

1. Thermal Conductivity: 0.27 at 75 degrees F.

E. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

F. TYPE P-6: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.

1. Thermal Conductivity: 0.30 at 75 degrees F.
2. Maximum Service Temperature: 300 degrees F.
3. Operating Temperature Range: Range: Minus 58 to 300 degrees F.

G. TYPE P-7: ASTM C534, Type I, flexible, nonhalogen, closed cell elastomeric insulation, tubular.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Maximum Service Temperature: 250 degrees F.
3. Operating Temperature Range: Range: Minus 58 to 250 degrees F.

H. TYPE P-8: ASTM C547, Type I or II, mineral fiber preformed pipe insulation, noncombustible.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Maximum Service Temperature: 1200 degrees F.
3. Canvas Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric treated with fire retardant lagging adhesive.

I. TYPE P-9: ASTM C591, Type IV, polyisocyanurate foam insulation, formed into shapes for use as pipe insulation.

1. Density: 4.0 pounds per cubic foot.
2. Thermal Conductivity: 180 day aged value of 0.19 at 75 degrees F.
3. Operating Temperature Range: Range: Minus 297 to 300 degrees F.
4. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied film of 4 mils thickness and water vapor permeance of 0.02 perms.

J. TYPE P-10: ASTM C578, Type XIII, extruded polystyrene insulation, formed into shapes for use as pipe insulation.

1. Thermal Conductivity: 180 day aged value of 0.259 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 297 to 165 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied film of 4 mils thickness and water vapor permeance of 0.02 perms.

K. TYPE P-11: ASTM C533; Type I, hydrous calcium silicate pipe insulation, rigid molded white; asbestos free.

1. Thermal Conductivity: 0.45 at 200 degrees F.
2. Operating Temperature Range: 140 to 1200 degrees F.

## 2.3 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:

1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

B. PVC Plastic Pipe Jacket:

1. Product Description: ASTM D1785, one piece molded type fitting covers and sheet material, off-white color.
2. Thickness: 30 mil.
3. Connections: Brush on welding adhesive with VOC content of 50 g/l according to CFR 59, Subpart D (EPA Method 24).

C. ABS Plastic Pipe Jacket:

1. Jacket: One piece molded type fitting covers and sheet material, off-white color.

2. Minimum service temperature: -40 degrees F.
3. Maximum service temperature of 180 degrees F.
4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
5. Thickness: 30 mil.
6. Connections: Brush on welding adhesive.
7. Connections: Brush on welding adhesive with VOC content of 50 g/l according to CFR 59, Subpart D (EPA Method 24).

D. Aluminum Pipe Jacket:

1. ASTM B209.
2. Thickness: 0.020 inch thick sheet.
3. Finish: Smooth Embossed.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.2 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 1/2 inch wide; 0.015 inch thick aluminum. 0.020 inch thick stainless steel.

E. Stainless Steel Pipe Jacket:

1. ASTM A240/A240M OR ASTM 666 Type 304 stainless steel.
2. Thickness: 0.016 inch thick.
3. Finish: Smooth.
4. Metal Jacket Bands: 1/2 inch wide; 0.020 inch thick stainless steel.

F. Field Applied Glass Fiber Fabric Jacket System:

1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:

   a. Cloth: Untreated; 9 oz/sq yd weight.
   b. Blanket: 1.0 lb/cu ft density.

3. Indoor Vapor Retarder Finish:

   a. Cloth: Untreated; 9 oz/sq yd weight.
   b. Vinyl emulsion type acrylic, compatible with insulation, white color.

## 2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self adhesive closure. Thickness to match pipe insulation.

F. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

I. Adhesives: Compatible with insulation.

## 2.5 EQUIPMENT INSULATION

A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.

1. Thermal Conductivity: 0.24 at 75 degrees F.
2. Operating Temperature Range: 0 to 450 degrees F.
3. Density: 1.65 pound per cubic foot.

B. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied kraft reinforced aluminum foil jacket.

1. Thermal Conductivity: 0.24 at 75 degrees F.
2. Operating Temperature Range: 0 to 450 degrees F.
3. Density: 3.0 pound per cubic foot.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

C. TYPE E-3: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: 0 to 650 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

D. TYPE E-4: ASTM C612; semi-rigid, fibrous glass board noncombustible.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: 0 to 650 degrees F.

E. TYPE E-5: ASTM C612, man made mineral fiber, noncombustible, Classes 1-4.

1. Thermal Conductivity: 0.25 at 100 degrees F.
2. Maximum Service Temperature: 1200 degrees F.
3. Density: 4 pound per cubic foot.

## 2.6 EQUIPMENT INSULATION JACKETS

A. PVC Plastic Equipment Jacket:

1. Product Description: ASTM D1785, sheet material, off-white color.
2. Minimum Service Temperature: -40 degrees F.
3. Maximum Service Temperature: 150 degrees F.
4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
5. Thickness: 30 mil.
6. Connections: Brush on welding adhesive with VOC content of 50 g/l according to CFR 59, Subpart D (EPA Method 24).

B. Aluminum Equipment Jacket:

1. ASTM B209.
2. Thickness: 0.020 inch thick sheet.
3. Finish: Embossed.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.02 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum. 0.020 inch thick stainless steel.

C. Canvas Equipment Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

D. Vapor Retarder Jacket:

1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

E. Field Applied Glass Fiber Fabric Jacket System:

1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:

    a. Cloth: Untreated; 9 oz/sq yd weight.
    b. Blanket: 1.0 lb/cu ft density.

3. Indoor Vapor Retarder Finish:

    a. Cloth: Untreated; 9 oz/sq yd weight.
    b. Vinyl emulsion type acrylic, compatible with insulation, black white color.

## 2.7 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

E. Adhesives: Compatible with insulation.

## 2.8 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

1. Manufacturers:

**a. Childers Products, Division of ITW; CP-97.**
**b. Foster Products Corporation, H. B. Fuller Company; 81-27/81-93.**
**c. Marathon Industries, Inc.; 290.**

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:

**a. Childers Products, Division of ITW; CP-96.**
**b. Foster Products Corporation, H. B. Fuller Company; 81-33.**

2. calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Manufacturers:

**a. Aeroflex USA Inc.; Aeroseal.**
**b. Armacell LCC; 520 Adhesive.**
**c. Foster Products Corporation, H. B. Fuller Company; 85-75.**

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers:

**a. Childers Products, Division of ITW; CP-82.**
**b. Foster Products Corporation, H. B. Fuller Company; 85-20.**
**c. Marathon Industries, Inc.; 225.**

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Manufacturers:

**a. Childers Products, Division of ITW; CP-82.**
**b. Foster Products Corporation, H. B. Fuller Company; 85-20.**
**c. Marathon Industries, Inc.; 225.**

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Manufacturers:

**a. Dow Chemical Company (The); 739, Dow Silicone.**
**b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.**
**c. Speedline Corporation; Speedline Vinyl Adhesive.**

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.9 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content that meets the requirement of the South Coast Air Quality Management District Rule #1168. VOC limits to be per amendment date 1/7/05.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Manufacturers:

**a. Childers Products, Division of ITW; CP-35.**
**b. Foster Products Corporation, H. B. Fuller Company; 30-90.**
**c. Marathon Industries, Inc.; 590.**

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Manufacturers:

**a. Childers Products, Division of ITW; CP-30.**
**b. Foster Products Corporation, H. B. Fuller Company; 30-35.**
**c. Marathon Industries, Inc.; 501.**

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Manufacturers:

**a. Childers Products, Division of ITW; Encacel.**
**b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.**
**c. Marathon Industries, Inc.; 570.**

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.
6. For outdoor aluminum finish, use 60-39 mastic.

## 2.10 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products - Manufacturers:

**a. Childers Products, Division of ITW; CP-76.**
**b. Foster Products Corporation, H. B. Fuller Company; 30-45.**
**c. Marathon Industries, Inc.; 405.**

2. Joint Sealant for Polystyrene Products - Manufacturers:

**a. Childers Products, Division of ITW; CP-70.**
**b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.**
**c. Marathon Industries, Inc.; 405.**

3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.

5. Service Temperature Range: Minus 100 to plus 300 deg F.
6. Color: White or gray.
7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers:

**a. Childers Products, Division of ITW; CP-76-8.**
**b. Foster Products Corporation, H. B. Fuller Company; 95-44.**
**c. Marathon Industries, Inc.; 405.**

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Manufacturers:

**a. Childers Products, Division of ITW; CP-76.**

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.11 FIELD APPLIED FABRIC – REINFORCING MASH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

1. Manufacturers:

**a. Vimasco Corporation; Elastafab 894.**

B. Woven Glass-Fiber Fabric for Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.

1. Manufacturers:

**a. Childers Products, Division of ITW; Chil-Glas No. 5.**

C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for equipment and pipe.

1. Manufacturers:

**a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.**
**b. Vimasco Corporation; Elastafab 894.**

## 2.12 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

1. Manufacturers:

**a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.**

## 2.13 SECUREMENTS

A. Bands:

1. Manufacturers:

**a. Childers Products; Bands.**
**b. PABCO Metals Corporation; Bands.**
**c. RPR Products, Inc.; Bands.**

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
5. Copper clad annealed steel wire having a minimum 16 gauge thickness.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.

a. Manufacturers:

**1) AGM Industries, Inc.; CWP-1.**
**2) GEMCO; CD.**
**3) Midwest Fasteners, Inc.; CD.**

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

    a. Manufacturers:

        **1) AGM Industries, Inc.; CWP-1.**
        **2) GEMCO; Cupped Head Weld Pin.**
        **3) Midwest Fasteners, Inc.; Cupped Head.**

3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Manufacturers:

        **1) AGM Industries, Inc.; RC-150.**
        **2) GEMCO; R-150.**
        **3) Midwest Fasteners, Inc.; WA-150.**

    b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

4. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Manufacturers:

        **1) GEMCO.**
        **2) Midwest Fasteners, Inc.**

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy.

1. Manufacturers:

    **a. C & F Wire.**
    **b. Childers Products.**
    **c. PABCO Metals Corporation.**

## 2.14 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

## PART 3 - EXECUTION

### 3.1 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. For penetrations of assemblies with fire resistance rating greater than one hour. See all sections in Division.

C. Piping Systems Conveying Fluids Below Ambient Temperature:

1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:

1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Polyisocyanurate Foam Insulation Extruded Polystyrene Insulation:

1. Wrap elbows and fitting with vapor retarder tape.
2. Seal butt joints with vapor retarder tape.

F. Hot Piping Systems 140 degrees F or less:

1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

G. Inserts and Shields:

1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.

    a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
    b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.

3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

H. Insulation Terminating Points:

1. Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the control valve.
2. Condensate Piping: Insulate entire piping system and components to prevent condensation.

I. Closed Cell Elastomeric Insulation:

1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer’s recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.

K. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o’clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

L. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

M. Heat Traced Piping Interior to Building: As recommended by Heat Trace System Manufacturer.

N. Heat Traced Piping Exterior to Building: As recommended by Heat Trace System Manufacturer.

O. Prepare pipe insulation for finish painting.

## 3.2 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:

1. Insulate entire equipment surfaces.
2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Fluids 140 degrees F Or Less:

1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

F. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.

G. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.

H. Cover insulation with aluminum jacket.

I. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

J. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

K. Prepare equipment insulation for finish painting.

## 3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies.

## 3.4 SCHEDULES

A. Water Supply Services Piping Insulation Schedule:

| PIPING SYSTEM | INSULATION TYPE | PIPE SIZE | INSULATION THICKNESS inches |
|---|---|---|---|
| Domestic Hot Water Supply and Recirculation | P-1 | 1-1/4 inches and smaller<br>1-1/2 inches and larger | 1.0<br>2.0 |
| Domestic Hot Water Supply and Recirculation systems with domestic water temperature maintenance cable | P-1 | 1 inch and smaller<br>1-1/4 inches to 2 inches<br>2-1/2 inches and larger | 1.0<br>1.5<br>2.0 |
| Domestic Cold Water (Exposed) | P-1 or P-5 | 1-1/4 inches and smaller<br>1-1/2 inches and larger | 0.75<br>1.0 |
| Deionized Water | P-1 or P-5 | All sizes | 1.0 |

B. Drainage Services Piping Insulation Schedule:

| PIPING SYSTEM | INSULATION TYPE | PIPE SIZE | INSULATION THICKNESS inches |
|---|---|---|---|
| Storm Piping (horizontal above ground within building) | P-1 or P-5 | All sizes | 1.0 |
| Sanitary Sewer Piping (Exposed) | P-1 or P-5 | All sizes | 1.0 |

C. Equipment Insulation Schedule:

| EQUIPMENT | INSULATION TYPE | INSULATION THICKNESS inches |
|---|---|---|
| Roof Drain Bodies | E-2 | 1.0 |
| Domestic Hot Water Storage Tanks | E-1 E-2 | 2.0 |
| Domestic Water Storage Tanks | E-1, E-2, | 2.0 |
| Domestic Water Booster Pump Bodies | E-5 | 1.0 |
| Water Softeners and Tanks | E-1, E-2, | 2.0 |

## 3.5 DOMESTIC WATER HEAT EXCHANGER INSULATION SCHEDULE

A. Round, exposed breeching and connector insulation shall be the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

B. Round, concealed breeching and connector insulation shall be the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

C. Rectangular, exposed breeching and connector insulation shall be the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

D. Rectangular, concealed breeching and connector insulation shall be the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

## 3.6 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Grease Waste Piping, All Sizes, Where Heat Tracing Is Installed: Cellular glass, 2 inches thick.

## 3.7 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 22 07 00

# SECTION 22 11 00-FACILITY WATER DISTRIBUTION

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section Includes:

1. Domestic water piping, within 5 feet of building.
2. Domestic water piping, above grade.
3. Pressure gages.
4. Pressure gage taps.
5. Thermometers.
6. Flow control valves.
7. Water pressure reducing valves.
8. Relief valves.
9. Strainers.
10. Hose bibs.
11. Hydrants.
12. Wall box outlet.
13. Backflow preventers.
14. Water hammer arrestors.
15. Thermostatic mixing valves.
16. Pressure balanced mixing valves.

### 1.2 REFERENCES

A. Comply with appropriate standards.

1. American National Standards Institute: ANSI
2. American Society of Mechanical Engineers: ASME
3. American Society of Sanitary Engineering: ASSE
4. ASTM International: American Society of Testing and Materials: ASTM
5. American Welding Society: AWS
6. American Water Works Association: AWWS
7. Manufacturers Standardization Society of the Valve and Fittings Industry: MSS
8. National Electrical Manufacturers Association: NEMA
9. Plumbing and Drainage Institute: PDI
10. Underwriters Laboratories Inc.: U.L.
11. Los Angeles Plumbing Code: LAPC
12. Los Angeles Department of Building and Safety: LADBS
13. National Sanitation Foundation: NSF

## 1.3 SUBMITTALS

A. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturer's catalog information.
2. Domestic Water Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.

B. Manufacturer's Installation Instructions: Submit installation instructions for pumps, valves and accessories.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

## 1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of valves and equipment.

B. Operation and Maintenance Data: Submit spare parts list, exploded assembly views and recommended maintenance intervals.

## 1.5 WARRANTY

A. Furnish one-year minimum warranty.

# PART 2 - PRODUCTS

## 2.1 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Copper Tubing: ASTM B88, Type K, hard drawn.

1. Fittings: ASME B16.18, cast copper alloy ASME B16.22, wrought copper and bronze Annex G NSF/ANSI 61.
2. Joints:

a. Soldered – ASTM B32 E & HB lead-free allow, with water soluble flux per ASTM B-13.
b. Press-fit – ASTM B75; NSF 61, C.S.A., UPC listed and approved; 250 degree F – 200 PSI; compatible with ASTM B88 seamless copper; with elastomeric EPDM seals.

B. Copper Tubing: ASTM B88 Type L, annealed soft copper, to trap primers – fittings and joints not allowed.

C. Ductile-Iron Pipe And Fittings

1. Mechanical-Joint, Thickness Class 54, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

    a. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
    b. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.

        1) Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

## 2.2 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tubing: ASTM B88, Type L hard drawn.

1. Fittings: ASME B16.18, cast copper alloy ASME B16.22, wrought copper and bronze Annex G NSF/ANSI 61.
2. Joints:

    a. Soldered – ASTM B32 E & HB lead-free allow, with water soluble flux per ASTM B-13.
    b. Press-fit – ASTM B75; NSF 61, C.S.A., UPC listed and approved; 250 degree F – 200 PSI; compatible with ASTM B88 seamless copper; with elastomeric EPDM seals.

B. Copper Tubing: ASTM B88, Type L, rolled grooved ends.

1. Fittings: ASME B16.18 cast copper alloy, or ASME B16.22 wrought copper and bronze, grooved ends.
2. Joints: Grooved mechanical couplings meeting ASTM F1476.

    a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, enamel coated, compatible with copper tubing sizes, to engage and lock designed to permit some angular deflection, contraction, and expansion.
    b. Gasket: Elastomer composition for operating temperature range to 200 degrees F.
    c. Accessories: Stainless steel bolts, nuts, and washers.

## 2.3 PIPE JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

## 2.4 CORROSION PROTECTION PIPING ENCASEMENT

A. Encasement for Underground Metal Piping:

1. Standards: ASTM A 674 or AWWA C105.
2. Form: Sheet or tube.
3. Material: LLDPE film of 0.008-inch minimum thickness.
4. Material: LLDPE film of 0.008-inch minimum thickness, or high-density, crosslaminated PE film of 0.004-inch minimum thickness.
5. Material: High-density, crosslaminated PE film of 0.004-inch minimum thickness.
6. Color: Black.

## 2.5 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

## 2.6 WATER METERS

A. Displacement-Type Water Meters:

1. Manufacturers:

**a. Badger Meter, Inc.**
**b. Neptune.**
**c. Sensus Metering Systems.**

2. Description:

a. Standard: AWWA C700, and C710 Standards.
b. Pressure Rating: 150-psig working pressure.
c. Temperature Rating: -40° to + 150° F.
d. Registration: In gallons or cubic feet as required by LAWA.
e. Case: Bronze.
f. End Connections: Threaded.
g. Remote read per AWWA Standard C706.

3. Magnetic drive, type meter with 150 psig bronze body, lined cast iron frost proof body, threaded ends, internal strainer, wheel encoder register and receptacle.

B. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by LAWA.

C. Remote Registration System: Encoder type complying with AWWA C707; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by LAWA.

## 2.7 UNIONS AND FLANGES

A. Unions for Pipe 2-1/2 inches and Smaller:

1. Ferrous Piping: Class 150, malleable iron, threaded.
2. Copper Piping: Class 150, bronze unions with brazed joints.
3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Flanges for Pipe 2-1/2 inches and Larger:

1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
2. Copper Piping: Class 150, slip-on bronze flanges.
3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

## 2.8 PRESSURE GAGES

A. Manufacturers:

**1. Ametek, Inc.**
**2. Trerice.**
**3. Weiss.**

B. Gage: ASME B40.1, with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.

1. Case: Cast aluminum.
2. Bourdon Tube: Copper plated brass.
3. Dial Size: 6 inch diameter.

## 2.9 PRESSURE GAGE TAPS

A. Manufacturers:

**1. Ametek, Inc.**
**2. Trerice.**
**3. Weiss.**

## 2.10 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.

C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.

D. One Piece, Stamped Steel: Chrome-plated finish with setscrew.

E. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.

F. Split Plate, Stamped Steel: Chrome-plated finish with concealed hinge.

G. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

H. Split-Casting Floor Plates: Cast brass with concealed hinge.

## 2.11 WALL PENETRATION SYSTEMS

A. Manufacturer:

**1. SIGMA.**

B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.

1. Carrier-Pipe Deflection: Up to 5 percent without leakage.
2. Housing: Ductile-iron casting with hub, waterstop, anchor ring, and locking devices. Include gland, bolts, and nuts.
3. Housing-to-Sleeve Gasket: EPDM rubber.
4. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber.
5. Pipe Sleeve: AWWA C151, ductile-iron pipe or ASTM A 53/A 53M, Schedule 40, zinc-coated steel pipe.

## 2.12 STEM TYPE THERMOMETERS

A. Manufacturers:

**1. Ashcroft.**
**2. Trerice.**
**3. Weiss.**

B. Thermometer: ASTM E1, red appearing mercury, lens front tube, cast aluminum case with enamel finish.

1. Size: 6” scale.
2. Window: Clear glass.

3. Stem: Copper plated brass, 3/4 inch NPT, 3-1/2 inch long.
4. Accuracy: ASTM E77. Plus or minus 1 percent to 1.5 max of range.
5. Calibration: Degrees F.

## 2.13 FLOW CONTROL VALVES

A. Manufacturers:

**1. Bell & Gossett.**
**2. Griswold.**
**3. Flocon.**

B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, combination blow-down or back-flush drain.

C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 5 psi.

## 2.14 WATER PRESSURE REDUCING VALVES

A. Manufacturers:

**1. Zurn-Wilkins.**
**2. Conbraco.**
**3. Watts.**

B. 2 inches and Smaller: MSS SP 80, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded and single union double union ends.

C. 2 inches and Larger: MSS SP 85, cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged.

## 2.15 TEST PLUGS

A. Manufacturers:

**1. Peterson.**
**2. Sisco.**
**3. Watts.**

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for water service at 20 to 200 deg F shall be CR.
2. Insert material for water service at minus 30 to plus 275 deg F shall be EPDM.

E. Test Kit: Furnish two test kit(s) containing one pressure gage and adaptor, two thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
2. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
3. Carrying case shall have formed instrument padding.

## 2.16 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers:

**a. Watts.**
**b. Zurn.**
**c. Conbraco.**

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Chrome plated.
7. Equal to Watts No. 288A.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers:

**a. Watts.**
**b. Zurn.**
**c. Conbraco.**

2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.
6. Equal to Watts No. NF8 or No. 8A.

C. Pressure Vacuum Breakers:

1. Manufacturers:

**a. Watts.**
**b. Zurn.**
**c. Conbraco.**

2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Accessories: Ball type, on inlet and outlet.

D. Spill-Resistant Vacuum Breakers:

1. Manufacturers:

**a. Watts.**
**b. Zurn.**
**c. Conbraco.**

2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Accessories:

a. Valves: Ball type, on inlet and outlet.

## 2.17 RELIEF VALVES

A. Manufacturers:

**1. Conbraco.**
**2. Watts.**
**3. Zurn-Wilkins.**

B. Pressure Relief:

1. ANSI Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.

C. Temperature and Pressure Relief:

1. ANSI Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME certified and labeled.

## 2.18 STRAINERS

A. Manufacturers:

**1. Conbraco.**
**2. Watts.**

**3. Zurn-Wilkins.**

B. 2 inch and Smaller: Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

C. 3 inch and Larger: Class 125, flanged iron body, basket pattern with type 304 1/8 inch stainless steel perforated screen.

## 2.19 HOSE BIBS

A. Manufacturers:

**1. Acorn Mfg.**
**2. MIFAB.**
**3. J.R. Smith.**

B. Rough-Bronze body with integral wall flange, threaded or soldered end, replaceable disc, hose thread spout, with lock shield and removable key integral and non-removable vacuum breaker in conformance with ASSE 1011.

C. Provide rough-chrome or polished chrome finish as required.

## 2.20 HYDRANTS

A. Manufacturers:

**1. Acorn Mfg.**
**2. MIFAB.**
**3. Zurn.**

B. Wall Hydrant: ASSE 1019; non-freeze, self-draining type with chrome plated, or polished bronze; wall plate lockable recessed box hose thread spout, hand wheel lock shield and removable key, and integral non-removable vacuum breaker.

C. Floor Hydrant: ASSE 1019; chrome plated polished bronze; lockable recessed box, hose thread spout, lock shield and removable key, or non-removable vacuum breaker.

## 2.21 RECESSED VALVE BOX

A. Manufacturers:

**1. I.P.S. Corp.**
**2. Sioux Chief Mfg.**

B. Washing Machine: Water tight recessed plastic, preformed rough-in box, ½" copper connections with chrome ¼ turn ball valves; integral water hammer arrestors; 2" center drain outlet.

C. Refrigerator: Plastic water-tight recessed plastic, preformed rough-in box, ½" copper connection with chrome ¼ turn ball valve preformed rough-in box with brass valves with wheel handle slip finishing cover.

## 2.22 BACKFLOW PREVENTERS

A. Manufacturers:

1. **Conbraco Ind.**
2. **Watts.**
3. **Zurn-Wilkins.**

B. Reduced Pressure Principle Backflow Preventers:

1. Comply with ASSE 1013 for continuous pressure operations.
2. Bronze body, with bronze internal parts and stainless steel springs.
3. Two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve opening under back pressure in case of diaphragm failure; non-threaded vent outlet; integral with two gate valves, strainer, and four test cocks.

C. Double Check Valve Assemblies: Comply with ASSE ASSE 1015 or AWWA C510; Bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.

## 2.23 WATER HAMMER ARRESTORS

A. Manufacturers:

1. **MIFAB.**
2. **Watts.**
3. **Zurn-Wilkins**.

B. ASSE 1010; copper construction, bellows or piston type sized in accordance with PDI WH-201.

C. Pre-charged suitable for 35 to 100 degrees temperature range, working pressure.

D. Provide distribution box as required.

## 2.24 THERMOSTATIC MIXING VALVES

A. Manufacturers:

1. **Watts.**
2. **Zurn**
3. **Simmons Ind.**

B. Master Mixing Valves

1. Bronze body and cap with replaceable corrosion-resistant stainless steel piston and liner.
2. Factory assembly shall include: Check stops, thermometer removable strainers, inlet and outlet ball-type shut-off valves.
3. Provide recessed or surface mounted cabinet, stainless steel or white enamel.
4. Hi-low or standard type valve assembly shall comply with ASSE 1017, U.P.C. and C.S.A. for 125 PSI max. operating pressure, 200 degrees max. inlet temperature, for 5 G.P.M. min. flow.

C. Point-of-Use Mixing Valves

1. For lavatory or sink faucets – 0.5 G.P.M. min. flow capacity.
2. Integral adjustable set-point and in-line check stops.
3. 105 degree maximum outlet temperature.

## 2.25 PRESSURE BALANCED MIXING VALVES

A. Manufacturers:

**1. Symmons Ind.**
**2. Watts.**
**3. Zurn.**

B. Valve: Chrome plated cast brass body, stainless steel cylinder and integral temperature adjustment.

C. Accessories:

1. Volume control shut-off valve on outlet.
2. Stem thermometer on outlet.
3. Strainer stop checks on inlets.

D. Provide recessed or surface mounted cabinet, stainless steel or white enamel, as required.

## 2.26 WATER FILTERS

A. In-line cold water filter for up to 1.3 GPM capable of removing dirt/rust, odor and scale.

1. Manufacturer:

**a. Everpure.**

B. On cold water lines for the following:

1. Coffee makers.
2. Electric water coolers.

3. Refrigerators.
4. Ice makers.

## 2.27 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

## 2.28 TRAP SSEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

1. Manufacturers:

**a. PPP Inc. Solo Prime for single traps.**
**b. PPP Inc. Mini Prime for up to four traps.**

2. Standard: ASSE 1044,
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: Recessed-mounting steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
6. Vacuum Breaker: ASSE 1001.
7. Size Outlets: NPS 1/2.

# PART 3 - EXECUTION

## 3.1 INSTALLATION - ABOVE GROUND PIPING

A. Install non-conducting dielectric connections wherever jointing dissimilar metals.

## 3.2 INSTALLATION - SERVICE CONNECTIONS

A. Provide new water service complete with approved reduced pressure double check back-flow preventer and water meter with by-pass valves pressure reducing valve, and strainer as required.

B. Provide sleeve in wall for service main and support at wall with reinforced-concrete bridge. Caulk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.

C. Provide 18 gage galvanized sheet metal sleeve around service main to 6 inch above floor and 6 feet minimum below grade. Size for minimum of 2 inches of loose batt insulation stuffing.

END OF SECTION 22 11 00

# SECTION 22 13 00-FACILITY SANITARY SEWERAGE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Sanitary sewer piping buried beyond 5 feet of building.
2. Sanitary sewer piping buried within 5 feet of building.
3. Sanitary sewer piping above grade.
4. Chemical resistant sewer piping.
5. Unions and flanges.
6. Floor drains.
7. Floor sinks.
8. Cleanouts.
9. Backwater valves.
10. Sumps.
11. Interceptors.
12. Manholes.
13. Sewage ejectors.
14. Bedding and cover materials.

### 1.2 REFERENCES

A. General: Comply with appropriate standards.

1. American Society of Mechanical Engineers: ASME.
2. American Society of Testing and Materials: ASTM.
3. Cast Iron Soil Pipe Institute: CISPI.
4. Manufacturers Standardization Society of the Valve and Fittings Industry: MSS.
5. Plumbing and Drainage Institute: PDI.
6. Los Angeles Plumbing Code: LAPC.
7. Los Angeles Department of Building and Safety: LADBS.
8. Los Angeles Public Works: LAPW.

### 1.3 SUBMITTALS

A. Submit data on all materials, fittings, accessories and equipment.

B. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

D. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes for sewage-ejectors, and manholes.

E. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
2. Sanitary Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
3. Pumps: Submit pump type, capacity, certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

F. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.

G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

H. Product Data: For grease interceptor indicated. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.

I. Shop Drawings: For each type and size of pre-cast concrete interceptor indicated.

1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.
2. Include calculations for aircraft loading.

J. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Interceptors.
2. Piping connections. Include size, location, and elevation of each.
3. Interface with underground structures and utility services.
4. Coordinate installation with site utility and site paving contractor to prevent interceptor damage.

## 1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of equipment and clean-outs.

B. Operation and Maintenance Data: Submit frequency of treatment required for interceptors. Include, spare parts lists, exploded assembly views for pumps and equipment.

## 1.5 WARRANTY

A. Furnish one-year minimum warranty.

## PART 2 - PRODUCTS

### 2.1 SANITARY SEWER PIPING, BURIED BEYOND 5 FEET OF BUILDING

A. Coordinate with Civil Engineer.

B. Ductile-Iron Pipe and Fittings

1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

    a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    b. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
2. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

    1) Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    2) Gaskets: AWWA C111, rubber.

3. Flanges: ASME 16.1, Class 125, cast iron.

C. Vitrified Clay Pipe: Pipe and fittings shall be extra strength or high strength manufactured in accordance with ASTM C700.

D. ABS Pipe: Pipe, fittings and joints shall comply with codes and standards in effect at time of installation.

E. Drainage Fittings: ASME B16.12, galvanized, threaded, cast-iron drainage pattern.

F. Pressure Fittings:

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
4. Cast-Iron Flanges: ASME B16.1, Class 125.
5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.

### 2.2 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Soil Pipe: CISPI, ASTM A888 service weight, hubless, aboveground.

1. Fittings: Cast iron, ASTM A888 and CISPI – with stainless steel clamp and shield assembly.
2. Joints: CISPI ASTM C564, rubber gasket joint devices.

3. Manufacturers – Heavy Duty Stainless Steel Couplings

    **a. Husky SD 4000.**
    **b. Clamp-All Corp.**
    **c. Ideal Corp.**

4. Manufacturers – Heavy Duty Cast or Ductile Iron Couplings

    **a. MG Piping Products.**
    **b. Victaulic.**

B. Ductile-Iron Pipe and Fittings

1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

    a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    b. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

    1) Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    2) Gaskets: AWWA C111, rubber.

3. Flanges: ASME 16.1, Class 125, cast iron.

C. ABS Pipe: Pipe, fittings and joints shall comply with codes and standards in effect at time of installation.

## 2.3 SANITARY SEWER PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI, ASTM A888, hub-less, service weight, hubless.

1. Fittings: Cast iron, CISPI, ASTM A888.
2. Joints: CISPI, ASTM C564, rubber gaskets and stainless steel clamp-and-shield assemblies.

B. Copper Tube: ASTM B306, DWV. Type L.

1. Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper.
2. Joints:

    a. Solder - ASTM B32, Alloy Grade Sb5 tin-antimony.
    b. Press-Fit-ASTM B75; NSF 61; C.S.A., UPC Listed and Approved; 250 Degree F, 200 PSI.

C. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized.

1. Fittings: Cast Iron, ASME B16.1, flanges and fittings or ASME B16.4, threaded fittings.
2. Fittings: Malleable Iron, ASME B16.3, threaded type ASTM A47/A47M.
3. Joints: Threaded for pipe 2 inch and smaller; flanged for pipe 2-1/2 inches and larger.

D. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized, grooved ends.

1. Fittings: ASTM A395/A395M and ASTM A536 ductile iron, or ASTM A234/A234M carbon steel, grooved ends.
2. Joints: Grooved mechanical couplings meeting ASTM F1476.

    a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, enamel coated hot dipped galvanized, compatible with steel piping sizes, rigid or flexible type.
    b. Gasket: Elastomer composition for operating temperature range from -30 86 degrees F to 230 180 degrees F.
    c. Accessories: Steel Stainless steel bolts, nuts, and washers.

## 2.4 CHEMICAL RESISTANT SEWER PIPING

A. Cast Iron Pipe: CISPI 301, hubless, service weight, aboveground.

1. Fittings: Cast iron, CISPI 301.
2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

B. ABS Pipe: ASTM D2751 or ASTM F628, Acrylonitrile-Butadiene-Styrene (ABS) material.

1. Fittings: ABS, ASTM D2751.
2. Joints: ASTM D2235, solvent weld.

C. PVC Pipe: ASTM D2729 or ASTM D2665, polyvinyl chloride (PVC) material.

1. Fittings: PVC, ASTM D2729 or ASTM D2665.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

D. Glass Pipe: ASTM C1053, borosilicate glass material.

1. Fittings: ASTM C1053, borosilicate glass.
2. Joints: Stainless steel compression couplings with tetra-fluoroethylene seal ring.

E. PP PPFR Pipe: Polypropylene, flame retardant.

1. Fittings: Polypropylene.
2. Joints: Electrical resistance fusion.

## 2.5 SPECIAL PIPE FITTINGS

A. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for

expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

   **a. EBAA Iron Sales, Inc.**
   **b. Romac Industries, Inc.**
   **c. Star Pipe Products; Star Fittings Div.**

B. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Manufacturers:

   **a. SIGMA Corp.**

## 2.6 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Description: ASTM A 674 or AWWA C105, LLDPE film of 0.008-inch minimum thickness.

B. Form: tube.

C. Color: Black.

## 2.7 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:

1. Copper Piping: Class 150, bronze unions with soldered brazed joints.
2. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Flanges for Pipe 2-1/2 inches and Larger:

1. Copper Piping: Class 150, slip-on bronze flanges.
2. Gaskets: 1/16 inch thick preformed neoprene gaskets.

## 2.8 FLOOR DRAINS

A. Manufacturers:

**1. J.R. Smith.**
**2. Zurn.**
**3. MiFAB.**

B. Floor Drain: Shall be ductile, cast or grey iron body with double drainage flange, weep holes, anchor flange, round or square, adjustable nickel-bronze strainer, trap primer inlet, white acid resistant interior-size as required.

C. Provide heavy-duty traffic weight grate, sediment bucket, or stainless steel type where required.

D. Furnish materials in accordance with Sate of California Codes and City of Los Angeles Department of Building and Safety Standards.

E. Cast-Iron Floor Drains:

1. Manufacturers:

   **a. J.R.Smith.**
   **b. MIFAB, Inc.**
   **c. Zurn.**

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Outlet: Bottom.
6. Backwater Valve: Integral, ASME A112.14.1, swing-check type.
7. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
8. Top or Strainer Material: Nickel bronze.
9. Top of Body and Strainer Finish: Nickel bronze.
10. Top Shape: Round.
11. Top Loading Classification: Heavy Duty.
12. Trap Material: Cast iron.
13. Trap Pattern: Deep-seal P-trap.
14. Trap Features: Trap-seal primer valve drain connection.

F. General:

1. In accordance with ANSI A112.21.1 and where required for the following construction types. For built up membrane, provide a flashing clamp. For liquid membrane, provide a four inch wide flange. For elastomeric type floor, provide a four inch wide top flange at required height. Provide strainers with a nickel bronze finish except as noted.
2. Provide a coated cast iron body, except as noted, with integral double drainage flange and weep holes, inside caulked outlet or hub outlet for compression gasket connection, or hubless outlet except as noted.
3. Type, General, Shown Round: An adjustable extension neck and 6-inch diameter cast strainer, flashing clamp for membrane, equal to MIFAB 1100C, Smith No. 2010-A or Zurn ZN-415-6B. Floor drains with back water valves, equal to MIFAB 1100C-B, Smith No. 2010-AV or Zurn ZN415-6B-V. 6-inch x 6-inch strainers in kitchens equal to Smith No. 2010-B or Zurn ZN-415-6S, MIFAB F1100C-X.
4. Type, Showers: 6-inch diameter strainers for 3-inch outlet size and five-inch diameter strainers for 2-inch outlet size.

5. Type, In machinery rooms and unfinished areas shown round, adjustable cast iron extension neck and tractor type top grate, equal to MIFAB F1320C, Smith No. 2320 or Zurn Z520.
6. Type, In machinery rooms and unfinished areas shown square, adjustable cast iron extension neck and maximum diameter bottom bar strainer on short legs, equal to MIFAB F1320C, Smith No. 2320 or Zurn Z520 for 3-inch outlet and MIFAB 1340, Smith 2340 for 4 inch and 6-inch outlet modified without top grate.
7. Type, Shown square in kitchens and where noted. As noted above for floor drains in kitchens shown round or square, plus funnel where required.

    a. For drains receiving single indirect waste, provide strainer with matching 4-inch diameter x 3-1/4 inch high secured funnel, equal to MIFAB F4, Smith No. 3580 or Zurn Z-328-4.
    b. For drains receiving multiple indirect wastes, provide with matching 83 inch x 33 inch x 3 inch high secured funnel, equal to MIFAB G, Smith No. 3591 or Zurn Z-329-9.
    c. Where indirect waste is too low for standard funnel, provide strainer with matching 6 inch x 2½ inch x 1 inch high secured funnel, equal to MIFAB-J, Smith No. 3590 or Zurn-Z329-7.

8. Type, Vegetable Peeler Drain: An adjustable cast iron extension neck and deep removable bucket, equal to MIFAB F1340-14-5, Smith No. 2360 or Zurn Z526-Y.
9. Type, Can Wash Area: An adjustable cast iron extension neck and deep removable bucket, equal to MIFAB F1480-5, Smith No. 2630 (less top grate) or Zurn Z566-6T-Y-L6.
10. Type, Pit Wall Drain: Side outlet body and brass flap type backwater valve and bronze wall grate, equal to MIFAB BV1210, Smith No. 7000 or Zurn Z-629.
11. Type, Walk in Areaway Drain: Bottom outlet and flat strainer, equal to MIFAB F1320-Y-14, Smith No. 2110 or Zurn Z550 and with side outlet and flat strainer, equal to MIFAB F-1320C-90-Y-14, Smith No. 2115 or Zurn Z550-90.
12. Type, For Other Areaways: Bottom outlet and dome strainer, equal to MIFAB F1320C-Y-14-18, Smith No. 2110 D or Zurn 2550-D and with side outlet and dome strainer, equal to MIFAB F1320C-Y-14-18, Smith No. 2115-D or Zurn Z550-D-90.
13. Type, for Elastomeric Type Floors: Four-inch wide top flange at required depth. Shown round provide drain equal to MIFAB F1320-Y-14-5-2, Smith No. DX 2565 or Zurn Z-531 less bucket. Shown square Type , provide with maximum diameter bottom bar strainer, MIFAB F1340-Y-2-5-14, equal to Smith No. DX-2566 or Zurn Z532-LG modified without top grate.
14. Type, Flushing Rim Floor Drain: Acid resistant porcelain enamel inside and flushing connection and brass flushing rim top with.

## 2.9 FLOOR SINKS

A. Manufacturers:

**1. J.R. Smith.**
**2. Zurn.**
**3. MiFAB.**

B. Floor Sink: Shall be ductile, cast or grey iron body with double drainage flange, weep holes, anchor flange, round or square, or ½ or ¾ nichel-bronze grate, trap primer inlet, white acid resistant enamel interior-size as required.

C. Provide heavy-duty traffic weight grate, sediment bucket, or stainless steel type where required.

D. Cast-Iron Floor Sinks Except as Noted:

1. Manufacturers:

   **a. J.R. Smith.**
   **b. MIFAB, Inc.**
   **c. Zurn**

2. Standard: ASME A112.6.3.
3. Pattern: Indirect waste receptors.
4. Body Material: Gray iron.
5. Outlet: Bottom.
6. Backwater Valve: Integral, ASME A112.14.1, swing-check type.
7. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
8. Top or Strainer Material: Cast iron.
9. Top of Body and Strainer Finish: Cast iron.
10. Top Shape: Round, square.
11. Top Loading Classification: Heavy Duty.
12. Trap Material: Cast iron.
13. Trap Pattern: P-trap.
14. Trap Features: Trap-seal primer valve drain connection.

E. General:

1. In accordance with ANSI A112.21.1 and where required for the following construction types. For built up membrane, provide a flashing clamp. For liquid membrane, provide a four inch wide flange. For elastomeric type floor, provide a four inch wide top flange at required height. Provide strainers with a nickel bronze finish except as noted.
2. Provide a coated cast iron body, except as noted, with integral double drainage flange and weep holes, inside caulked outlet or hub outlet for compression gasket connection, or hubless outlet except as noted.
3. Type FS-1, General, Shown Square: An adjustable extension neck and 6-inch diameter cast strainer, flashing clamp for membrane, adjustable cast iron extension neck and tractor type top grate, equal to MIFAB FS-1730-FL-150, Smith No. 3150-Y-C-12 or Zurn Z520,
4. Type FS-2, In plumbing chases shown round, adjustable cast iron extension neck, bottom dome strainer, equal to MIFAB FS-1750-FL or Smith No. 3040-Y.

   a. For floor sinks receiving indirect waste, provide ½ grate strainer and frame.
   b. For round floor sinks, provide full round strainer and grate.

## 2.10 CLEANOUTS

A. Manufacturers:

1. **J.R. Smith.**
2. **Zurn.**
3. **MiFAB.**

B. Exterior Surfaced Areas: Round or Square lacquered cast iron body with anchor flange, neoprene gasket, adjustable access cover and plug top assembly.

C. Exterior Unsurfaced Areas: Line type with lacquered cast iron body and round epoxy coated cover with gasket.

D. Interior Finished Floor Areas: Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round scored cover with gasket in service areas and round square depressed cover with gasket to accept floor finish in finished floor areas.

E. Interior Finished Wall Areas: Cast bronze or cast iron body raised head plug, gasket, round or square stainless steel access cover secured with machine screw.

F. Interior Unfinished Accessible Areas: Threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

## 2.11 BACK WATER VALVES

A. Manufacturers:

1. **J.R. Smith.**
2. **Zurn.**
3. **MiFAB.**

B. Cast Iron: ASME A112.14.1; cast iron body and cover, removable bronze swing valve, extension sleeve as required, Bolted access cover, horizontal or vertical type, threaded or hubless ends.

## 2.12 SUMPS

A. Manufacturers:

1. **Pro-Cast Inc.**
2. **Jensen.**
3. **Zoeller.**

B. Water-tight, factory fabricated; reinforced fiberglass or concrete; sleeved inlet, outlet and vent openings. Provide sidewall openings for pipe and vent connections.

C. Cover shall have integral seals, gaskets and bushings, sized for sump access.

D. Exterior locations shall have hinged and lockable traffic weight covers.

E. Furnish materials in accordance with Sate of California Codes and City of Los Angeles Department of Building and Safety Standards.

## 2.13 GREASE INTERCEPTORS

A. Manufacturers:

1. **Pro-Cast Inc.**
2. **Jensen Precast.**
3. **Pro-Ceptor.**

B. Furnish materials in accordance with Sate of California Codes and City of Los Angeles Department of Building and Safety Standards.

C. Comply with LAC – industrial waste division requirements.

D. Construction:

1. Material: Per equipment schedule and details.
2. Rough in: Below grade.

E. Accessories: Integral baffle, deep seal trap, sample box.

F. Cover: Heavy duty steel with gasket, liquid tight, bolt-down frame.

## 2.14 OIL INTERCEPTORS

A. Manufacturers:

1. **Zurn.**
2. **Pro-Cast Inc.**
3. **Jensen Precast.**

B. Construction:

1. Material: Epoxy coated fabricated steel, or pre-cast concrete.
2. Rough in: Flush with floor (suspended) installation with anchor flange.

C. Accessories: Integral deep seal trap, removable, adjustable draw-off assembly, sediment bucket.

D. Cover: Steel, epoxy coated, non-skid with gasket, securing handle.

E. Cover shall have integral seals, gaskets and bushings, sized for sump access.

F. Exterior locations shall have hinged and lockable traffic weight covers.

## 2.15 SEDIMENT INTERCEPTORS

A. Manufacturers:

1. **Zurn.**
2. **Pro-Cast Inc.**
3. **Jensen Precast.**

B. Construction:

1. Material: Epoxy coated fabricated steel, or pre-cast concrete.
2. Rough in: Flush with floor (suspended) installation with anchor flange.

C. Accessories: Integral deep seal trap, removable, adjustable draw-off assembly, sediment bucket.

D. Cover: Steel, epoxy coated, non-skid with gasket, securing handle.

E. Cover shall have integral seals, gaskets and bushings, sized for sump access.

F. Exterior locations shall have hinged and lockable traffic weight covers.

## 2.16 MANHOLES

A. Coordinate with Civil Engineer.

## 2.17 PRECAST CONCRETE MANHOLE RISERS

A. Extra-Heavy Duty Precast Concrete Manhole Risers: ASTM C 478, with rubber-gasket joints.

1. Structural Design Loads:

   a. Extra-Heavy Duty -Traffic Load.

2. Length: From top of underground concrete structure to grade.
3. Riser Sections: 3-inch minimum thickness and 36-inch diameter.
4. Top Section: Eccentric cone, unless otherwise indicated. Include top of cone to match grade ring size.
5. Gaskets: ASTM C 443, rubber.

B. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.

C. Extra-Heavy Duty 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.

1. Ductile Iron: ASTM A 536-80, Grade 100-70-03, or stronger, rated at 100,000 pounds.
2. Include indented top design with lettering cast into cover, using wording equivalent to the following:

a. Grease Interceptors in Sanitary Sewerage System: "GREASE INTERCEPTOR."

## 2.18 SEWAGE EJECTORS

A. Manufacturers:

1. **Weil Aquatronics.**
2. **Paco.**
3. **Zoeller.**

B. Type: Vertical centrifugal, direct connected, simplex duplex arrangement.

C. Casing: Cast iron volute with radial clearance around impeller, slide away couplings.

D. Impeller: Cast iron; open non-clog, keyed and secured to stainless steel shaft.

E. Support: Cast iron pedestal motor support on steel floor plate with gas tight gaskets.

F. Bearings: Oil lubricated bronze sleeve spaced maximum 48 inches and grease lubricated ball thrust at floor plate.

G. Drive: Flexible coupling to vertical, solid shaft ball bearing electric motor.

H. Sump: Steel cover plate with steel curb frame for grouting sump with inspection opening and cover, and alarm fittings.

I. Controls (Duplex): Float operated mechanical alternator with float rod, stops, and corrosion resistant float to alternate operation of pumps. Cut-in second pump on rising level or lead pump failure. Furnish separate pressure switch high level alarm with transformer, alarm bell, and standpipe, and extra set of wired terminals for remote alarm circuit and emergency float switch with float rod, stops, and corrosion resistant float to operate both pumps on failure of alternator. Provide NEMA 250, Type 1 enclosure.

## 2.19 SUBMERSIBLE SEWAGE EJECTORS

A. Manufacturers:

1. **Weil Aquatronics.**
2. **Paco.**
3. **Zoeller.**

B. Type: Completely submersible, vertical, centrifugal.

C. Casing: Cast iron pump body and oil filled motor chamber.

D. Impeller: Cast iron; open non-clog, stainless steel shaft.

E. Bearings: Ball bearings.

F. Sump: Fiberglass, steel or concrete with steel cover plate.

G. Accessories: Oil resistant cord and plug, with three-prong connector, for connection to electric wiring system including grounding connector.

H. Servicing: Slide-away coupling consisting of discharge elbow secure to sump floor, movable bracket, guide pipe system, lifting chain and chain hooks.

I. Controls: Integral level controls, with separate high level alarm.

J. Controls: Motor control panel containing across-the-line electric motor starters with ambient compensated quick trip overloads in each phase with manual trip button and reset button, circuit breaker, control transformer, electro-mechanical alternator, hand-off-automatic selector switches, pilot lights, high water alarm pilot light, reset button and alarm horn. Furnish mercury switch liquid level controls, steel shell switch encased in polyurethane foam with cast iron weight for pump on (each pump), pump off (common), and alarm. Provide NEMA 250, Type 1 enclosure.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

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

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. Field verify that connection to existing piping systems sizes, locations, and invert are as required.

F. Establish elevations of buried piping with not less than allowed per code.

G. Establish minimum separation of from other piping services in accordance with code.

### 3.2 PIPING APPLICATION

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:

1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
2. Steel pipe, drainage fittings, and threaded joints.
3. Stainless-steel pipe and fittings, gaskets, and gasketed joints.

4. Copper DWV tube, copper drainage fittings, and soldered joints.
5. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

C. Aboveground, soil and waste piping NPS 5 and larger shall be the following:

1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
2. Steel pipe, drainage fittings, and threaded joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

D. Aboveground, vent piping NPS 4 and smaller shall be the following:

1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
2. Steel pipe, drainage fittings, and threaded joints.
3. Stainless-steel pipe and fittings gaskets, and gasketed joints.
4. Copper DWV tube, copper drainage fittings, and soldered joints.

    a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.

5. Galvanized steel piping for horizontal offsets of vent headers.

E. Aboveground, vent piping NPS 5 and larger shall be the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Steel pipe, drainage fittings, and threaded joints.
3. Galvanized steel piping for horizontal offsets of vent headers.
4. Stainless steel pipe and fittings gaskets, and gasketed joints

F. Underground, soil, waste, and vent piping NPS 4 and smaller shall be the following:

1. Extra-Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, cast-iron couplings; and hubless-coupling joints.
3. Stainless-steel pipe and fittings, gaskets, and gasketed joints.

G. Underground, soil and waste piping NPS 5 and larger shall be the following:

1. Extra-Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, cast-iron couplings; and hubless-coupling joints.

H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be the following:

1. Galvanized schedule 40 Steel pipe, pressure fittings, and threaded joints.

I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 shall be the following:

1. Galvanized schedule 40 Steel pipe, pressure fittings, and threaded joints.

J. Underground sanitary-sewage force mains NPS 4 and smaller shall be the following:

1. Galvanized schedule 40 Steel pipe, pressure fittings, and threaded joints.

K. Above ground condensate shall be the following:

1. Hard copper ASTM B 88 with pressure fittings or DWV copper ASTM B 306 with drainage fittings.

## 3.3 PIPING INSTALLATION

A. Sanitary sewer piping five feet outside the building is specified in Civil Engineers Section."

B. Provide basic piping installation as required.

C. Install seismic restraints on piping.

D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

E. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

F. Install underground, steel, force-main piping. Install encasement on piping according to ASTM A 674 or AWWA C105.

G. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside the building between wall and floor penetrations and connection to sanitary sewer piping outside the building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

1. Install encasement on piping according to ASTM A 674 or AWWA C105.

H. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Provide sleeves and mechanical sleeve seals as required.

I. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

J. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side

with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 6 and smaller.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow NPS 2 (DN80) and smaller at 1/4 inch per foot minimum.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

O. Hubless piping shall be installed in a rigid, linear, and plumb system without any deflection at the joints either horizontally or vertically. The system shall be supported and secured to the building structure to prevent movement induced by a ten-foot head of water and its associated thrust forces.

1. When horizontal hubless CI piping is suspended in excess of 18 inch by means of non-rigid hangers, provide sway bracing to prevent horizontal movement.
2. For all horizontal hubless CI piping 5-inch and larger, provide sway bracing to prevent horizontal movement at every branch opening and change of direction by securing to building structure, or provide pipe clamps and rodding across coupling.

P. Exterior exposed vent terminations to be stainless steel at through exterior wall penetrations.

## 3.4 HANGER & SUPPORT INSTALLATION

A. Pipe hangers and supports - Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports as required.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 10 feet, 0 inches with 3/8-inch rod.
2. NPS 3: 10 feet, 0 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 10 feet, 0 inches with 5/8-inch rod.
4. NPS 6: 10 feet, 0 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 10 feet, 0 inches with 7/8-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 84 inches with 3/8-inch rod.
2. NPS 3: 96 inches with 1/2-inch rod.
3. NPS 4: 108 inches with 1/2-inch rod.
4. NPS 6: 10 feet with 5/8-inch rod.

J. Install supports for vertical stainless-steel piping every 10 feet.

K. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

L. Install supports for vertical copper tubing every 10 feet.

M. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

## 3.5 SANITARY PIPING INSTALLATION

A. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

I. Install through-penetration firestop assemblies in plastic at floor penetrations.

J. Assemble open drain fittings and install with top of hub 2 inches above floor.

K. Install deep-seal traps on floor drains and other waste outlets, if indicated.

L. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

M. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

N. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

O. Install vent caps on each vent pipe passing through roof.

P. Do not install vent caps at wall penetrations.

Q. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

R. Install grease interceptors, including trapping, venting, and sampling box, according to authorities having jurisdiction and with clear space for servicing.

S. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

T. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

U. Install electric self regulating temperature maintenance cable on all grease waste piping as required.

## 3.6 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings as required.

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

## 3.7 SANITARY INTERCEPTORS INSTALLATION

A. Install interceptor inlets and outlets at elevations indicated.

B. Place concrete for cast-in-place interceptors according to ACI 318/318R and ACI 350R.

C. Install precast concrete interceptors according to ASTM C 891. Set level and plumb.

D. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.

E. Set tops of manhole frames and covers coordinated with site paving contractor and LAWA requirements.

F. Clean and prepare concrete surfaces to be field painted. Remove loose efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen surface as required to remove glaze. Paint the following concrete surfaces as recommended by paint manufacturer:

1. Precast Concrete Interceptors: All exterior and interior.

## 3.8 SEWERAGE PUMPS INSTALLATION

A. Provide excavating, trenching, and backfilling as required.

B. Install sewage pumps according to applicable requirements in HI 1.4.

C. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.

D. Set submersible sewage pumps on basin floors. Make direct connections to sanitary drainage piping.

1. Anchor guide-rail supports to basin bottoms and sidewalls or covers. Install pumps so pump and discharge pipe disconnecting flanges make positive seals when pumps are lowered into place.

E. Install sewage pump basins and connect to drainage and vent piping. Brace interior of basins according to manufacturer's written instructions to prevent distortion or collapse during concrete placement. Set basin cover and fasten to basin top flange. Install cover so top surface is flush with finished floor.

F. Construct sewage pump pits and connect to drainage and vent piping. Set pit curb frame recessed in and anchored to concrete. Fasten pit cover to pit curb flange. Install cover so top surface is flush with finished floor.

G. Install packaged, submersible sewage pump units and make direct connections to drainage and vent piping.

H. Install packaged, wastewater pump unit basins on floor or concrete base unless recessed installation is indicated. Make direct connections to drainage and vent piping.

I. Support piping so weight of piping is not supported by pumps.

END OF SECTION 22 13 00

# SECTION 22 14 00-FACILITY STORM DRAINAGE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Storm water piping buried beyond 5 feet of building.
2. Storm water piping buried within 5 feet of building.
3. Storm water piping above grade.
4. Unions and flanges.
5. Roof drains.
6. Parapet drains.
7. Canopy and cornice drains.
8. Special purpose downspout covers.
9. Downspout nozzles.
10. Area drains.
11. Exterior planter drains.
12. Cleanouts.
13. Sumps.
14. Interceptors.
15. Catch basins.
16. Manholes.
17. Sump pumps.
18. Bedding and cover materials.

### 1.2 REFERENCES

A. General: Comply with Appropriate Standards.

1. American Society of Mechanical Engineers: ASME.
2. American Society or Testing and Materials: ASTM.
3. Cast Iron Soil Pipe Institute: CISPI.
4. Manufacturers Standardization Society of the Valve and Fittings Industry: MSS.
5. Plumbing and Drainage Institute: PDI.
6. Los Angeles Plumbing Code: LAPC.
7. Los Angeles Department of Building and Safety: LADBS.
8. Los Angeles Department of Public Works: LADPW.
9. Standard Urban Stormwater Mitigation Plan: SUSMP.

### 1.3 SUBMITTALS

A. Submit data on all materials, fittings, accessories and equipment.

B. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

D. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes for sump pumps, and manholes.

E. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes for sump-pumps, catch basins and manholes.

F. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
2. Storm Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
3. Pumps: Submit pump type, capacity, certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

G. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.

H. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

## 1.4 WARRANTY

A. Furnish one-year minimum warranty.

## 1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of equipment and clean-outs.

B. Operation and Maintenance Data: Submit spare parts lists, exploded assembly views for pumps and equipment.

# PART 2 - PRODUCTS

## 2.1 STORM WATER PIPING, BURIED BEYOND 5 FEET OF BUILDING

A. Coordinate with Civil Engineer.

B. Cast Iron Soil Pipe: CISPI, ASTM A888 service weight, hubless.

1. Fittings: Cast iron, ASTM A888 and CISPI – with stainless steel clamp and shield assembly.

2. Joints: CISPI ASTM C564, rubber gasket joint devices.
3. Manufacturers – Heavy Duty Stainless Steel Couplings

    **a. Husky SD 4000.**
    **b. Clamp-All Corp.**
    **c. Ideal Corp.**

4. Manufacturers – Heavy Duty Cast Iron or Ductile Iron Couplings

    **a. MG Piping Products.**
    **b. Victaulic.**

C. Ductile-Iron Pipe and Fittings

1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

    a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    b. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
2. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

    1) Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    2) Gaskets: AWWA C111, rubber.

3. Flanges: ASME 16.1, Class 125, cast iron.

D. ABS Pipe: Pipe, fittings and joints shall comply with codes and standards in effect at time of installation.

## 2.2 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Soil Pipe: CISPI, ASTM A888 service weight, hubless.

1. Fittings: Cast iron, ASTM A888 and CISPI – with stainless steel clamp and shield assembly.
2. Joints: CISPI ASTM C564, rubber gasket joint devices.
3. Manufacturers – Heavy Duty Stainless Steel Couplings

    **a. Husky SD 4000.**
    **b. Clamp-All Corp.**
    **c. Ideal Corp.**

4. Manufacturers – Heavy Duty Cast Iron or Ductile Iron Couplings

    **a. MG Piping Products.**
    **b. Victaulic.**

B. Ductile-Iron Pipe and Fittings

1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

    a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    b. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
2. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

    1) Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    2) Gaskets: AWWA C111, rubber.

3. Flanges: ASME 16.1, Class 125, cast iron.

## 2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.

B. Drainage Fittings: ASME B16.12, galvanized, threaded, cast-iron drainage pattern.

C. Pressure Fittings:

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
4. Cast-Iron Flanges: ASME B16.1, Class 125.
5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.

D. Grooved-Joint Systems:

1. Manufacturers:

    **a. Anvil International.**
    **b. Star Pipe Products; Star Fittings Div.**
    **c. Victaulic Co. of America.**
    **d. Ward Manufacturing, Inc.**

2. Grooved-End, Steel-Piping Fittings: ASTM A 47/A 47M, galvanized, malleable-iron casting; ASTM A 106, galvanized-steel pipe; or ASTM A 536, galvanized, ductile-iron casting; with dimensions matching steel pipe.
3. Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

## 2.4 SPECIAL PIPE FITTINGS

A. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

**a. ANACO.**

B. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

1. Manufacturers:

**a. Cascade Waterworks Mfg. Co.**
**b. Dresser, Inc.; DMD Div.**
**c. EBAA Iron Sales, Inc.**

2. Center-Sleeve Material: Ductile iron or malleable iron.
3. Gasket Material: Natural or synthetic rubber.
4. Metal Component Finish: Corrosion-resistant coating or material.

C. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.

1. Manufacturers:

**a. EBAA Iron Sales, Inc.**

D. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Manufacturers:

**a. SIGMA Corp.**

## 2.5 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch or LLDPE film of 0.008-inch minimum thickness.

B. Form: Sheet or tube.

C. Color: Black.

## 2.6 STORM WATER PIPING, ABOVE GRADE

A. Cast Iron Pipe CISPI: ASTM A888, service weight, hubless.

1. Fittings: Cast iron, ASTM A888.
2. Joints: ASTM C564, rubber gasket and stainless steel clamp and shield assemblies.
3. Unions for Pipe 2 inches and Smaller:

    a. Copper Piping: Class 150, bronze unions with soldered brazed joints.
    b. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

4. Flanges for Pipe 2-1/2 inches and Larger:

    a. Copper Piping: Class 150, slip-on bronze flanges.
    b. Gaskets: 1/16 inch thick preformed neoprene gaskets.

## 2.7 ROOF DRAINS

A. Manufacturers:

**1. J.R. Smith.**
**2. Zurn.**
**3. MiFAB.**

B. Roof Drain (RD-1):

1. Assembly: ASME A112.21.2M.
2. Body: Lacquered stainless steel with sump.
3. Strainer: Removable cast iron dome with vandal proof screws.
4. Accessories: Coordinate with roofing type as required.

    a. Membrane flange and membrane clamp with integral gravel stop.
    b. Adjustable under deck clamp.
    c. Roof sump receiver.
    d. Waterproofing flange.
    e. Leveling frame.
    f. Adjustable extension sleeve for roof insulation.
    g. Perforated or slotted ballast guard extension for inverted roof.
    h. Perforated stainless steel ballast guard extension.

C. Roof Drain (RD-2): Overflow type.

1. Same as RD-1, with 2” min. height water dam.

## 2.8 PARAPET DRAINS

A. Manufacturers:

1. **J.R. Smith.**
2. **Zurn.**
3. **MiFAB.**

B. Lacquered cast iron body with flashing clamp collar and nickel bronze grate.

## 2.9 CANOPY AND CORNICE DRAINS

A. Manufacturers:

1. **J.R. Smith.**
2. **Zurn.**
3. **MiFAB.**

B. Lacquered cast iron body with flashing clamp collar and nickel bronze flat strainer.

## 2.10 SPECIAL PURPOSE DOWNSPOUT COVER

A. Manufacturers:

1. **J.R. Smith.**
2. **Zurn.**
3. **MiFAB.**

B. Product Description: Brass or Stainless steel with stainless steel mesh liner, vandal proof lock nut, and pipe clamp.

## 2.11 DOWNSPOUT NOZZLES

A. Manufacturers:
1. **J.R. Smith.**
2. **Zurn.**
3. **MiFAB.**

B. Product Description: Nickel or Polished bronze body and round wall flange with straight bottom section and screened outlet.

## 2.12 AREA DRAINS

A. Manufacturers:

1. **J.R. Smith.**
2. **Zurn.**
3. **MiFAB.**

B. Area Drain (AD-1): Lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer.

C. Area Drain (Trench Drain) (AD-2): Lacquered cast iron ductile iron or stainless steel; with drainage flange, heavy duty grate 6 inches 12 inches wide, 12 inches 24 inches long, dome strainer, end plates with gaskets; end, middle or bottom outlet.

## 2.13 EXTERIOR PLANTER DRAINS

A. Manufacturers:

**1. J.R. Smith.**
**2. Zurn.**
**3. MiFAB.**

B. Furnish materials in accordance with State of California Codes City of Los Angeles and City of Los Angeles Department of Building and Safety Standards.

C. Lacquered cast iron body with sump.

D. Strainer: Removable polyethylene dome with stainless steel screen.

E. Accessories: Membrane flange and membrane clamp with integral gravel stops.

## 2.14 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected piping.

B. Downspout Boots:

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout.
3. Description: ASTM A 74, Service class, hub-and-spigot, cast-iron soil pipe.
4. Size: Same as or larger than connected downspout.

C. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

D. Overflow Outlet:

1. Stainless steel type 304 with hinged perforated cover similar to J.R. Smith 1775, vandal proof, same size as connected downspout.

## 2.15 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft. thickness.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

## 2.16 CLEANOUTS

A. Exterior Surfaced Areas (CO-1): Round or square cast nickel bronze access frame and non-skid cover.

B. Exterior Unsurfaced Areas (CO-2): Line type with lacquered cast iron body and round epoxy coated cover with gasket.

C. Interior Finished Floor Areas (CO-3): Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round scored cover with gasket in service areas and round square depressed cover with gasket to accept floor finish in finished floor areas.

D. Interior Finished Wall Areas (CO-4): Line type with lacquered cast iron body and round epoxy coated cover with gasket, and round stainless steel access cover secured with machine screw.

E. Interior Unfinished Accessible Areas (CO-5): Caulked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

## 2.17 SUMPS

A. Manufacturers:

1. **Pro-Cast Inc.**
2. **Jensen.**
3. **Zoeller.**

B. Water-tight, factory fabricated; reinforced fiberglass or concrete; sleeved inlet, outlet and vent openings, and any other sidewall openings for pipe connections.

C. Cover shall be cast iron, airtight and have integral seals, gaskets and bushings, sized for sump access.

D. Exterior locations shall have hinged and lockable traffic weight covers.

## 2.18 SEDIMENT INTERCEPTORS

A. Manufacturers:

1. **J.R. Smith.**
2. **Zurn.**

B. Sediment Interceptor: Epoxy coated cast iron, Stainless steel or Precast concrete body and secured cover with removable stainless steel sediment bucket.

## 2.19 SUMP PUMPS

A. Manufacturers:

1. **Weil Aquatronics.**
2. **Paco.**
3. **Zoeller.**

B. Pump Type: Vertical centrifugal, direct connected, simplex duplex arrangement.

C. Casing: Cast iron volute with radial clearance around impeller, inlet strainer, slide away couplings.

D. Impeller: Cast iron; open non-clog, keyed to stainless steel shaft.

E. Support: Cast iron pedestal motor support on steel floor plate with gas tight gaskets.

F. Bearings: Oil lubricated bronze sleeve spaced maximum 48 inches and grease lubricated ball thrust at floor plate.

G. Drive: Flexible coupling to vertical, solid shaft ball bearing electric motor.

H. Sump: Steel cover plate with steel curb frame for grouting into sump with inspection opening and cover, and alarm fittings.

I. Controls (Duplex): Float operated mechanical alternator with float rod, stops, and corrosion resistant float to alternate operation of pumps. Cut-in second pump on rising level or lead pump failure. Furnish separate pressure switch high level alarm with transformer, alarm bell, and standpipe, and extra set of wired terminals for remote alarm circuit and emergency float switch with float rod, stops, and corrosion resistant float to operate both pumps on failure of alternator. Provide NEMA 250, Type 1 enclosure.

## 2.20 SUBMERSIBLE SUMP PUMPS

A. Manufacturers:

1. **Weil Aquatronics.**
2. **Paco.**
3. **Zoeller.**

B. Pump Type: Completely submersible, vertical, centrifugal.

C. Casing: Cast iron pump body and oil filled motor chamber.

D. Impeller: Cast iron; closed, stainless steel.

E. Bearings: Ball bearings.

F. Sump: Fiberglass steel or concrete, basin with steel cover plate.

G. Accessories: Oil resistant cord and plug with three-prong connector for connection to electric wiring system including grounding connector.

H. Servicing: Slide-away coupling consisting of discharge elbow secure to sump floor, movable bracket, guide pipe system, lifting chain and chain hooks.

I. Integral level controls with separate level alarm.

J. Controls: Motor control panel containing across-the-line electric motor starters with ambient compensated quick trip overloads in each phase with manual trip button and reset button, circuit breaker, control transformer, electro-mechanical alternator, hand-off-automatic selector switches, pilot lights, high water alarm pilot light, reset button and alarm horn. Furnish mercury switch liquid level controls, steel shell switch encased in polyurethane foam with cast iron weight for pump on (each pump), pump off (common), and alarm. Provide NEMA 250, Type 1 enclosure.

## 2.21 BUILDING AUTOMATION SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:

1. On-off status of each pump.
2. Alarm status.
3. Pump failure.

## 2.22 ALARM PANEL

A. Remote-mounted alarm panel, shall consist of a single NEMA 1 enclosure complete with 3 indicating lights, reset buttons, alarm horn or bell and silencing switch. Lights shall be normally dim-glow and shall change to full-glow and sound the alarm under any of the following conditions:

1. Power failure to the pump control panel.
2. High water condition.
3. Simultaneous two pump operation.
4. Failure of either pump.

B. Coordinate location and wiring of alarm panel with electrical contractor

C. Wiring diagrams:

1. Furnish and turn over to LAWA, complete wiring diagrams showing full details of the factory wiring.

## 2.23 CONTROL PANEL

A. Combination unfused disconnect switch and across-the-line magnetic starter with overload protection for each phase leg, for each pump.

1. Undervoltage protection.
2. 120 volt control circuit transformer, fused on primary, and grounded on secondary, with automatic transfer between each pump's incoming supply in the event of failure or shutdown of power supply to any pump. Connections to pump incoming supplies shall be made downstream of controller disconnect devices.
3. Momentary contact push buttons marked MANUAL, for bypassing automatic control when held in (JOGGING).
4. Automatic electric alternator (four lead units).
5. Moisture sensing audible and visual alarm.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

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

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. Field verify that connection to existing piping systems sizes, locations, and invert are as required.

F. Establish elevations of buried piping with not less than allowed per code.

G. Establish minimum separation of from other piping services in accordance with code.

## 3.2 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground storm drainage piping NPS 6 and smaller shall be the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.
3. Galvanized steel pipe, drainage fittings, and threaded joints.
4. Grooved end galvanized malleable iron fittings and bolted clamp type malleable iron couplings with rubber sealing gaskets for grooved end pipe equal to Victaulic Style 75 or 77.
5. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

C. Aboveground, storm drainage piping NPS 8 and larger shall be the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.
3. Steel pipe, drainage fittings, and threaded joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

D. Underground storm drainage piping NPS 6 and smaller shall be the following:

1. Extra-heavy class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.
3. Galvanized steel pipe, drainage fittings, and threaded joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

E. Underground, storm drainage piping NPS 8 and larger shall be the following:

1. Extra-Heavy class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel and heavy-duty shielded, cast-iron couplings; and coupled joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

F. Aboveground storm drainage force mains NPS 2-1/2 to NPS 6 shall be the following:

1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
2. Galvanized steel pipe, pressure fittings, and threaded joints.
3. Grooved-end galvanized steel pipe, grooved-joint system fittings and couplings, and grooved joints.

G. Underground storm drainage force mains NPS 4 and smaller shall be the following:

1. Galvanized steel pipe, pressure fittings, and threaded joints.

    a. Include grooved-joint system fittings and couplings and grooved joints where indicated.

2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical joints.

    a. Include grooved-joint system fittings and couplings and grooved joints where indicated.

3. Pressure pipe couplings if dissimilar pipe materials or piping with small difference in OD must be joined.

## 3.3 PIPING INSTALLATION

A. Install seismic restraints on piping as required

B. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers as required.

C. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

D. Install underground, steel, force-main piping. Install encasement on piping according to ASTM A 674 or AWWA C105.

E. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

    1. Install encasement on piping according to ASTM A 674 or AWWA C105.

F. Install underground, ductile-iron, special pipe fittings according to AWWA C600.

    1. Install encasement on piping according to ASTM A 674 or AWWA C105.

G. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

H. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.

I. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

    1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

J. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:

1. Building Storm Drain: 2 percent downward in direction of flow for all piping.
2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

M. Install force mains at elevations indicated.

N. Install engineered controlled-flow storm drainage piping in locations indicated.

O. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Q. Hubless piping shall be installed in a rigid, linear and plumb system without any deflection at the joints either horizontally or vertically. The system shall be supported and secured to the building structure to prevent movement induced by a ten-foot head of water and its associated thrust forces.

1. When horizontal hubless CI piping is suspended in excess of 18 inch by means of non-rigid hangers, provide sway bracing to prevent horizontal movement.
2. For all horizontal hubless CI piping 5-inch and larger, provide sway bracing to prevent horizontal movement at every branch opening and change of direction by securing to building structure, or provide pipe clamps and rodding across coupling.

## 3.4 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports - Install the following:

1. Vertical Piping: MSS Type 8 or Type 42 clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports as required.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

## 3.5 PIPING SPECIALTIES INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping.
4. Locate at base of each vertical storm drain riser.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

E. Assemble non-ASME A112.3.1, stainless-steel channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

F. Install roof drains at low points of roof areas and where indicated according to roof membrane manufacturer's written installation instructions.

1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Position roof drains for easy access and maintenance.
3. Coated cast iron body roof drains with an inside caulked bottom outlet, except as noted and in accordance with ANSI A112.21.2.
4. For liquid membrane roofs, use four inch wide flange, for built up membrane roofs, a combined flashing flange and gravel stop; and, for steel or precast decks, a deck clamp.
5. Where insulation is applied over a structural roof deck, provide an extension collar with weep holes.
6. For IRMA type roofs, 4 inch high, brass gravel guard, 16 inch diameter perforated with 1/4 inch holes.
7. Provide tops of drains for decks and canopies with a bronze, nickel bronze, statuary bronze finish.

G. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

H. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

I. Install manufactured, gray-iron downspout boots at grade with top 12 inches above grade. Secure to building wall.

J. Install cast-iron soil pipe downspout boots at grade with top of hub 12 inches above grade.

K. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

L. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

## 3.6 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

## 3.7 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

## 3.8 SUMP PUMP INSTALLATION

A. Provide excavating, trenching, and backfilling as required.

B. Install sump pumps according to applicable requirements in HI 1.4.

C. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.

D. Set submersible sump pumps on basin or pit floor. Make direct connections to storm drainage piping.

E. Install sump pump basins and connect to drainage piping. Brace interior of basins according to manufacturer's written instructions to prevent distortion or collapse during concrete placement. Set basin cover and fasten to basin top flange. Install cover so top surface is flush with finished floor.

F. Construct sump pump pits and connect to drainage piping. Set pit curb frame recessed in and anchored to concrete. Fasten pit cover to pit curb flange. Install cover so top surface is flush with finished floor.

G. Install packaged submersible, drainage pump unit basins on floor or concrete base unless recessed installation is indicated. Make direct connections to storm drainage piping.

H. Support piping so weight of piping is not supported by pumps.

## 3.9 START UP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify bearing lubrication.
3. Disconnect couplings and check motors for proper direction of rotation.
4. Verify that each pump is free to rotate by hand. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
5. Verify that pump controls are correct for required application.
6. Verify sump basin is clear and no large debris before pump start up.

B. Start pumps without exceeding safe motor power:

1. Start motors.
2. Open discharge valves slowly.
3. Check general mechanical operation of pumps and motors.

C. Test and adjust controls and safeties.

D. Remove and replace damaged and malfunctioning components.

1. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.
2. Set field-adjustable switches and circuit-breaker trip ranges as indicated, or if not indicated, for normal operation.

E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

END OF SECTION 22 14 00

# SECTION 22 32 00-DOMESTIC WATER FILTRATION EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes the following types of filtering equipment:

1. Centralized softener, reverse osmosis or carbon filtering.
2. Point of use filters.

### 1.2 REFERENCES

A. General: Comply with appropriate standards.

1. American National Standards Institute: ANSI.
2. American Society of Mechanical Engineers: ASME.
3. American Society of Sanitary Engineering: ASSE.
4. American Society of Testing and Materials: ASTM.
5. American Welding Society: AWS
6. American Water Works Association: AWWS.
7. Manufacturers Standardization Society: MSS.
8. National Electrical Manufacturers Association: NEMA.
9. Plumbing and Drainage Institute: PDI.
10. Underwriters Laboratories Inc.: UL.
11. Los Angeles Plumbing Code: LAPC.
12. Los Angeles Department of Building and Safety: LADBS.
13. National Sanitation Foundation: NSF.
14. California AB 1953 Lead Free.

### 1.3 SUBMITTALS

A. Submit data on all materials, fittings, accessories and equipment.

B. Shop Drawings: Indicate pipe materials used, joining methods, supports, floor and wall penetrations seals. Indicate installation, layout, weights, mounting and support details, and piping connections. Provide detail water filtration assemblies and indicate dimensions, weight loads, and required clearances.

C. Product Data: Submit capacity, electrical characteristics and connection requirements. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, taps, drains, controls, and operating sequence. Indentify center of gravity and locate and describe mounting and anchorage provisions.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

E. Welding certificate.

F. Source quality-control test reports.

G. Field quality-control test reports.

H. Startup service test reports.

I. Operation and Maintenance Data: For water filtration equipment to include in emergency, operation, and maintenance manuals.

1. Do not install water filtration media until final water piping systems have been flushed and cleaned.
2. Prepare filter media per manufacturer requirements.

## 1.4 WARRANTY

A. Furnish five year manufacturer warranty or as required by facility representative.

# PART 2 - PRODUCTS

## 2.1 CENTRALIZED FILTERING EQUIPMENT

A. Manufacturers:

**1. Bottle-Free Water Co.**
**2. Filtrene Mfg Co..**
**3. Watersoft.**

B. Equipment capacities and related piping as required.

## 2.2 POINT OF USE FILTERS

A. Manufacturers:

**1. Bottle-Free Water Co.**
**2. Everpure.**
**3. Filtrene.**

B. Sizes, flow capacities, and type as required.

## 2.3 CATRIDGE FILTER

A. Off-Floor Cartridge Filters:

1. Manufacturers:

**a. Bottle-Free Water Company.**

**b. Everpure, Inc.**
**c. Filtrine.**
**d. WaterSoft.**

2. Description: Simplex, in-line wall-mounting housing with replaceable element for removing suspended particles from water (1/2 micron).

a. Housing: Corrosion resistant; designed to separate feedwater from filtrate and to direct feedwater through water filter element; with element support.

1) Pipe Connections: Threaded according to ASME B1.20.1.
2) Support: Wall bracket.

b. Element: Replaceable; of shape to fit housing.

## 2.4 CARBON FILTER

A. Description: Simplex carbon filter, with media tank, media, and automatic backwash for removing chlorine from and improving color, odor, and taste of water.

1. Manufacturers:

**a. Everpure.**
**b. Culligan International Company.**
**c. CUNO Incorporated.**

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install the following piping accessories on water conditioning equipment domestic water piping connections.

1. On inlet:

a. Thermometer.
b. Strainer.
c. Pressure gage.
d. Shut-off valve.

2. On outlet:

a. Shut-off valve.

B. Install drain piping from tanks to nearest approved receptor.

END OF SECTION 22 31 00

# SECTION 22 33 00-ELECTRIC DOMESTIC WATER HEATERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Commercial electric water heaters.

### 1.2 REFERENCES

A. Comply with appropriate standards.

1. American Society of Heating, Refrigerating and Air-Conditioning Engineers: ASHRAE.
2. American Society of Mechanical Engineers: ASME.
3. American Society for Testing and Materials: ASTM.
4. National Fire Protection Association: NFPA.
5. California Energy Commission: C.E.C.
6. Canadian Standards Authority: C.S.A.
7. Department of Energy Test Procedures: D.O.E.
8. National Electrical Manufacturers Association: NEMA.
9. Southern California air Quality Management District: SCAQMD.
10. Los Angeles Plumbing Code: LAPC.
11. Los Angeles Department of Building and Safety: LADBS.
12. Los Angeles Municipal Code: LAMC.

### 1.3 SUBMITTALS

A. Submit data on all materials.

B. Shop Drawings: Indicate heat exchanger dimensions, size of taps, and performance data. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, taps, and drains.

C. Product Data: Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Submit electrical characteristics and connection locations.

D. Manufacturer's Installation Instructions: Submit mounting and support requirements.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

### 1.4 WARRANTY

A. One year standard warranty.

## PART 2 - PRODUCTS

### 2.1 ELECTRIC WATER HEATERS – TANK TYPE

A. Manufacturers:
   1. **Lochinvar.**
   2. **Rheem.**
   3. **A.O. Smith.**

B. Type: Automatic, electric, vertical storage.

C. Tank: Glass lined welded steel, thermally insulated with one inch Non-CFC foam, encased in corrosion-resistant steel jacket with baked-on enamel finish, dielectric fittings, brass drain valve, T&P relief valve.

D. Controls: Automatic water thermostat with adjustable temperature range from 120 to 170 degrees F, flanged or screw-in nichrome elements, enclosed controls and electrical junction box and operating light. Wire double element units so elements do not operate simultaneously.

E. Accessories: Seismic anchoring straps, State of California listed and approved.

### 2.2 COMMERCIAL ELECTRIC WATER HEATERS – INSTANTANEOUS/POINT-OF-USE

A. Manufacturers:

   1. **Chromite.**
   2. **Eemax.**
   3. **Rinnau.**

B. Type: Factory-assembled and wired, electric, non-storage type.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Maintain manufacturer's recommended clearances around and over water heaters.

B. Install tank type water heater on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than water heater base on each side or on listed and approved shelf.

C. Connect domestic hot water and domestic cold water piping to supply and return water heater connections mixing valves and/or circulating pump as required.

D. Install point-of-use type below counter height, adjacent to fixture on tank type.

E. Install the following piping accessories.

1. On supply:

    a. Thermometer well and thermometer.
    b. Strainer.
    c. Pressure gage.
    d. Shutoff valve.

2. On return:

    a. Thermometer well and thermometer.
    b. Pressure gage.
    c. Shutoff valve.

F. Install discharge piping from relief valves and drain valves to nearest approved receptor.

G. Install water heater trim and accessories furnished loose for field mounting.

H. Install electrical devices furnished loose for field mounting.

I. Install control wiring between water heater control panel and field mounted control devices.

END OF SECTION 22 33 00

# SECTION 22 34 00-FUEL-FIRED DOMESTIC WATER HEATERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Commercial gas-fired water heaters.
2. Packaged water heating systems.
3. Domestic hot water storage tanks.

### 1.2 REFERENCES

A. Comply with appropriate standards.

1. American National Standards Institute: ANSI.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers: ASHRAE.
3. American Society of Mechanical Engineers: ASME.
4. National Fire Protection Association: NFPA.
5. United States Department of Energy: D.O.E.
6. Canadian Standards Authority: CSA.
7. California Energy Commission: C.E.C.
8. National Electrical Manufacturers Association: NEMA.
9. Southern California Air Quality Control Management District: SCQMD Rule 1121 Low Nox Emission Stds.
10. Los Angeles Plumbing Code: LAPC.
11. Los Angeles Department of Building and Safety: LADBS.
12. Los Angeles Municipal Code: LAMC.

### 1.3 SUBMITTALS

A. Submit data on all materials.

B. Shop Drawings: Indicate heat exchanger dimensions, size of taps, and performance data. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, taps, and drains.

C. Product Data:

1. Water Heaters: Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Indicate pump type, capacity and power requirements. Submit electrical characteristics and connection locations.
2. Pumps: Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

D. Manufacturer's Installation Instructions: Submit mounting and support requirements.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

## 1.4 QUALITY ASSURANCE

A. Conform to ASME code.

B. Water Heater Performance Requirements: Equipment efficiency not less than prescribed by ASHRAE 90.1 when tested in accordance with all required standards.

## 1.5 WARRANTY

A. One year standard warranty.

# PART 2 - PRODUCTS

## 2.1 COMMERCIAL GAS FIRED WATER HEATERS

A. Manufacturers:

1. **Lochinvar.**
2. **Rheem.**
3. **A.O. Smith.**

B. Type: Automatic, natural gas-fired, vertical storage.

C. Capacity:

1. Minimum recovery rate: As required.
2. Maximum working pressure: 150 psig.
3. Certification: ANSI Z21.10.1.

D. Tank: Glass lined welded steel with single flue passage, flue baffle and draft hood; thermally insulated with Non-CFC foam and encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs, dielectric fittings, brass drain valve, T&P relief valve.

E. Controls: Automatic water thermostat and built-in gas pressure regulator; temperature range adjustable from 120 to 170 degrees F, cast iron or stainless steel burner, safety pilot and thermocouple, electronic ignition and power vent if required.

F. Accessories: Brass dip tube, drain valve, magnesium anode, anchoring straps, State of California listed and approved.

## 2.2 PACKAGED WATER HEATING SYSTEMS

A. Manufacturers:

1. **Rheem.**
2. **A.O. Smith.**
3. **Lochinvar.**

B. System: Gas-fired circulating pump, factory controls, piping and valves, storage tank, all mounted on skid or equipment pad as required.

C. Boiler:

1. Type: natural gas-fired water tube boiler, with copper finned tube heat exchanger, one inch minimum diameter, 13 gage steel boiler tubes and copper tube heat exchanger with bronze heads, steel jacket with glass fiber insulation.
2. Boiler Trim: Gas burner, thermometer and pressure gauge. Immersion thermostats for operating and high limit protection, 100 percent safety shut-off. Electric gas valve with transformer, electronic safety pilot and pilot burner, gas pressure regulator. Manual gas shut-off, low water cut off, ASME rated temperature and pressure relief valve, coil relief valve, automatic boiler fill and expansion tank, draft inverter.

D. Vertical or Horizontal storage tank:

1. Working pressure: 150 psi ASME labeled.
2. Lining: 15 mils thick epoxy lining extended through flanges and couplings.
3. Support: Two factory welded tank saddles not less than 4 inches wide by 1/4 inch thick, mounted on 2 inch pipe stand with minimum four cross braced legs; sheet teflon isolation strip between tank and saddle; dielectric unions between tank and piping system.
4. Insulation: 3 inch glass fiber insulation with aluminum jacket.

E. Pump:

1. Type: All bronze, in-line circulation pump mounted on boiler, between heater and storage tank, controlled by tank mounted immersion thermostat set at max. outlet temperature as required.
2. Pump Capacity: As required.
3. Electrical Characteristics: As required.

F. Thermostatic Valve: Three-way, self-contained, full line size, bronze body 1/2 to 2 inches size, iron body 2-1/2 inches and over, set at 140 degrees F max. inlet temperature – outlet temperature as required.

## 2.3 DOMESTIC HOT WATER STORAGE TANKS

A. Manufacturers:

1. **Rheem.**
2. **A.O. Smith.**
3. **Lochinvar.**

B. Tank: Welded steel, ASME labeled for working pressure of 125 psig psig, steel support saddles, taps for accessories, threaded connections of stainless steel, access manhole.

C. Lining:

1. Corrosion-resistant concrete approximately 3/4 inch thick. Glass-lined or as provided as manufacturer.

D. Openings: Up to 3 inches, copper-silicone threaded; over 4 inches, flanged; flanged collar for heat exchanger; man-way fitting.

E. Accessories: Tank drain, water inlet and outlet, thermometer range of 40 to 200 degrees F, ASME pressure relief valve suitable for maximum working pressure.

F. Vertical or Horizontal storage tank:

1. Nominal capacity: Length and dimensions as required.
2. Support: Two welded tank saddles not less than 4 inches wide by 1/4 inch thick, mounted on 2 inch pipe stand with minimum four cross braced legs; sheet teflon isolation strip between tank and saddle; dielectric unions between tank and piping system.

G. Insulation: Factory furnished 2 inch minimum glass fiber insulation with steel aluminum jacket.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Maintain manufacturer's recommended clearances around and over water heaters.

B. Install water heater on concrete housekeeping pad, minimum 4 inches high and 6 inches larger than water heater base on each side.

C. Seismic Bracing: Provide approved anchoring straps – two (2) minimum.

D. Connect natural gas piping to water heater, full size of water heater gas train inlet. Arrange piping with clearances for burner removal and service.

E. Connect domestic hot water and domestic cold water piping to supply and return water heater connections.

F. Install the following piping accessories.

1. On supply:

a. Thermometer well and thermometer.
b. Strainer.
c. Pressure gage.
d. Shutoff valve.

2. On return:

a. Thermometer well and thermometer.
b. Pressure gage.
c. Shutoff valve.

G. Install the following piping accessories on natural gas piping connections.

1. Strainer.
2. Pressure gage.
3. Shutoff valve.
4. Pressure reducing valve.

H. Install discharge piping from relief valves and drain valves to nearest approved receptor.

I. Install circulator and diaphragm expansion tank on water heater.

J. Install water heater trim and accessories furnished loose for field mounting.

K. Install electrical devices furnished loose for field mounting.

L. Install control wiring between water heater control panel and field mounted control devices.

M. Connect flue to water heater outlet, full size of outlet.

N. Domestic Hot Water Storage Tanks:

1. Provide piping support, independent of building structural framing members.
2. Clean and flush after installation. Seal until pipe connections are made.
3. Provide seismic bracing.

END OF SECTION 22 34 00

# SECTION 22 40 00-PLUMBING FIXTURES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Water closets.
2. Urinals.
3. Lavatories.
4. Sinks.
5. Service sinks.
6. Electric water coolers.
7. Wash fountains.

### 1.2 REFERENCES

A. General: comply with appropriate standards.

1. American National Standards Institute: ANSI.
2. Air-Conditioning and Refrigeration Institute: ARI.
3. American Society of Mechanical Engineers: ASME.
4. American Society for Testing and Materials: ASTM.
5. California Energy Commission: CEC.
6. National Electrical Manufacturers Association: NEMA.
7. Americans with Disabilities Act: ADA.
8. Los Angeles Plumbing Code: LAPC.
9. Los Angeles Department of Building and Safety: LADBS
10. National Sanitation Foundation: NSF.
11. International Association of Plumbing and Mechanical Officials: IAPMO.
12. California State AB 1953.

### 1.3 SUBMITTALS

A. Submit data on all materials, fittings, accessories and equipment. Indicate materials, finishes, dimensions, construction details and flow control roles.

B. Manufacturer's Installation Instructions: Submit installation methods and procedures.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

D. CalGreen Submittal/ Tier Level Performance Requirements: Obtain LAWA Tier Level requirements for the project.

E. Shop Drawings: Diagram power, signal, and control wiring.

F. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

H. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

## 1.4 WARRANTY

A. Furnish five year minimum warranty.

## PART 2 - PRODUCTS

## 2.1 GENERAL

The following gallons per flush or flow in gallons per minute are required maximum flows for project:

| | |
|---|---|
| Water Closets Flushometer | 1.28 gallons per flush |
| Urinals Flushometer | 0.125 gallons per flush |
| Lavatory Faucet | 0.5 gallons per minute |
| Showers Heads | 1.5 gallons per minute |
| Pantry Sinks | 1.5 gallons per minute |
| Mop Sinks | Per ASME A112.18.1, 4.0 gallons per minute |

## 2.2 FLUSH VALVE WATER CLOSETS

A. Manufacturers: Vitreous China.

**1. American Standard. Afwall 2257.001**
   a. Approved manufacturers
      1) Kohler.
      2) Toto USA, Inc.

B. Manufacturers: Type 304 stainless steel

**1. Zurn.**
**2. Willoughby.**

C. Manufacturers: Flush Valves.

**1. Sloan.**
**2. Zurn.**
**3. American Standard.**

D. Bowl: ASME A112.19.2M; wall hung, siphon jet , with elongated rim, exposed top spud, or concealed back-size per flush valve requirements, bolt caps; floor anchored carrier.

E. Bowl: ASME A112.19.2M; floor mounted, siphon jet or blow out, with elongated rim, exposed top spud, or concealed back-size per flush valve requirements; bolt caps.

F. Disabled Access: Where required.

G. Exposed Flush Valve: ASME A112.18.1; exposed chrome plated, diaphragm type with oscillating handle, escutcheon, seat bumper, integral screwdriver stop and vacuum breaker 1.28 maximum gallon per flush.

H. Water Closet Flushometers:

1. Sensor Operated - Hard Wired:

a. Concealed diaphragm type, chrome plated, sensor operated flushometer valve. Low consumption valves shall have dual filtered type diaphragm kit for flush discharge accuracy. Valve shall be non-hold-open, solenoid operator, skirted high back pressure vacuum breaker with bottom hex coupling nut, back-check control stop will have free spinning vandal resistant stop cap and sweat solder adapter kit with cast set screw all flange. Valve shall include self-adaptive infrared sensor with indicator light, courtesy flush override button, (2) chrome plated wall cover plates (for 2-gag electrical box) with vandal resistant screws. Valve body, cover tailpiece and control stop will be in conformance with ASTM Alloy Classification for Semi-Red Brass. Valve shall be in compliance with the applicable sections of ASSE 1037, ANSI/ASME 112.19.6, and Military Specification V-29193 Standards. Sloan Optima 152-1.28 ES-S.

I. Seats.

1. Manufacturers:

**a. Olsenite 95C**
1) Approved Equals
a) American Standard.
b) Beneke.
c) Kohler.

2. Seat: Shall be white heavy-duty plastic, open front, extended back, self-sustaining hinge, brass bolts, without cover.

J. Carriers.

1. Manufacturers:

**a. J.R. Smith 600**
1) Approved Equal
a) Zurn.
b) MiFAB.

2. Carrier: ASME A112.6.1; adjustable or non-adjustable, cast iron or ductile iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers; single, double, vertical or horizontal type as required.

K. Water-Closet Supports:

1. Description: Combination carrier designed for accessible and standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
2. Concealed adjustable extra heavy cast iron combination drainage fitting and chair carriers with an adjustable base anchored to slab using all base support holes, rear anchor foot assembly for stud walls, adjustable cast iron outlet nipple and/or coupling, neoprene gasket and steel supporting bolts with chrome plated washers and cap nuts, equal to Smith Series No. 100, No. 200, No. 400, or No. 500 for siphon jet.

    a. For employee use bariatric supports for a 1000 pound load rating.

3. Set bowls for physically handicapped with top of seat 17 to 19 inches above floor and provide carrier, equal to Smith No. 600. For blowout, use Smith No. 620.

## 2.3 WALL HUNG URINALS

A. Manufacturers: Vitreous China

**1. American Standards 6590.001**
   a. Approved Equal
      1) Sloan.
      2) Kohler.

B. Manufacturers: Flush Valves.

**1. Sloan WEUS-1010.1311-0.13 ES-S**
   a. Approved Equal
      1) American Standard.
      2) Zurn.

C. Urinal: ASME A112.19.2M or ANSI Z124.9, wall hung washout or siphon jet, integral trap, exposed or concealed spud type, size per flush valve requirements, floor anchored carrier.
   1. Waterless urinals are unacceptable.

D. Exposed Flush Valve: ASME A112.18.1; exposed chrome plated, diaphragm type with oscillating handle, or push plate, escutcheon, integral screwdriver stop, vacuum breaker; equal to 0.125 gallon per flush.

E. Sensor Operated Flush Valve: ASME A112.18.1; concealed rough brass or exposed chrome plated, diaphragm type with low voltage or battery operated solenoid operator, infrared sensor

and over-ride button in chrome plated plate, wheel handle stop and vacuum breaker; equal to 0.13 gallon per flush.

F. Urinal Flushometers:

1. Sensor-Operated Hard-Wired:

a. Concealed diaphragm type, chrome plated, sensor operated flushometer valve. Low consumption valves shall have dual filtered type diaphragm kit for flush discharge accuracy. Valve shall be non-hold-open, solenoid operator, skirted high back pressure vacuum breaker with bottom hex coupling nut, back-check control stop will have free spinning vandal resistant stop cap and sweat solder adapter kit with cast set screw wall flange. Valve shall include Optima EL-1500 self-adaptive infrared sensor with indicator light, (2) chrome plated wall cover plates (for 2-gang electrical box) with vandal resistant screws. Valve, body, cover, tailpiece and control stop shall be in conformance with ASTM Alloy Classification for Semi-Red Brass. Valve shall be Sloan WEUS-1010.1311-0.13 ES-S.

G. Flush (Metering) Valve: ASME A112.18.1; exposed chrome plated, porous felt type for 1/2 inch supply with oscillating handle, or push button, screwdriver stop and vacuum breaker.

H. Carriers:

1. Manufacturers:
   **a. J.R. Smith. 0636 or 0637**
   b. Approved Equal
      1) Zurn.
      2) MiFAB.

2. Wall Mounted Carrier: ASME A112.6.1; cast iron or ductile iron frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs, elastometric gasket or approved setting compound, for fixture to flange connection.

I. Disabled Access: Approved type where required.

## 2.4 LAVATORIES

A. Manufacturers: Vitreous China/Porcelain Enameled Cast Iron.

**1. American Standard.**
**2. Kohler.**
**3. Crane.**

B. Manufacturers: Integral basin type.

**1. Corian self-draining with integral bowl or approved equal**

C. Manufacturers: Faucets.

**1. Sloan Solis EAF-275 CP**

2. Approved Equal
   a. Chicago.
   b. American Standard.

D. Wall Hung Basins: size as required, with 4 inch high back; drillings on 4 inch or 8 inch centers or single hold punch, rectangular basin with splash lip, front overflow, and soap depression.

E. Counter Top Basins: self-rimming lavatory-size as required with drillings on 4 inch or 8 inch centers, front overflow, soap depression, seal of putty, caulking, or concealed vinyl gasket.

F. Undercounter Lavatory: unglazed rim for under counter mount with rear overflow, size as required with drillings on 4 inch or 8 inch centers or single hole.

G. Manufacturers:

**1. American Standard Companies, Inc.**
**2. Brasscraft.**
**3. Chicago Faucet Co.**

H. Metered Faucet: ASME A112.18.1; chrome plated metered manual mixing faucet low voltage or battery operated solenoid operator and infrared sensor, water economy aerator spray and cover plate.

I. Disabled Access: Approved type where required with insulated stops, supplies, trap and drain outlet, offset grid strainer

J. Carriers: where required.

1. Manufacturers:

**a. J.R. Smith.**
**b. Zurn.**
**c. MiFAB.**

K. Lavatory insulation kit where required: Tru-Bro, Plumerex.

L. Waste Outlets - Manufacturers:

**1. American Standard.**
**2. Brasscraft.**
**3. Chicago Faucet Co.**

a. All Lavatory Types Unless Otherwise Noted:

1) Description: Lavatory waste outlets with open strainer waste & trap shall have a cast brass waste connection with brass compression ring and brass slip unit connected to concealed piping in wall. Connect to concealed piping using cast brass waste connection with brass compression ring and brass slip unit.

2) C.P. brass open strainer waste outlet with 17-gauge 1-1/4 inch tail piece, unless otherwise noted.

3) 1-1/4 inch by 1-1/2 inch cast brass P-trap with brass cleanout.

4) 17 gauge copper tubing wall outlet with set-screw type cast brass escutcheon.

5) Waste Outlets for handicap lavatories: Open strainer waste outlet with offset waste.

M. Fixture Supports - Manufacturers:

**1. J.R. Smith.**
**2. American Standard.**
**3. Chicago Faucet Co.**

a. All Lavatory Types Unless Otherwise Noted:

1) Description: For lavatories, provide concealed adjustable iron uprights with concealed arm chair carriers.
2) Locations: All lavatories.
3) For stud walls, supports with 3-inch x 1-inch rectangular uprights welded to base.
4) For Handicap Accessible Lavatories: Provide concealed adjustable iron arm chair carriers.

## 2.5 SINKS

A. Manufacturers: Fixtures.

1. Stainless Steel:

**a. Elkay.**
**b. Franke.**
**c. Just.**

B. Manufacturers: Faucets.

**1. Chicago.**
**2. Sloan.**
3. **American Standard**.

C. Sink Description: Two compartment, self-rimming, counter-mounting, stainless-steel commercial sink in counter with five (5) holes, faucet openings eight 8) inches on centers. Sink shall be No. 18 USSG genuine 18-8 solid stainless steel and shall be bonded to and reinforced with heavy gauge formed metal. Underside shall be sound deadened. Provide one piece with bowls welded integrally to tops. Horizontal and vertical corners of bowls shall be rounded to 1-3/4 inch radius. Joints shall be welded and ground smooth. Bottom shall be

pitched to drain outlet and drilled for trim as required. Provide wood strips for fastening top to cabinets.

1. Type SK1:

    a. Size: 33 inch x 21 ¼ inch x 5 ½ inch deep with five (5) holes, four (4) faucet openings one (1) stainless steel air-gap fitting (8) inches on centers.

D. Supplies, Stops, Fittings:

1. Chrome plated combination rigid supply fitting with grid strainer or crumb strainer, loose key stops, chrome plated trap and drain outlet.
2. Manufacturers:

    **a. Brasscraft.**
    **b. Chicago.**
    **c. Zurn.**

E. Waste Outlets - Manufacturers:

**1. American Standard Companies, Inc.**
**2. Brasscraft.**
**3. Chicago Faucet Co.**

a. Type: All Sinks.

1) Description:
2) Provide 316 stainless steel open strainer waste with 1 ½ inch 17 gauge copper tubing tailpiece.
3) 1-1/2 in. x 2 in., cast brass P-trap with cleanout, with 17 gage copper tubing.
4) Connect to concealed waste piping using C.P. cast brass wall outlet nipple with C.P. brass set screw and escutcheon.
5) Waste outlets for handicap stainless steel sinks: Provide open strainer waste.

b. Traps for handicap accessible fixtures shall run close to backwall to clear knees (if more than six [6] inches off wall). Provide ½ inch insulation on exposed drainage piping.

## 2.6 ELECTRIC WATER COOLERS

A. Manufacturers:

**1. Elkay.**
**2. Haws.**
**3. Halsey Taylor.**

B. Furnish materials in accordance with LADBS.

C. Fountain:

1. ARI 1010; stainless steel, single or dual height, type as required; with stainless steel top, stainless steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket, or floor anchored carrier refrigerated with integral air cooled condenser and stainless steel grille.
2. Capacity: 8 gph of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F.
3. Electrical: 115/1/60 compressor, 6 foot cord and plug for connection to electric wiring system including grounding connector.

## 2.7 WALL MOUNTED OPERATIONS LEVEL DRINKING FOUNTAINS

A. Drinking Fountains (combination high-low fountains at new construction):

1. Manufacturers:

**a. Elkay.**
**b. Halsey Taylor.**
**c. Haws.**

2. Type wall mount.
3. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting drinking fountain for adult, child and ADA-mounting height.

a. Cabinet: Single, all stainless steel.
b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
c. Control: Push button.
d. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
f. Drain(s): Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.1.
g. Support: Type I, drinking fountain carrier.

## 2.8 FIXTURE SUPPORTS

A. Manufacturers:

**1. J.R. Smith.**
**2. MIFAB.**
**3. Zurn.**

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Type I: Hanger-type carrier with two vertical uprights.
2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

## 2.9 MOP SINKS

A. Enameled Cast Iron or Terrazzo

B. Manufacturers:

**1. Commercial Enameling Co. 871**
2. Approved Equal
   a. American Standard.
   b. Kohler.

C. Floor Mounted Basin: 28”x28”x12” high minimum chrome plated strainer, rim guard, 3” cast iron P-trap with adjustable floor flange.

D. Faucet:

1. Exposed wall type supply with lever handles, spout wall brace, vacuum breaker, hose end spout, strainers, eccentric adjustable inlets, integral screwdriver stops with covering caps and adjustable threaded wall flanges.
2. Manufacturers:

**a. Chicago 305-VB-R**
b. Approved Equal
   1) Speakman.
   2) T & S Brass.

E. Accessories:

1. 5 feet of 1/2 inch diameter plain end reinforced plastic rubber hose.
2. Hose clamp hanger.
3. Mop hanger.

## 2.10 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers:

**a. Engineered Brass Co.**
**b. TRUEBRO, Inc.**
**c. Zurn.**

2. Description: Manufactured insulating wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

## 2.11 GARBAGE DISPOSER

A. Garbage disposer to be stainless steel grinder, chamber and blades, fully sound insulated, 1-horsepower, 120-volt, 1 phase, InSinkErator, Evolution Excel Series 3-stage grind, Jam-sensor circuit and sound baffle collar or approved equal.

B. Provide stainless steel or chrome plated air gap fitting at dishwasher only.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome plated rigid supplies to fixtures with loose key stops, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall supports, carriers and bolts.

E. Seal fixtures to wall and floor surfaces with sealant color to match fixture.

## 3.2 PLUMBING FIXTURE INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
4. Lag fixture carrier base plates or feet to slab with lead expansion shields and insert bolts in all bolt holes.
5. Where wall hung water closets are supported adjacent to stud walls, provide rear anchor foot assembly bolted to slab.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb as required.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves as required.

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

P. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

Q. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

R. Install shower flow-control fittings with specified maximum flow rates in shower arms.

S. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

T. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings.

U. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

## 3.3 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use mounting frames for recessed water coolers, unless otherwise indicated.

C. Set remote water coolers on floor, unless otherwise indicated.

D. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

## 3.4 DRINKING FOUNTAINS AND WATER COOLERS INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

1. On block walls, fasten wall hanger to 18 inch by 4 inch built-in iron backing plates,
2. Fasten wall hanger to concealed adjustable iron chair carrier. For block walls, use supports
3. For stud walls, use supports

C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation.

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

H. Do not install filter until after domestic water piping system has been disinfected and flushed.

END OF SECTION 22 40 00

# SECTION 22 40 00-PLUMBING FIXTURES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Water closets.
2. Urinals.
3. Lavatories.
4. Sinks.
5. Service sinks.
6. Electric water coolers.
7. Wash fountains.

### 1.2 REFERENCES

A. General: comply with appropriate standards.

1. American National Standards Institute: ANSI.
2. Air-Conditioning and Refrigeration Institute: ARI.
3. American Society of Mechanical Engineers: ASME.
4. American Society for Testing and Materials: ASTM.
5. California Energy Commission: CEC.
6. National Electrical Manufacturers Association: NEMA.
7. Americans with Disabilities Act: ADA.
8. Los Angeles Plumbing Code: LAPC.
9. Los Angeles Department of Building and Safety: LADBS
10. National Sanitation Foundation: NSF.
11. International Association of Plumbing and Mechanical Officials: IAPMO.
12. California State AB 1953.

### 1.3 SUBMITTALS

A. Submit data on all materials, fittings, accessories and equipment. Indicate materials, finishes, dimensions, construction details and flow control roles.

B. Manufacturer's Installation Instructions: Submit installation methods and procedures.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

D. CalGreen Submittal/ Tier Level Performance Requirements: Obtain LAWA Tier Level requirements for the project.

E. Shop Drawings: Diagram power, signal, and control wiring.

F. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

H. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

## 1.4 WARRANTY

A. Furnish five year minimum warranty.

## PART 2 - PRODUCTS

## 2.1 GENERAL

The following gallons per flush or flow in gallons per minute are required maximum flows for project:

| | |
|---|---|
| Water Closets Flushometer | 1.28 gallons per flush |
| Urinals Flushometer | 0.125 gallons per flush |
| Lavatory Faucet | 0.5 gallons per minute |
| Showers Heads | 1.5 gallons per minute |
| Pantry Sinks | 1.5 gallons per minute |
| Mop Sinks | Per ASME A112.18.1, 4.0 gallons per minute |

## 2.2 FLUSH VALVE WATER CLOSETS

A. Manufacturers: Vitreous China.

**1. American Standard. Afwall 2257.001**
   a. Approved manufacturers
      1) Kohler.
      2) Toto USA, Inc.

B. Manufacturers: Type 304 stainless steel

**1. Zurn.**
**2. Willoughby.**

C. Manufacturers: Flush Valves.

**1. Sloan.**
**2. Zurn.**
**3. American Standard.**

D. Bowl: ASME A112.19.2M; wall hung, siphon jet , with elongated rim, exposed top spud, or concealed back-size per flush valve requirements, bolt caps; floor anchored carrier.

E. Bowl: ASME A112.19.2M; floor mounted, siphon jet or blow out, with elongated rim, exposed top spud, or concealed back-size per flush valve requirements; bolt caps.

F. Disabled Access: Where required.

G. Exposed Flush Valve: ASME A112.18.1; exposed chrome plated, diaphragm type with oscillating handle, escutcheon, seat bumper, integral screwdriver stop and vacuum breaker 1.28 maximum gallon per flush.

H. Water Closet Flushometers:

1. Sensor Operated - Hard Wired:

a. Concealed diaphragm type, chrome plated, sensor operated flushometer valve. Low consumption valves shall have dual filtered type diaphragm kit for flush discharge accuracy. Valve shall be non-hold-open, solenoid operator, skirted high back pressure vacuum breaker with bottom hex coupling nut, back-check control stop will have free spinning vandal resistant stop cap and sweat solder adapter kit with cast set screw all flange. Valve shall include self-adaptive infrared sensor with indicator light, courtesy flush override button, (2) chrome plated wall cover plates (for 2-gag electrical box) with vandal resistant screws. Valve body, cover tailpiece and control stop will be in conformance with ASTM Alloy Classification for Semi-Red Brass. Valve shall be in compliance with the applicable sections of ASSE 1037, ANSI/ASME 112.19.6, and Military Specification V-29193 Standards. Sloan Optima 152-1.28 ES-S.

I. Seats.

1. Manufacturers:

**a. Olsenite 95C**
1) Approved Equals
a) American Standard.
b) Beneke.
c) Kohler.

2. Seat: Shall be white heavy-duty plastic, open front, extended back, self-sustaining hinge, brass bolts, without cover.

J. Carriers.

1. Manufacturers:

**a. J.R. Smith 600**
1) Approved Equal
a) Zurn.
b) MiFAB.

2. Carrier: ASME A112.6.1; adjustable or non-adjustable, cast iron or ductile iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers; single, double, vertical or horizontal type as required.

K. Water-Closet Supports:

1. Description: Combination carrier designed for accessible and standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
2. Concealed adjustable extra heavy cast iron combination drainage fitting and chair carriers with an adjustable base anchored to slab using all base support holes, rear anchor foot assembly for stud walls, adjustable cast iron outlet nipple and/or coupling, neoprene gasket and steel supporting bolts with chrome plated washers and cap nuts, equal to Smith Series No. 100, No. 200, No. 400, or No. 500 for siphon jet.

    a. For employee use bariatric supports for a 1000 pound load rating.

3. Set bowls for physically handicapped with top of seat 17 to 19 inches above floor and provide carrier, equal to Smith No. 600. For blowout, use Smith No. 620.

## 2.3 WALL HUNG URINALS

A. Manufacturers: Vitreous China

**1. American Standards 6590.001**
   a. Approved Equal
      1) Sloan.
      2) Kohler.

B. Manufacturers: Flush Valves.

**1. Sloan WEUS-1010.1311-0.13 ES-S**
   a. Approved Equal
      1) American Standard.
      2) Zurn.

C. Urinal: ASME A112.19.2M or ANSI Z124.9, wall hung washout or siphon jet, integral trap, exposed or concealed spud type, size per flush valve requirements, floor anchored carrier.
   1. Waterless urinals are unacceptable.

D. Exposed Flush Valve: ASME A112.18.1; exposed chrome plated, diaphragm type with oscillating handle, or push plate, escutcheon, integral screwdriver stop, vacuum breaker; equal to 0.125 gallon per flush.

E. Sensor Operated Flush Valve: ASME A112.18.1; concealed rough brass or exposed chrome plated, diaphragm type with low voltage or battery operated solenoid operator, infrared sensor

and over-ride button in chrome plated plate, wheel handle stop and vacuum breaker; equal to 0.13 gallon per flush.

F. Urinal Flushometers:

1. Sensor-Operated Hard-Wired:

a. Concealed diaphragm type, chrome plated, sensor operated flushometer valve. Low consumption valves shall have dual filtered type diaphragm kit for flush discharge accuracy. Valve shall be non-hold-open, solenoid operator, skirted high back pressure vacuum breaker with bottom hex coupling nut, back-check control stop will have free spinning vandal resistant stop cap and sweat solder adapter kit with cast set screw wall flange. Valve shall include Optima EL-1500 self-adaptive infrared sensor with indicator light, (2) chrome plated wall cover plates (for 2-gang electrical box) with vandal resistant screws. Valve, body, cover, tailpiece and control stop shall be in conformance with ASTM Alloy Classification for Semi-Red Brass. Valve shall be Sloan WEUS-1010.1311-0.13 ES-S.

G. Flush (Metering) Valve: ASME A112.18.1; exposed chrome plated, porous felt type for 1/2 inch supply with oscillating handle, or push button, screwdriver stop and vacuum breaker.

H. Carriers:

1. Manufacturers:
   **a. J.R. Smith. 0636 or 0637**
   b. Approved Equal
      1) Zurn.
      2) MiFAB.

2. Wall Mounted Carrier: ASME A112.6.1; cast iron or ductile iron frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs, elastometric gasket or approved setting compound, for fixture to flange connection.

I. Disabled Access: Approved type where required.

## 2.4 LAVATORIES

A. Manufacturers: Vitreous China/Porcelain Enameled Cast Iron.

**1. American Standard.**
**2. Kohler.**
**3. Crane.**

B. Manufacturers: Integral basin type.

**1. Corian self-draining with integral bowl or approved equal**

C. Manufacturers: Faucets.

**1. Sloan Solis EAF-275 CP**

2. Approved Equal
   a. Chicago.
   b. American Standard.

D. Wall Hung Basins: size as required, with 4 inch high back; drillings on 4 inch or 8 inch centers or single hold punch, rectangular basin with splash lip, front overflow, and soap depression.

E. Counter Top Basins: self-rimming lavatory-size as required with drillings on 4 inch or 8 inch centers, front overflow, soap depression, seal of putty, caulking, or concealed vinyl gasket.

F. Undercounter Lavatory: unglazed rim for under counter mount with rear overflow, size as required with drillings on 4 inch or 8 inch centers or single hole.

G. Manufacturers:

**1. American Standard Companies, Inc.**
**2. Brasscraft.**
**3. Chicago Faucet Co.**

H. Metered Faucet: ASME A112.18.1; chrome plated metered manual mixing faucet low voltage or battery operated solenoid operator and infrared sensor, water economy aerator spray and cover plate.

I. Disabled Access: Approved type where required with insulated stops, supplies, trap and drain outlet, offset grid strainer

J. Carriers: where required.

1. Manufacturers:

**a. J.R. Smith.**
**b. Zurn.**
**c. MiFAB.**

K. Lavatory insulation kit where required: Tru-Bro, Plumerex.

L. Waste Outlets - Manufacturers:

**1. American Standard.**
**2. Brasscraft.**
**3. Chicago Faucet Co.**

a. All Lavatory Types Unless Otherwise Noted:

1) Description: Lavatory waste outlets with open strainer waste & trap shall have a cast brass waste connection with brass compression ring and brass slip unit connected to conceal piping in wall. Connect to conceal piping using cast brass waste connection with brass compression ring and brass slip unit.

2) C.P. brass open strainer waste outlet with 17-gauge 1-1/4 inch tail piece, unless otherwise noted.

3) 1-1/4 inch by 1-1/2 inch cast brass P-trap with brass cleanout.

4) 17 gauge copper tubing wall outlet with set-screw type cast brass escutcheon.

5) Waste Outlets for handicap lavatories: Open strainer waste outlet with offset waste.

M. Fixture Supports - Manufacturers:

**1. J.R. Smith.**
**2. American Standard.**
**3. Chicago Faucet Co.**

a. All Lavatory Types Unless Otherwise Noted:

1) Description: For lavatories, provide concealed adjustable iron uprights with concealed arm chair carriers.
2) Locations: All lavatories.
3) For stud walls, supports with 3-inch x 1-inch rectangular uprights welded to base.
4) For Handicap Accessible Lavatories: Provide concealed adjustable iron arm chair carriers.

## 2.5 SINKS

A. Manufacturers: Fixtures.

1. Stainless Steel:

**a. Elkay.**
**b. Franke.**
**c. Just.**

B. Manufacturers: Faucets.

**1. Chicago.**
**2. Sloan.**
3. **American Standard**.

C. Warewashing Sink Description: Three compartment, self-rimming, counter-mounting, stainless-steel commercial sink with two integral metal drainboards in counter with five (5) holes, faucet openings eight (8) inches on centers. Sink shall be No. 18 USSG genuine 18-8 solid stainless steel and shall be bonded to and reinforced with heavy gauge formed metal. Underside shall be sound deadened. Provide one piece with bowls welded integrally to tops. Horizontal and vertical corners of bowls shall be rounded to 1-3/4 inch radius. Joints shall be

welded and ground smooth. Bottom shall be pitched to drain outlet and drilled for trim as required. Provide wood strips for fastening top to cabinets.

1. Type SK1:

    a. Size: 33 inch x 21 ¼ inch x 5 ½ inch deep with five (5) holes, four (4) faucet openings one (1) stainless steel air-gap fitting (8) inches on centers.

D. Supplies, Stops, Fittings:

1. Chrome plated combination rigid supply fitting with grid strainer or crumb strainer, loose key stops, chrome plated trap and drain outlet.
2. Manufacturers:

    **a. Brasscraft.**
    **b. Chicago.**
    **c. Zurn.**

E. Waste Outlets - Manufacturers:

**1. American Standard Companies, Inc.**
**2. Brasscraft.**
**3. Chicago Faucet Co.**

a. Type: All Sinks.

1) Description:
2) Provide 316 stainless steel open strainer waste with 1 ½ inch 17 gauge copper tubing tailpiece.
3) 1-1/2 in. x 2 in., cast brass P-trap without cleanout, with 17 gage copper tubing.
4) Connect to concealed waste piping using C.P. cast brass wall outlet nipple with C.P. brass set screw and escutcheon.
5) Waste outlets for handicap stainless steel sinks: Provide open strainer waste.

b. Traps for handicap accessible fixtures shall run close to backwall to clear knees (if more than six [6] inches off wall). Provide ½ inch insulation on exposed drainage piping.

## 2.6 ELECTRIC WATER COOLERS

A. Manufacturers:

**1. Elkay.**
**2. Haws.**
**3. Halsey Taylor.**

B. Furnish materials in accordance with LADBS.

C. Fountain:

1. ARI 1010; stainless steel, single or dual height, type as required; with stainless steel top, stainless steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket, or floor anchored carrier refrigerated with integral air cooled condenser and stainless steel grille.
2. Capacity: 8 gph of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F.
3. Electrical: 115/1/60 compressor, 6 foot cord and plug for connection to electric wiring system including grounding connector.

## 2.7 WALL MOUNTED OPERATIONS LEVEL DRINKING FOUNTAINS

A. Drinking Fountains (combination Hi-low fountains at new construction):

1. Manufacturers:

**a. Elkay.**
**b. Halsey Taylor.**
**c. Haws.**

2. Type wall mount.
3. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting drinking fountain for adult, child and ADA-mounting height.

a. Cabinet: Single, all stainless steel.
b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
c. Control: Push button.
d. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
f. Drain(s): Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.1.
g. Support: Type I, drinking fountain carrier.

## 2.8 FIXTURE SUPPORTS

A. Manufacturers:

**1. J.R. Smith.**
**2. MIFAB.**
**3. Zurn.**

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Type I: Hanger-type carrier with two vertical uprights.
2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

## 2.9 MOP SINKS

A. Enameled Cast Iron or Terrazzo

B. Manufacturers:

1. **Commercial Enameling Co. 871**
2. Approved Equal
   a. American Standard.
   b. Kohler.

C. Floor Mounted Basin: 28”x28”x12” high minimum chrome plated strainer, rim guard, 3” cast iron P-trap with adjustable floor flange.

D. Faucet:

1. Exposed wall type supply with lever handles, spout wall brace, vacuum breaker, hose end spout, strainers, eccentric adjustable inlets, integral screwdriver stops with covering caps and adjustable threaded wall flanges.
2. Manufacturers:

   **a. Chicago 305-VB-R**
   b. Approved Equal
      1) Speakman.
      2) T & S Brass.

E. Accessories:

1. 5 feet of 1/2 inch diameter plain end reinforced plastic rubber hose.
2. Hose clamp hanger.
3. Mop hanger.

## 2.10 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers:

   **a. Engineered Brass Co.**
   **b. TRUEBRO, Inc.**
   **c. Zurn.**

2. Description: Manufactured insulating wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

## 2.11 GARBAGE DISPOSER

A. Garbage disposer to be stainless steel grinder, chamber and blades, fully sound insulated, 1-horsepower, 120-volt, 1 phase, InSinkErator, Evolution Excel Series 3-stage grind, Jam-sensor circuit and sound baffle collar or approved equal.

B. Provide stainless steel or chrome plated air gap fitting at dishwasher only.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome plated rigid supplies to fixtures with loose key stops, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall supports, carriers and bolts.

E. Seal fixtures to wall and floor surfaces with sealant color to match fixture.

## 3.2 PLUMBING FIXTURE INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
4. Lag fixture carrier base plates or feet to slab with lead expansion shields and insert bolts in all bolt holes.
5. Where wall hung water closets are supported adjacent to stud walls, provide rear anchor foot assembly bolted to slab.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb as required.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves as required.

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

P. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

Q. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

R. Install shower flow-control fittings with specified maximum flow rates in shower arms.

S. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

T. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings.

U. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

## 3.3 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use mounting frames for recessed water coolers, unless otherwise indicated.

C. Set remote water coolers on floor, unless otherwise indicated.

D. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

## 3.4 DRINKING FOUNTAINS AND WATER COOLERS INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

1. On block walls, fasten wall hanger to 18 inch by 4 inch built-in iron backing plates,
2. Fasten wall hanger to concealed adjustable iron chair carrier. For block walls, use supports
3. For stud walls, use supports

C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation.

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

H. Do not install filter until after domestic water piping system has been disinfected and flushed.

END OF SECTION 22 40 00

# SECTION 22 40 00-PLUMBING FIXTURES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Water closets.
2. Urinals.
3. Lavatories.
4. Sinks.
5. Service sinks.
6. Electric water coolers.
7. Wash fountains.

### 1.2 REFERENCES

A. General: comply with appropriate standards.

1. American National Standards Institute: ANSI.
2. Air-Conditioning and Refrigeration Institute: ARI.
3. American Society of Mechanical Engineers: ASME.
4. American Society for Testing and Materials: ASTM.
5. California Energy Commission: CEC.
6. National Electrical Manufacturers Association: NEMA.
7. Americans with Disabilities Act: ADA.
8. Los Angeles Plumbing Code: LAPC.
9. Los Angeles Department of Building and Safety: LADBS
10. National Sanitation Foundation: NSF.
11. International Association of Plumbing and Mechanical Officials: IAPMO.
12. California State AB 1953.

### 1.3 SUBMITTALS

A. Submit data on all materials, fittings, accessories and equipment. Indicate materials, finishes, dimensions, construction details and flow control roles.

B. Manufacturer's Installation Instructions: Submit installation methods and procedures.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

D. CalGreen Submittal/ Tier Level Performance Requirements: Obtain LAWA Tier Level requirements for the project.

E. Shop Drawings: Diagram power, signal, and control wiring.

F. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

H. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

## 1.4 WARRANTY

A. Furnish five year minimum warranty.

## PART 2 - PRODUCTS

## 2.1 GENERAL

The following gallons per flush or flow in gallons per minute are required maximum flows for project:

| | |
|---|---|
| Water Closets Flushometer | 1.28 gallons per flush |
| Urinals Flushometer | 0.125 gallons per flush |
| Lavatory Faucet | 0.5 gallons per minute |
| Showers Heads | 1.5 gallons per minute |
| Pantry Sinks | 1.5 gallons per minute |
| Mop Sinks | Per ASME A112.18.1, 4.0 gallons per minute |

## 2.2 FLUSH VALVE WATER CLOSETS

A. Manufacturers: Vitreous China.

1. **American Standard. Afwall 2257.001**
   a. Approved manufacturers
      1) Kohler.
      2) Toto USA, Inc.

B. Manufacturers: Type 304 stainless steel

1. **Zurn.**
2. **Willoughby.**

C. Manufacturers: Flush Valves.

1. **Sloan.**
2. **Zurn.**
3. **American Standard.**

D. Bowl: ASME A112.19.2M; wall hung, siphon jet , with elongated rim, exposed top spud, or concealed back-size per flush valve requirements, bolt caps; floor anchored carrier.

E. Bowl: ASME A112.19.2M; floor mounted, siphon jet or blow out, with elongated rim, exposed top spud, or concealed back-size per flush valve requirements; bolt caps.

F. Disabled Access: Where required.

G. Exposed Flush Valve: ASME A112.18.1; exposed chrome plated, diaphragm type with oscillating handle, escutcheon, seat bumper, integral screwdriver stop and vacuum breaker 1.28 maximum gallon per flush.

H. Water Closet Flushometers:

1. Sensor Operated - Hard Wired:

a. Concealed diaphragm type, chrome plated, sensor operated flushometer valve. Low consumption valves shall have dual filtered type diaphragm kit for flush discharge accuracy. Valve shall be non-hold-open, solenoid operator, skirted high back pressure vacuum breaker with bottom hex coupling nut, back-check control stop will have free spinning vandal resistant stop cap and sweat solder adapter kit with cast set screw all flange. Valve shall include self-adaptive infrared sensor with indicator light, courtesy flush override button, (2) chrome plated wall cover plates (for 2-gag electrical box) with vandal resistant screws. Valve body, cover tailpiece and control stop will be in conformance with ASTM Alloy Classification for Semi-Red Brass. Valve shall be in compliance with the applicable sections of ASSE 1037, ANSI/ASME 112.19.6, and Military Specification V-29193 Standards. Sloan Optima 152-1.28 ES-S.

I. Seats.

1. Manufacturers:

**a. Olsenite 95C**
1) Approved Equals
a) American Standard.
b) Beneke.
c) Kohler.

2. Seat: Shall be white heavy-duty plastic, open front, extended back, self-sustaining hinge, brass bolts, without cover.

J. Carriers.

1. Manufacturers:

**a. J.R. Smith 600**
1) Approved Equal
a) Zurn.
b) MiFAB.

2. Carrier: ASME A112.6.1; adjustable or non-adjustable, cast iron or ductile iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers; single, double, vertical or horizontal type as required.

K. Water-Closet Supports:

1. Description: Combination carrier designed for accessible and standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
2. Concealed adjustable extra heavy cast iron combination drainage fitting and chair carriers with an adjustable base anchored to slab using all base support holes, rear anchor foot assembly for stud walls, adjustable cast iron outlet nipple and/or coupling, neoprene gasket and steel supporting bolts with chrome plated washers and cap nuts, equal to Smith Series No. 100, No. 200, No. 400, or No. 500 for siphon jet.

    a. For employee use bariatric supports for a 1000 pound load rating.

3. Set bowls for physically handicapped with top of seat 17 to 19 inches above floor and provide carrier, equal to Smith No. 600. For blowout, use Smith No. 620.

## 2.3 WALL HUNG URINALS

A. Manufacturers: Vitreous China

**1. American Standard 6590.001**
   a. Approved Equal
      1) Sloan.
      2) Kohler.

B. Manufacturers: Flush Valves.

**1. Sloan WEUS-1010.1311-0.13 ES-S**
   a. Approved Equal
      1) American Standard.
      2) Zurn.

C. Urinal: ASME A112.19.2M or ANSI Z124.9, wall hung washout or siphon jet, integral trap, exposed or concealed spud type, size per flush valve requirements, floor anchored carrier.
1. Waterless urinals are unacceptable.

D. Exposed Flush Valve: ASME A112.18.1; exposed chrome plated, diaphragm type with oscillating handle, or push plate, escutcheon, integral screwdriver stop, vacuum breaker; equal to 0.125 gallon per flush.

E. Sensor Operated Flush Valve: ASME A112.18.1; concealed rough brass or exposed chrome plated, diaphragm type with low voltage or battery operated solenoid operator, infrared

sensor and over-ride button in chrome plated plate, wheel handle stop and vacuum breaker; equal to 0.13 gallon per flush.

F. Urinal Flushometers:

1. Sensor-Operated Hard-Wired:

a. Concealed diaphragm type, chrome plated, sensor operated flushometer valve. Low consumption valves shall have dual filtered type diaphragm kit for flush discharge accuracy. Valve shall be non-hold-open, solenoid operator, skirted high back pressure vacuum breaker with bottom hex coupling nut, back-check control stop will have free spinning vandal resistant stop cap and sweat solder adapter kit with cast set screw wall flange. Valve shall include Optima EL-1500 self-adaptive infrared sensor with indicator light, (2) chrome plated wall cover plates (for 2-gang electrical box) with vandal resistant screws. Valve, body, cover, tailpiece and control stop shall be in conformance with ASTM Alloy Classification for Semi-Red Brass. Valve shall be Sloan WEUS-1010.1311-0.13 ES-S.

G. Flush (Metering) Valve: ASME A112.18.1; exposed chrome plated, porous felt type for 1/2 inch supply with oscillating handle, or push button, screwdriver stop and vacuum breaker.

H. Carriers:

1. Manufacturers:
   **a. J.R. Smith. 0636 or 0637**
   b. Approved Equal
      1) Zurn.
      2) MiFAB.

2. Wall Mounted Carrier: ASME A112.6.1; cast iron or ductile iron frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs, elastometric gasket or approved setting compound, for fixture to flange connection.

I. Disabled Access: Approved type where required.

## 2.4 LAVATORIES

A. Manufacturers: Vitreous China/Porcelain Enameled Cast Iron.

**1. American Standard.**
**2. Kohler.**
**3. Crane.**

B. Manufacturers: Integral basin type.

**1. Corian self-draining with integral bowl or approved equal**

**2. Du Pont Corian (or equal) integral Linear Lavatory.**

See separate 'Linear Lavatory' document

C. Manufacturers:
1. Deck mounted Faucets. Sensor-Operated Hard-Wired.
   **a. Sloan Solis EAF-275 CP**
   b. Approved Equal
      1) Chicago.
      2) American Standard.

2. Wall mounted Faucets. Sensor- Operated Hard-Wired.
   **a. Lovair L-182C. Polished chrome.**

3. Wall mounted Soap Dispenser. Pump Activated.
   **a. Lovair L-484C. Polished chrome.**

D. Wall Hung Basins: size as required, with 4 inch high back; drillings on 4 inch or 8 inch centers or single hold punch, rectangular basin with splash lip, front overflow, and soap depression.

E. Counter Top Basins: self-rimming lavatory-size as required with drillings on 4 inch or 8 inch centers, front overflow, soap depression, seal of putty, caulking, or concealed vinyl gasket.

F. Undercounter Lavatory: unglazed rim for under counter mount with rear overflow, size as required with drillings on 4 inch or 8 inch centers or single hole.

G. Manufacturers:

**1. American Standard Companies, Inc.**
**2. Brasscraft.**
**3. Chicago Faucet Co.**

H. Metered Faucet: ASME A112.18.1; chrome plated metered manual mixing faucet low voltage or battery operated solenoid operator and infrared sensor, water economy aerator spray and cover plate.

I. Disabled Access: Approved type where required with insulated stops, supplies, trap and drain outlet, offset grid strainer

J. Carriers: where required.

1. Manufacturers:

   **a. J.R. Smith.**
   **b. Zurn.**

**c. MiFAB.**

K. Lavatory insulation kit where required: Tru-Bro, Plumerex.

L. Waste Outlets - Manufacturers:

**1. American Standard.**
**2. Brasscraft.**
**3. Chicago Faucet Co.**

a. All Lavatory Types Unless Otherwise Noted:

1) Description: Lavatory waste outlets with open strainer waste & trap shall have a cast brass waste connection with brass compression ring and brass slip unit connected to conceal piping in wall. Connect to conceal piping using cast brass waste connection with brass compression ring and brass slip unit.
2) C.P. brass open strainer waste outlet with 17-gauge 1-1/4 inch tail piece, unless otherwise noted.

3) 1-1/4 inch by 1-1/2 inch cast brass P-trap with brass cleanout.

4) 17 gauge copper tubing wall outlet with set-screw type cast brass escutcheon.

5) Waste Outlets for handicap lavatories: Open strainer waste outlet with offset waste.

M. Fixture Supports - Manufacturers:

**1. J.R. Smith.**
**2. American Standard.**
**3. Chicago Faucet Co.**

a. All Lavatory Types Unless Otherwise Noted:

1) Description: For lavatories, provide concealed adjustable iron uprights with concealed arm chair carriers.
2) Locations: All lavatories.
3) For stud walls, supports with 3-inch x 1-inch rectangular uprights welded to base.
4) For Handicap Accessible Lavatories: Provide concealed adjustable iron arm chair carriers.

## 2.5 SINKS

A. Manufacturers: Fixtures.

1. Stainless Steel:

**a. Elkay.**
**b. Franke.**

**c. Just.**

B. Manufacturers: Faucets.

**1. Chicago.**
**2. Sloan.**
3. **American Standard**.

C. Warewashing Sink Description: Three compartment, self-rimming, counter-mounting, stainless-steel commercial sink with two integral metal drainboards in counter with five (5) holes, faucet openings eight 8) inches on centers. Sink shall be No. 18 USSG genuine 18-8 solid stainless steel and shall be bonded to and reinforced with heavy gauge formed metal. Underside shall be sound deadened. Provide one piece with bowls welded integrally to tops. Horizontal and vertical corners of bowls shall be rounded to 1-3/4 inch radius. Joints shall be welded and ground smooth. Bottom shall be pitched to drain outlet and drilled for trim as required. Provide wood strips for fastening top to cabinets.

1. Type SK1:

a. Size: 33 inch x 21 ¼ inch x 5 ½ inch deep with five (5) holes, four (4) faucet openings one (1) stainless steel air-gap fitting (8) inches on centers.

D. Supplies, Stops, Fittings:

1. Chrome plated combination rigid supply fitting with grid strainer or crumb strainer, loose key stops, chrome plated trap and drain outlet.
2. Manufacturers:

**a. Brasscraft.**
**b. Chicago.**
**c. Zurn.**

E. Waste Outlets - Manufacturers:

**1. American Standard Companies, Inc.**
**2. Brasscraft.**
**3. Chicago Faucet Co.**

a. Type: All Sinks.

1) Description:
2) Provide 316 stainless steel open strainer waste with 1 ½ inch 17 gauge copper tubing tailpiece.
3) 1-1/2 in. x 2 in., cast brass P-trap without cleanout, with 17 gage copper tubing.
4) Connect to concealed waste piping using C.P. cast brass wall outlet nipple with C.P. brass set screw and escutcheon.
5) Waste outlets for handicap stainless steel sinks: Provide open strainer waste.

b. Traps for handicap accessible fixtures shall run close to backwall to clear knees (if more than six [6] inches off wall). Provide ½ inch insulation on exposed drainage piping.

## 2.6 ELECTRIC WATER COOLERS

A. Manufacturers:

**1. Elkay.**
**2. Haws.**
**3. Halsey Taylor.**

B. Furnish materials in accordance with LADBS.

C. Fountain:

1. ARI 1010; stainless steel, single or dual height, type as required; with stainless steel top, stainless steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket, or floor anchored carrier refrigerated with integral air cooled condenser and stainless steel grille.
2. Capacity: 8 gph of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F.
3. Electrical: 115/1/60 compressor, 6 foot cord and plug for connection to electric wiring system including grounding connector.

## 2.7 WALL MOUNTED OPERATIONS LEVEL DRINKING FOUNTAINS

A. Drinking Fountains (combination Hi-low fountains at new construction):

1. Manufacturers:

**a. Elkay.**
**b. Halsey Taylor.**
**c. Haws.**

2. Type wall mount.
3. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting drinking fountain for adult, child and ADA-mounting height.

a. Cabinet: Single, all stainless steel.
b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
c. Control: Push button.
d. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
f. Drain(s): Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.1.
g. Support: Type I, drinking fountain carrier.

## 2.8 FIXTURE SUPPORTS

A. Manufacturers:

1. **J.R. Smith.**
2. **MIFAB.**
3. **Zurn.**

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Type I: Hanger-type carrier with two vertical uprights.
2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

## 2.9 MOP SINKS

A. Enameled Cast Iron or Terrazzo

B. Manufacturers:

1. **Commercial Enameling Co. 871**
2. Approved Equal
   a. American Standard.
   b. Kohler.

C. Floor Mounted Basin: 28”x28”x12” high minimum chrome plated strainer, rim guard, 3” cast iron P-trap with adjustable floor flange.

D. Faucet:

1. Exposed wall type supply with lever handles, spout wall brace, vacuum breaker, hose end spout, strainers, eccentric adjustable inlets, integral screwdriver stops with covering caps and adjustable threaded wall flanges.
2. Manufacturers:

   **a. Chicago 305-VB-R**
   b. Approved Equal
      1) Speakman.
      2) T & S Brass.

E. Accessories:

1. 5 feet of 1/2 inch diameter plain end reinforced plastic rubber hose.
2. Hose clamp hanger.
3. Mop hanger.

## 2.10 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers:

   **a. Engineered Brass Co.**
   **b. TRUEBRO, Inc.**
   **c. Zurn.**

2. Description: Manufactured insulating wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

## 2.11 GARBAGE DISPOSER

A. Garbage disposer to be stainless steel grinder, chamber and blades, fully sound insulated, 1-horsepower, 120-volt, 1 phase, InSinkErator, Evolution Excel Series 3-stage grind, Jam-sensor circuit and sound baffle collar or approved equal.

B. Provide stainless steel or chrome plated air gap fitting at dishwasher only.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome plated rigid supplies to fixtures with loose key stops, reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall supports, carriers and bolts.

E. Seal fixtures to wall and floor surfaces with sealant color to match fixture.

## 3.2 PLUMBING FIXTURE INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

4. Lag fixture carrier base plates or feet to slab with lead expansion shields and insert bolts in all bolt holes.
5. Where wall hung water closets are supported adjacent to stud walls, provide rear anchor foot assembly bolted to slab.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb as required.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves as required.

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

P. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

Q. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

R. Install shower flow-control fittings with specified maximum flow rates in shower arms.

S. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

T. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings.

U. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

## 3.3 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Use mounting frames for recessed water coolers, unless otherwise indicated.

C. Set remote water coolers on floor, unless otherwise indicated.

D. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

## 3.4 DRINKING FOUNTAINS AND WATER COOLERS INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

1. On block walls, fasten wall hanger to 18 inch by 4 inch built-in iron backing plates,
2. Fasten wall hanger to concealed adjustable iron chair carrier. For block walls, use supports
3. For stud walls, use supports

C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation.

E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

H. Do not install filter until after domestic water piping system has been disinfected and flushed.

END OF SECTION 22 40 00

**SECTION 23 05 00-COMMON WORK RESULTS FOR HVAC**

**PART 1 - GENERAL**

**1.1 SUMMARY**

A. This Section supplements all Sections of this Division and shall apply to all phases of Work required to provide for complete installation of mechanical system.

> **NOTE:** Duct velocities shall be limited to values that ensure that the regenerated noise due to air movement is not excessive and is compliant with applicable noise criteria. Vibration isolation is recommended for all HVAC equipment. All suspended piping related to the mechanical system shall be isolated from the building structure.

**1.2 QUALITY REQUIREMENTS**

A. General Requirements.

1. All electrical Work performed under this Division shall be installed by competent craftsmen, skilled in the trade involved, and shall be installed in conformance with all applicable local codes.
2. Installation of all items shall be performed in strict accordance with all codes and regulations set forth by State, Local, and Federal authorities.

B. Requirements of Regulatory Agencies:

1. Codes and Ordinances.

a. All Work shall meet the requirements of local codes, ordinances, and utility companies except adhere to the Contract Documents when more strict requirements are specified.
b. Codes which govern mechanical Work in this Project are as follows:

1) California Plumbing Code
2) California Electrical Code
3) ASME Boiler Code
4) NFPA Life Safety Code l0l
5) NFPA 90A
6) NFPA l3
7) Factory Mutual Standards
8) California Mechanical Code
9) American Gas Association
10) California State Fire Marshal Regulations.
11) City of Los Angeles Mechanical Code.
12) City of Los Angeles Plumbing Code.
13) City of Los Angeles Electrical Code.
14) City of Los Angeles Building Code.

15) City of Los Angeles Fire Code.

C. Source Quality Control:

1. Manufacturer's Tests. All materials shall, so far as possible, be subjected to standard tests by the manufacturer before shipment.

## 1.3 SUBMITTALS

A. Shop Drawings and Product Data:

1. General requirements for all shop drawings are specified elsewhere in these specifications. Check individual sections for any specific submittal requirements.

B. Operation and Maintenance Data:

1. Maintenance Manuals.

a. Furnish two sets of maintenance manuals, each containing items specified below. Furnish manuals to LAWA before final acceptance of the mechanical Work.
b. Definitions Applicable to the Maintenance Manuals.

1) Literature. Any page (either whole or in part), sheet, drawing, or booklet describing the maintenance, operation, and parts of mechanical equipment, which is furnished either in the shipping carton, attached to the equipment, or otherwise prepared and distributed by the manufacturer for the user, not limited to papers submitted as shop drawings.
2) Mechanical Equipment. All major items shown in the Mechanical Division Drawings and Work for which shop drawings are requested except the following: thermometers, expansion tanks, air separating tanks, insulation materials, vibration isolation equipment, plumbing drains and fixture carriers, and boiler stack.
3) Instructions. An outline written by the Contractor with information necessary to help LAWA apply the maintenance manual and simplify verbal instructions.

c. Collection of "Literature." Collect "literature" in like new condition, of all pieces of "mechanical equipment" until two copies of each are obtained. Copies soiled during construction will not be accepted.
d. Assembly of "Literature."

1) Assemble "literature" in separate, multiples of two, 3-ring loose leaf binders, 2 inches (50 mm) size, with chrome-plated piano hinges and black hard coated covers.
2) Small or large "literature" not easily inserted in binders shall each be put in heavy manila envelopes.
3) Furnish each binder with plastic enclosed tabs on reinforced paper neatly arranged. Type each of the following on a separate tab.

a) Instructions
b) Valve Charts
c) Accessories
d) Lubrication
e) Testing and Balancing Reports
f) Each Specification and Title in the Project Specification for which "Literature" has been collected.

4) File "instructions" envelopes and "literature" under correct tabs. Clearly identify each piece of "literature" and envelope with equipment name and numbers.

e. Valve Charts.

1) Format. Arrange format of valve charts by rooms and sequence all valve numbers starting with mechanical equipment rooms and finishing with "occupied spaces."
2) Information. Furnish the following information typed on valve charts for each valve furnished throughout the Project in the Mechanical Division, except check valves and automatic valves.

a) Room numbers and name where valve is located, i.e. "ZG boiler room."
b) Valve number assigned by Contractor and stamped on brass plate, i.e. "l47."
c) Service medium using designation assigned to Drawings on mechanical symbols, i.e. "heating hot water supply" or "plumbing cold water."
d) Valve types as specified herein.
e) Function valve serves, i.e. "strainer shut-off" or "balancing valve."
f) Zone identification, i.e. "AHU-2" or "auxiliary heating."

3) Insert Charts in Manuals.

f. Lubrication Charts. Furnish a chart listing each lubricated piece of equipment, the proper type of oil or grease required, and recommended frequency of lubrication. Insert charts in manuals.

g. Accessories.

1) Furnish LAWA with a complete equipment accessory schedule listing each piece of equipment and the related size, type, number required, and manufacturer of the following items.

a) Filters
b) Fan Belts
c) Refrigerant Dryers

2) Insert Schedules in Manuals.

h. Insert 2 copies each of correct testing and balancing reports in manuals.

2. Instructions in Operation.

a. After all tests and adjustments have been made and the maintenance manual has been completed and given to LAWA, furnish one or more full-time qualified personnel as necessary to put the mechanical Work in continuous operation for a period of not less than two days, during which time the designated personnel's only purpose shall be to give complete operating and maintenance instructions to LAWA.

## 1.4 JOB CONDITIONS

A. Existing Conditions:

1. Existing Pipe Lines.

a. If any existing water, gas, or other pipes and appurtenances are encountered which interfere with the proper installation of new Work and which will not be used in connection with new Work, or existing systems, close such pipe in a proper manner, and if necessary, move or remove the pipes as directed by LAWA
b. Where existing Work is to be modified, it shall be done in conformance with the Specifications. Materials used shall be same as existing unless otherwise specified.

B. Sequencing, Scheduling:

1. Coordination of Work.

a. Plan all Work so that it proceeds with a minimum of interference with other trades. Inform the general Contractor of all openings required in the building construction for the installation of mechanical Work. Provisions shall be made for all special frames, openings, and pipe sleeves as required. The mechanical Contractor shall pay for all extra cutting and patching made necessary by his failure to properly direct such Work at the correct time.
b. Verify local utility company's inspection requirements and abide by their rights of inspection before covering or otherwise concealing any piping, wiring, or equipment.

# PART 2 - PRODUCTS

## 2.1 MATERIALS

A. Electrical.

1. All motors, starters, or any other electrical components furnished or installed under the mechanical Division shall be in complete compliance with Division 26, ELECTRICAL.

2. Unless otherwise specified, all electric motors, provided under this Division shall be 60 hertz. All motors shall be single phase or 3-phase as indicated on the Drawings. Motor starters shall be as scheduled on the Drawings or specified herein. If motors appliances or apparatus are furnished varying in horsepower and/or characteristics from those specified, accommodate the change at no additional cost to LAWA.

    a. All fan and pump motors shall be of the premium efficiency type, NEMA Design A or B, continuous rated:

| GUARANTEED MINIMUM FULL LOAD EFFICIENCY | | |
|---|---|---|
| Rated HP | Nominal 1200 RPM | Nominal 1800 RPM |
| 1 | 82.5 | 85.5 |
| 1.5 | 86.5 | 86.5 |
| 2 | 87.5 | 86.5 |
| 3 | 89.5 | 89.5 |
| 5 | 89.5 | 89.5 |
| 7.5 | 91.7 | 91.0 |
| 10 | 91.7 | 91.7 |
| 15 | 92.4 | 93.0 |
| 20 | 92.4 | 93.0 |
| 25 | 93.0 | 93.6 |
| 30 | 93.6 | 94.1 |
| 40 | 94.1 | 94.1 |
| 50 | 94.1 | 94.5 |
| 60 | 95.0 | 95.0 |
| 75 | 95.0 | 95.0 |
| 100 | 95.0 | 95.4 |
| 125 | 95.4 | 95.4 |
| 150 | 95.8 | 95.8 |
| 200 | 95.4 | 95.8 |

B. Electrical.

1. Raceways. Furnish UL approved rigid conduit raceways, sized in accordance with the allowable fill permitted by the National Electric Code.
2. Junction Boxes. Provide Appleton Electric Company, No. 4S-3/4 for interior use and "FS" series with cast cover and neoprene gaskets for exterior use. Size junction boxes in accordance with the allowable fill permitted by the National Electric Code.
3. Conductors. Furnish conductors conforming to UL, Fed. Specification. J-C-30, or IPCEA as applicable. Provide recently manufactured cable with guarantees and warranties initiated during the Contract period.

C. Equipment Identification.

1. Provide for each motor driven piece of equipment a "Dymo tape" identification tag, or 3M Tape shall be l/2 inch (l3 mm) wide with color and location as directed.

D. Access to Equipment.

1. All motors, valves, control devices, equipment, specialties, etc. shall be located for easy access for operation, repair and maintenance. If items are concealed, provide access doors of size required for easy access to the items.

E. List of Materials and Equipment

1. All items of material and equipment required by this section shall bear the approval of the LAWA prior to the start of any work. The Contractor shall submit all items requiring such approval, allowing ample time for checking and processing, and shall assume all responsibility for delays incurred due to rejected items. Neatly bind together submittal information covering all items into one or several packages; separate submittal of individual items not allowed. The procedure for submitting material shall be as specified herein. Within thirty (30) days after award of Contract, submit for approval, product information with at least the following minimum data for all materials, appurtenances, and equipment required under this section, including where applicable:

    a. Job name.
    b. Job location.
    c. Governing specification paragraph or subparagraphs, and governing drawing number.
    d. Dimensional information.
    e. Performance ratings, including at least the following, where applicable:

        1) Capacity in Btu per Hour.
        2) Water quantity.
        3) Entering and leaving water temperatures.
        4) Water pressure drop.
        5) Fouling factor.

    f. Pump size, RPM.
    g. Design working pressures.
    h. Motor horsepower and/or current rating; equipment current rating; voltage characteristics.
    i. Wiring diagrams for all equipment and control systems under this section requiring electrical connections.
    j. Cuts of all equipment, controls, thermometers, gauges and temperature indicators.

F. Substitutions and equal products

1. Named Manufacturers

    a. All design has been done with the first named equipment in each specification section of this Division.
    b. The first named manufacturer is the standard of quality, performance, space requirements, and coordination with other Divisions on the project.
    c. Any names beyond the first named is an acceptable manufacturer. However, being listed as an acceptable manufacturer does not imply that the manufacturer has a

product that meets or exceeds the project requirements. Contractor shall verify if these manufacturers provide items that meet or exceed the specifications.

d. All submittals of any manufacturer beyond the first named manufacturer shall be considered substitutions, shall be made in the form of substitutions, and will be reviewed as substitutions.
e. If an item is provided from a manufacturer that is not the first named, or a model number that is different from the Contract Documents, it is the Contractor's responsibility to determine that the item can be installed in the available location.

    1) Any redesign and change in installation methodology, and connections involved shall be the Contractor's responsibility, including coordination with all other trades.
    2) All costs for the changes of all trades involved shall be borne by the Contractor.
    3) Contractor shall pay for any redesign required.
    4) Contractor shall pay for and obtain any additional plan checks as a result of the substitution.
    5) Contractor shall provide dimensioned drawings of the revised installation with the submittal of the item.

## PART 3 - EXECUTION

### 3.1 INSTALLATION/APPLICATION/PERFORMANCE/ERECTION

A. Installation:

1. General.

    a. Cooperate with all other Contractors in furnishing material and information for correct location, in proper sequence, of all sleeves, bucks, inserts, foundations, wiring, etc.
    b. All piping connections to equipment shall be made with unions or flanges to permit dismantling. Flanges and unions shall also be installed in the piping systems to permit disassembly consistent with good installation practice and as required for removal of connected equipment from place of installation.

2. All belt drives, flexible couplings, and other exposed rotating or reciprocating parts shall be covered with OSHA approved safety covers. Covers shall be permanent type and easily removable.
3. All motors and bearings shall be covered with watertight and dust-proof covers during construction period.
4. Sleeves, frames, and wall pipes shall be furnished and installed for all pipes and ducts, passing through concrete floors and walls and shall be coordinated with other trades. Special sleeves through floors and walls shall be installed in accordance with manufacturers printed instructions and as detailed.

    a. All sleeves and frames through exterior floors and walls above ground and all interior floors and walls shall be black iron pipe unless otherwise noted. Sleeves

and frames shall be of a size to accommodate the pipe or duct and insulation. Sleeves and frames shall be grouted in place with installation left smooth and finished to match surrounding surfaces.

b. Pipes passing through exterior floors and walls below ground, 3 inch (75 mm) and larger, shall utilize cast iron wall pipes unless noted or detailed otherwise. The wall pipe shall be used to convey the liquid or gas through the floor or wall without the use of sleeves. Wall pipes shall be furnished complete with end connections and adapters required to connect to the piping material. Size of wall pipe shall equal or exceed the maximum pipe size connected thereto. Wall pipes shall be integrally cast into floor or wall construction and provide the best possible seal at the exterior exposure.

c. Pipes passing through exterior floors and walls below ground, 2-1/2 inch (63 mm) and smaller, shall utilize black iron pipe sleeves as specified for aboveground in conjunction with a modular mechanical type seal as hereinafter specified.

    1) The modular mechanical type seal shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. Tightening of the bolts shall cause the rubber sealing elements to expand providing a watertight seal between the pipe and wall sleeve.
    2) The required inside diameter of the sleeve and the installation of the seal shall be coordinated with the seal manufacturer to provide a watertight joint. Seals shall be "Link Seal" manufactured by Thunderline Corporation. A seal consisting of a combination of a sleeve and a pressure clamping system manufactured by O. Z. Manufacturing is acceptable.

d. Cutting of openings and installation of sleeves and frames through exterior floors and walls above grade, and interior floors and walls shall be done in a neat, workmanlike manner. Openings shall be cut only as large as required for the installation.

    1) At fire-rated floor and wall penetrations, provide penetration sealant as specified in herein.

e. Sleeves and frames at floors and walls in concealed locations and in unfinished spaces such as mechanical rooms, etc. shall extend 1 inch (25 mm) from the finished surface. All other sleeves at floors shall extend 1/4 inch (6 mm) from finished floor surface, but shall allow placement of escutcheons. All other sleeves at walls shall be installed flush with finished surface.

f. Escutcheons for exposed pipe through floors and walls where exposed to view shall be provided and shall be chromium plated except where special escutcheons are required under plumbing fixtures. Escutcheons shall be sized sufficiently to conceal the floor or wall opening and sleeve.

5. Interference.

    a. Wherever piping runs on ceilings, arrange the run of the piping in such a manner that it does not interfere with grilles, light outlets or light fixtures.

6. Valves.

    a. Valves shall be provided on all piping wherever shown or specified using adapters where required. All removable or replaceable equipment shall be valved. All valves shall have a securely fastened stamped brass metal plate each bearing a different number identified in the maintenance manual.

7. Openings in Pipes.

    a. All openings in pipes shall be kept closed during the progress of the Work.

8. Lubrication.

    a. Provide all lubrication for the operation of all equipment until substantial completion of the Project. Run in all bearings, and after they are run in, drain and flush bearings and refill with a new oil change. Refer to maintenance manual specification for lubrication chart.

## 3.2 ADJUSTMENT AND CLEANING

A. Safety Devices. Thoroughly check all safety devices to assure proper operation and protection.

B. Service.

1. Perform service on all mechanical Work until the date of substantial completion including oiling and greasing, adjustments, cleaning, packing of seals, and other items as recommended by equipment manufacturer in the maintenance manual hereinbefore specified.
2. Air filters.

    a. Do not operate air moving equipment having air filters unless temporary filters are in place to protect the mechanical Work.
    b. Clean or replace these temporary filters before final test and balance Work is begun as necessary for accurate readings. After completing the testing and balancing Work, replace temporary filters with new filter media as specified.

3. Strainers.

    a. Remove, clean and reinstall each strainer screen as specified below after systems have been flushed as specified in other sections of Division 23.

        1) Clean each strainer after all adjustments have been made and system has operated a minimum of 24 hours, but before final test and balancing operation is started.
        2) Clean each strainer again, after final test and balancing operation and before substantial completion of the Project.

    b. Certain screens may remain out of the strainer body after removal during the final cleaning only as directed by the LAWA.

4. Purge all air from water systems after each servicing.

    a. Protect all furnishings and finishes during each servicing operation, and repair or replace to original condition, those damaged as a result of servicing.

5. Replace insulation removed or damaged after each operation. Leave insulation as specified herein.
6. Contractor may coordinate servicing operations with LAWA's operating personnel so as to coincide with time interval specified for instruction in operation.
7. Put system in full operating condition before substantial completion of the Project.

C. Alarms. Test and adjust alarms for satisfactory operation.

D. Tests and Adjustments. Upon completion of the installation and before substantial completion of the Project, the Contractor shall make all necessary tests and adjustments to place the system in a working condition. Systems shall be balanced as specified herein. The general operating tests shall cover a period of not less than 12 hours after completion of final testing and balancing, and shall demonstrate that the entire equipment is functioning in accordance with the Specifications. Furnish all instruments, test equipment, and competent personnel that are required for the tests.

END OF SECTION 23 05 00

# SECTION 23 05 16-EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Flexible pipe connectors.
2. Expansion joints.
3. Expansion compensators.
4. Pipe alignment guides.
5. Pipe anchors.

### 1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.
4. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

C. City of Los Angeles Codes.

### 1.3 DESIGN REQUIREMENTS

A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

B. Expansion Compensation Design Criteria:

1. Installation Temperature: 50 degrees F.
2. Hot Water Heating System Temperature: 210 degrees F.
3. Chilled Water: 42 degrees F.

### 1.4 SUBMITTALS

A. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints. Submit shop drawings sealed by a registered California Structure professional engineer.

B. Product Data:

1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

C. Design Data: Indicate criteria and show calculations.

D. Manufacturer's Installation Instructions: Submit special procedures.

E. Provide Manufacturer's Certificate.

F. Manufacturer’s Field Reports: Indicate results of inspection by manufacturer’s representative.

## 1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

B. Operation and Maintenance Data: Submit adjustment instructions.

## 1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

B. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

# PART 2 - PRODUCTS

## 2.1 FLEXIBLE PIPE CONNECTORS

A. Manufacturers:

**1. Flexicraft.**
**2. Flex Hose.**
**3. Metraflex.**

B. Steel Piping:

1. Inner Hose: Stainless Steel.
2. Exterior Sleeve: Double braided stainless steel.
3. Pressure Rating: 200 psig WOG and 250 degrees F.
4. Joint: As specified for pipe joints.
5. Size: Use pipe-sized units.
6. Maximum offset: 3/4 inch to 1 inch on each side of installed center line.

C. Copper Piping:

1. Inner Hose: Bronze.
2. Exterior Sleeve: Braided bronze.
3. Pressure Rating: 200 psig WOG and 250 degrees F.
4. Joint: As specified for pipe joints.
5. Size: Use pipe sized units.
6. Maximum offset: 3/4 inch on each side of installed center line.

## 2.2 EXPANSION JOINTS

A. Manufacturers:

**1. Flexicraft.**
**2. Flex Hose.**
**3. Metraflex.**

B. Stainless Steel Bellows Type:

1. Pressure Rating: 200 psig WOG and 250 degrees F.
2. Maximum Compression: 1-3/4 inch.
3. Maximum Extension: 1/4 inch.
4. Joint: As specified in for piping system.
5. Size: Use pipe sized units.
6. Application: Steel piping 3 inch and smaller.

C. External Ring Controlled Stainless Steel Bellows Type:

1. Pressure Rating: 200 psig WOG and 250 degrees F.
2. Maximum Compression: 15/16 inch.
3. Maximum Extension: 5/16 inch 3/8 inch.
4. Maximum Offset: 1/8 inch.
5. Joint: Flanged.
6. Size: Use pipe sized units.
7. Accessories: Internal flow liner.
8. Application: Steel piping 3 inch and larger.

## 2.3 ACCESSORIES

A. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.

B. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

C. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.

D. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

E. Provide grooved piping systems with minimum one joint per inch pipe diameter instead of flexible connector supported by vibration isolation. Grooved piping systems need not be anchored.

## 3.2 MANUFACTURER'S FIELD SERVICES

A. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION 23 05 16

# SECTION 23 05 23-GENERAL-DUTY VALVES FOR HVAC PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Gate valves.
2. Globe valves.
3. Ball valves.
4. Plug valves.
5. Butterfly valves.
6. Check valves.

### 1.2 REFERENCES

A. ASTM International:

1. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
2. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
3. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.

B. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 67 - Butterfly Valves.
2. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
3. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
6. MSS SP 85 - Cast Iron Globe & Angle Valves, Flanged and Threaded.
7. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

C. City of Los Angeles Codes.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.

## PART 2 - PRODUCTS

### 2.1 GATE VALVES

A. Manufacturers:

1. Crane.
2. Milwaukee.
3. Nibco

B. 2 inches and Smaller: MSS SP 80, Class 125, bronze body, bronze trim, threaded bonnet, rising stem, inside screw solid wedge disc, solder or threaded ends.

C. 2-1/2 inches and Larger: MSS SP 70, Class 125, cast iron body, bronze trim, bolted bonnet, rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

### 2.2 GLOBE VALVES

A. Manufacturers:

**1. Crane**
**2. Milwaukee**
**3. Nibco**

B. 2 inches and Smaller: MSS SP 80, Class 125, bronze body, bronze trim, threaded bonnet, hand wheel, Buna-N composition disc, solder or threaded ends.

C. 2-1/2 inches and Larger: MSS SP 85, Class 125, cast iron body, bronze trim, hand wheel, outside screw and yoke, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

### 2.3 BALL VALVES

A. Manufacturers:

**1. Crane**
**2. Milwaukee**
**3. Nibco**

B. 2 inches and Smaller: MSS SP 110, Class 150, bronze, two piece body, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, solder or threaded end and handle with balancing stops.

## 2.4 PLUG VALVES

A. Manufacturers:

1. **Nordstrom**
2. **Dezurik**
3. **Crane**

B. 2 inches and Smaller: MSS SP 78, Class 300, cast iron construction, round port, full pipe area, pressure lubricated, teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench.

C. 2-1/2 inches and Larger: MSS SP 78, Class 300, cast iron construction, round port, full pipe area, pressure lubricated, teflon packing, flanged ends. Furnish wrench-operated or worm gear-operated.

## 2.5 BUTTERFLY VALVES

A. Manufacturers:

1. **Crane**
2. **Milwaukee**
3. **Nibco**

B. 2-1/2 inches and Larger: MSS SP 67, Class 200.

1. Body: Cast or ductile iron, lug or grooved ends, stainless steel stem, extended neck.
2. Disc: Aluminum bronze.
3. Seat: Resilient replaceable EPDM.
4. Handle and Operator: Infinite position lever handle with memory stop. Furnish gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

## 2.6 CHECK VALVES

A. Horizontal Swing Check Valves:

1. Manufacturers:

   a. **Crane**
   b. **Milwaukee**
   c. **Nibco**

2. 2 inches and Smaller: MSS SP 80, Class 150, bronze body and cap, bronze seat, Buna-N, solder or threaded ends.
3. 2-1/2 inches and Larger: MSS SP 71, Class 125, cast iron body, bolted cap, bronze or cast iron disc, renewable disc seal and seat, flanged ends.

B. Spring Loaded Check Valves:

1. Manufacturers:

    **a. Crane.**
    **b. Milwaukee**
    **c. Nibco**

2. 2 inches and Smaller: MSS SP 80, Class 250, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat, solder or threaded ends.
3. 2-1/2 inches and Larger: MSS SP 71, Class 125, wafer style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

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

B. Install valves with clearance for installation of insulation and allowing access.

C. Provide access where valves and fittings are not accessible.

### 3.2 VALVE APPLICATIONS

A. Install shutoff and drain valves at locations in accordance with this Section.

B. Install butterfly or gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install ball butterfly or globe valves for throttling, bypass, or manual flow control services.

D. Install spring loaded check valves on discharge of water pumps.

E. Install lug end butterfly valves adjacent to equipment when functioning to isolate equipment.

F. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly gate, or plug valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling and By-Pass Service: Globe, ball, or butterfly valves.
4. Pump-Discharge Check Valves: Center-guided silent check valves.
5. Lubricated plug valves may be used for throttling service. Non-lubricated plug valves may be used only when shut-off or isolating valves are also provided.
6. Install drain valves, with cap and chain, as noted.

    a. All applications use 3/4 inch ball or globe valves.

7. Provide 1/4 inch ball valve as gauge cocks.

G. Safety and Relief Valves:

1. Constructed, rated and stamped in accordance with ASME
   a. Install relief valves for unheated liquids.
   b. Install safety relief valves for heated liquids.
   c. Install safety valves for steam.
2. Set Pressures and Ratings:

   a. Suitable and rated for system pressure and temperature.

      1) For Safety Relief Valves: Minimum temperature rating shall be equal to saturated steam temperature corresponding to pressure 10 percent higher than valve set pressure.

   b. Set pressure; not to exceed pressure rating of protected equipment.

3. Valves to open, under test, at set pressure with following tolerance:

   a. Set pressure up to 70 psi: Plus or minus 2 psi.
   b. Set pressure, above 70 psi: Plus or minus 3 percent.

4. Capacities: Selected and sized to:

   a. Relieve maximum possible generated energy.
   b. Maintain pressure in protected equipment at not more than following:

      1) Low Pressure Boilers: 5 psi above boiler working pressure.
      2) Unfired Pressure Vessels: 10 percent above vessel working pressure.

5. Provide multiple valves if required to meet capacity requirements.

H. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

I. Select valves, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. For Grooved-End Copper Tubing and Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

## 3.3 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, brass with brass trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.
4. Bronze Gate Valves: Class 125, RS, bronze.
5. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.
3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze disc.
4. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 175 CWP.
5. Iron Swing Check Valves: Class 125, metal seats.
6. Iron, Grooved-End Check Valves, NPS 3 to NPS 12: 300 CWP.
7. Iron, Center-Guided Check Valves: Class 125, globe, metal seat.
8. Iron Gate Valves: Class 125, OS&Y.
9. Iron Globe Valves: Class 125.
10. Lubricated Plug Valves: Class 125, regular gland, flanged.

## 3.4 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, brass with brass trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.
4. Bronze Gate Valves: Class 125, RS.
5. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.
3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze disc.
4. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 175 CWP.
5. Iron Swing Check Valves: Class 125, metal seats.
6. Iron, Grooved-End Check Valves, NPS 3 to NPS 12: 300 CWP.

7. Iron, Center-Guided Check Valves: Class 125, globe, metal seat.
8. Iron Gate Valves: Class 125, OS&Y.
9. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 125.

## 3.5 HIGH TEMPERATURE HOT WATER VALVE SCHEDULE

A. Lubricated plug valves.

END OF SECTION 23 05 23

# SECTION 23 05 29-HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Equipment curbs.
6. Sleeves.
7. Mechanical sleeve seals.
8. Formed steel channel.
9. Firestopping relating to HVAC work.
10. Firestopping accessories.
11. Equipment bases and supports.

### 1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
2. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
3. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.

C. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

D. FM Global:

1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.

2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

F. Underwriters Laboratories Inc.:

1. UL 263 - Fire Tests of Building Construction and Materials.
2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
3. UL 1479 - Fire Tests of Through-Penetration Firestops.
4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

## 1.3 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

## 1.4 SYSTEM DESCRIPTION

A. Firestopping Materials: To achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.

B. Firestop interruptions to fire rated assemblies, materials, and components.

## 1.5 PERFORMANCE REQUIREMENTS

A. Firestopping: Conform to City of Los Angeles Mechanical Code and FM or UL for fire resistance ratings and surface burning characteristics.

B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

## 1.6 SUBMITTALS

A. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

B. Product Data:

1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

C. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers. Submit sizing methods calculations sealed by a registered professional engineer.

E. Manufacturer's Installation Instructions:

1. Hangers and Supports: Submit special procedures and assembly of components.
2. Firestopping: Submit preparation and installation instructions.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

## PART 2 - PRODUCTS

### 2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:

**1. B-Line Systems.**
**2. PHD Manufacturing.**
**3. Tolco Inc.**

B. Hydronic Piping:

1. Conform to ASME B31.9.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.
9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 4 Inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

14. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Copper-plated, carbon steel ring.

C. Refrigerant Piping:

1. Conform to ASME B31.5.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Copper-plated carbon-steel ring.

## 2.2 ACCESSORIES

A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

## 2.3 INSERTS

A. Manufacturers:

1. B-Line.
2. Tolco.
3. Hilti.

B. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

## 2.4 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to supportexterior piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Manufacturers:

a. ERICO/Michigan Hanger Co.
b. MIRO Industries.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers:

a. MIRO Industries.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:

a. ERICO/Michigan Hanger Co.
b. MIRO Industries.
c. Portable Pipe Hangers.

2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Manufacturers:

a. Portable Pipe Hangers.

2. Bases: One or more plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

## 2.5 FLASHING

A. Metal Flashing: 26 gage thick galvanized steel.

B. Metal Counterflashing: 22 gage thick galvanized steel.

C. Lead Flashing:

1. Waterproofing: 5 lb./sq. ft sheet lead.
2. Soundproofing: 1 lb./sq. ft sheet lead.

D. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

## 2.6 EQUIPMENT CURBS

A. Manufacturers: To match equipment.

## 2.7 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.

C. Sleeves for Round Ductwork: Galvanized steel.

D. Sleeves for Rectangular Ductwork: Galvanized steel or wood.

## 2.8 MECHANICAL SLEEVE SEALS

A. Manufacturers:

1. Thunderline Link-Seal, Inc.
2. NMP Corporation.

B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

## 2.9 FORMED STEEL CHANNEL

A. Manufacturers:

1. Tolco.
2. B-Line Systems.
3. Unistrut Corp.

B. Product Description: Galvanized 12 gage) thick steel. With holes 1-1/2 inches on center.

## 2.10 FIRESTOPPING

A. Manufacturers:

1. Dow Corning Corp.
2. Hilti Corp.
3. 3M fire Protection Products.

## 2.11 FIRESTOPPING ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

B. Dam Material: Permanent:

1. Mineral fiberboard.
2. Mineral fiber matting.
3. Sheet metal.
4. Plywood or particle board.
5. Alumina silicate fire board.

C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

D. General:

1. Furnish UL listed products.
2. Select products with rating not less than rating of wall or floor being penetrated.

E. Non-Rated Surfaces:

1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

B. Verify openings are ready to receive firestopping.

## 3.2 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.

B. Remove incompatible materials affecting bond.

C. Install materials to arrest liquid material leakage.

D. Obtain permission from LAWA before using powder-actuated anchors.

E. Obtain permission from LAWA before drilling or cutting structural members.

## 3.3 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

## 3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.

B. Place hangers within 12 inches of each horizontal elbow.

C. Use hangers with 1-1/2 inch minimum vertical adjustment.

D. Support vertical piping at every other floor.

E. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

F. Support riser piping independently of connected horizontal piping.

G. Design hangers for pipe movement without disengagement of supported pipe.

H. Prime coat exposed steel hangers and supports.

I. Provide clearance in hangers and from structure and other equipment for installation of insulation.

## 3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment.

B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

C. Construct supports of steel members formed steel channel steel pipe and fittings. Brace and fasten with flanges bolted to structure.

D. Provide rigid anchors for pipes after vibration isolation components are installed.

## 3.6 INSTALLATION - FLASHING

A. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.

C. Provide curbs for roof installations 14 inches minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach Counterflashing to equipment and lap base flashing on roof curbs. Flatten and solder joints.

D. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

## 3.7 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors one inch above finished floor level. Caulk sleeves.

E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with firestopping insulation and caulk. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install escutcheons at finished surfaces to match surface, or chrome.

## 3.8 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.

B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.

C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating.

D. Fire Rated Surface:

1. Seal openings.
2. Install firestopping product in accordance with manufacturer's instructions.

END OF SECTION 23 05 29

# SECTION 23 05 48-VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Vibration isolators.
2. Duct silencers.
3. Ductwork lagging.

### 1.2 REFERENCES

A. Air Movement and Control Association International, Inc.: AMCA.

B. American National Standards Institute:

1. ANSI S1.4 - Sound Level Meters.
2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
3. ANSI S1.13 - Methods for the Measurement of Sound Pressure Levels in Air.
4. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of Noise Sources.

C. Air-Conditioning and Refrigeration Institute:

1. ARI 575 - Method of Measuring Machinery Sound within Equipment Space.

D. American Society of Heating, Refrigerating and:

1. ASHRAE 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans.
2. ASHRAE Handbook - HVAC Applications.

E. ASTM International:

1. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
2. ASTM E477 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
3. ASTM E596 - Standard Test Method for Laboratory Measurement of the Noise Reduction of Sound-Isolating Enclosures.

F. Sheet Metal and Air Conditioning Contractors':

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

G. MSS SP-127.

## 1.3 SUBMITTALS

A. Shop Drawings: Indicate equipment bases and locate vibration isolators, with static and dynamic load on each. Indicate assembly, material, thickness, dimensional data, pressure losses, acoustical performance, layout, and connection details for sound attenuation products fabricated for this project.

B. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.

## 1.4 PERFORMANCE

A. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHDP, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings.

B. All anchor bolts and tie-ins to structure shall be designed for a 1.5 importance factor.

# PART 2 - PRODUCTS

## 2.1 VIBRATION ISOLATORS

A. Manufacturers:

1. Amber/Booth Company, Inc.
2. Mason Industries.
3. M.W. Sausse & Company (Vibrex).

B. Open Spring Isolators:

1. Spring Isolators:

   a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
   b. Code: Color code springs for load carrying capacity.

2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.

C. Restrained Spring Isolators:

1. Spring Isolators:

   a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
   b. Code: Color code springs for load carrying capacity.

2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
5. Restraint: Furnish mounting frame and limit stops.

D. Closed Spring Isolators:

1. Spring Isolators:

   a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
   b. Code: Color code springs for load carrying capacity.

2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.

E. Restrained Closed Spring Isolators:

1. Spring Isolators:

   a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
   b. Code: Color code springs for load carrying capacity.

2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.

3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.

F. Spring Hanger:

1. Spring Isolators:

a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
b. Code: Color code springs for load carrying capacity.

2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators rubber hanger with threaded insert.
4. Misalignment: Capable of 20 degree hanger rod misalignment.

G. Neoprene Pad Isolators:

1. Rubber or neoprene-waffle pads.

a. 30 durometer.
b. Minimum 1/2 inch thick.
c. Maximum loading 40 psi.
d. Height of ribs: not to exceed 0.7 times width.

2. Configuration: Single layer. 1/2 inch thick waffle pads bonded each side of 1/4 inch thick steel plate.

H. Rubber Mount or Hanger: Molded rubber designed for 0.5 inches deflection with threaded insert.

I. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.

J. Seismic Snubbers:

1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
2. Neoprene Elements: Replaceable, minimum of 0.75 inch thick.
3. Capacity: 4 times load assigned to mount groupings at 0.4 inch deflection.
4. Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

## 2.2 DUCT SILENCERS

A. Manufacturers:

1. Noise Control, Inc.
2. McGill Airflow LLC.
3. Semco.

B. Description: Duct section with sheet metal outer casing, sound absorbing fill material, and inner casing of perforated sheet metal; incorporating interior baffles of similar construction.

## 2.3 DUCTWORK LAGGING

A. Acoustic Insulation: 2 inch thick, 3 to 5 lb/cu ft density glass fiber or mineral wool insulation.

B. Covering: Sheet lead, vinyl, or gypsum board with surface weight minimum 4 lb/sq ft.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Verify equipment, ductwork and piping is installed before work in this section is started.

## 3.2 EXISTING WORK

A. Provide access to existing piping and ductwork and other installations remaining active and requiring access.

B. Extend existing piping and ductwork installations using materials and methods compatible with existing electrical installations.

## 3.3 INSTALLATION

A. Support duct silencers independent of ductwork.

B. Lag ductwork by wrapping with insulation and covering. Apply covering to be airtight. Do not attach covering rigidly to ductwork.

C. Install isolation for motor driven equipment.

D. Adjust equipment level.

E. Install spring hangers without binding.

F. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

## 3.4 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
4. All equipment whether isolated or not, shall be bolted to structure to allow for minimum 1/2 G of acceleration.
5. All structurally suspended overhead equipment isolated or non-isolated shall be four point independently braced within Type III seismic restraining system.
6. Where base anchoring is insufficient to resist seismic forces, supplementary restraining such as seismic restraint system Type III shall be used above systems center of gravity to suitably resist "G" force levels. Vertically mounted tanks may require this additional restraint.

B. Piping Restraints:

1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
2. Brace a change of direction longer than 12 feet.
3. Install Seismic Restraining System Type III: Taut for overhead suspended non-isolated equipment, piping and slack with 1/2 inch cable deflection for isolated systems.
4. Seismically restrain all piping with Type III restraining system in accordance with guideline as outlined below.
5. Install vibration isolation at all piping connected to rotating equipment and within 50 feet of each piece of equipment such as air handling units, fan coil units and computer room AC units, condensing units, exhaust fans and make-up air units.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

H. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify LAWA if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

END OF SECTION 23 05 48

# SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.
8. Warning Signs & Labels.

### 1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME A13.1 - Scheme for the Identification of Piping Systems.

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturers catalog literature for each product required.

B. Samples.

C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

### 1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

### 1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

## PART 2 - PRODUCTS

### 2.1 NAMEPLATES

A. Manufacturers:

**1. Craftmark.**
**2. Seton.**
**3. Kolbi.**

B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

C. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

### 2.2 TAGS

A. Plastic Tags:

1. Manufacturers:

**a. Seton.**
**b. Brady.**
**c. Kolbi.**

2. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter square.

B. Metal Tags:

1. Manufacturers:

**a. Seton.**
**b. Brady.**
**c. Kolbi.**

2. Aluminum with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.

C. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame plastic laminated.

## 2.3 STENCILS

A. Manufacturers:

**a. Seton.**
**b. Brady.**
**c. Kolbi.**

B. Stencils: With clean cut symbols and letters of following size:

1. Up to 2 inches Outside Diameter of Insulation or Pipe: 1/2 inch high letters.
2. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1-inch high letters.
3. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inches high letters.
4. Ductwork and Equipment: 1-3/4 inches high letters.

C. Stencil Paint: Semi-gloss enamel.

## 2.4 PIPE MARKERS

A. Plastic Pipe Markers:

1. Manufacturers:

**a. Seton.**
**b. Brady.**
**c. Kolbi.**

2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

B. Plastic Tape Pipe Markers:

1. Manufacturers:

**a. Seton.**
**b. Brady.**
**c. Kolbi.**

2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

## 2.5 CEILING TACKS

A. Manufacturers:

**1. Seton.**

**2. Brady.**
3. **Kolbi.**

B. Description: Steel with 3/4 inch diameter color-coded head.

C. Color code as follows:

1. HVAC equipment: Yellow.
2. Fire dampers/smoke dampers: Red.
3. Plumbing valves: Green.
4. Heating/cooling valves: Blue.

## 2.6 LABELS

A. Manufacturers:

**1. Seton.**
**2. Brady.**
**3. Kolbi.**

B. Description: Aluminum, size 1.9 x 0.75 inches, adhesive backed with printed identification.

C. Pipe Labels:

1. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
2. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

    a. NPS 5 (DN 125) and smaller: Attach to pipe without fasteners or adhesive.
    b. NPS 6 (DN 150) and larger: Attach to pipe with stainless steel spring fasteners.

3. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

    a. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
    b. Lettering Size: At least 1-1/2 inches high.

4. Maximum Temperature: Able to withstand temperatures up to 180 deg F (83 deg C).

D. Duct Labels:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: Blue.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
9. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

    a. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
    b. Lettering Size: At least 1-1/2 inches high.

## 2.7 LOCKOUT DEVICES

A. Lockout Hasps:

1. Manufacturers:

    **a. Seton.**
    **b. Brady.**
    **c. Kolbi.**

2. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

B. Valve Lockout Devices:

1. Manufacturers:

    **a. Seton.**
    **b. Brady.**
    **c. Kolbi.**

2. Steel device preventing access to valve operator, accepting lock shackle.

# PART 3 - EXECUTION

## 3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces for stencil painting.

## 3.2 INSTALLATION

A. Apply stencil painting.

B. Install identifying devices after completion of coverings and painting.

C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.

D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

E. Install tags using corrosion resistant chain. Number tags consecutively by location.

END OF SECTION 23 05 53

# SECTION 23 05 93-TESTING, ADJUSTING, AND BALANCING FOR HVAC

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Testing, adjusting, and balancing of air systems.
2. Testing, adjusting, and balancing of hydronic systems.
3. Measurement of final operating condition of HVAC systems.
4. Sound measurement of equipment operating conditions.
5. Vibration measurement of equipment operating conditions.
6. Testing, adjusting and balancing of smoke control systems.

### 1.2 REFERENCES

A. Associated Air Balance Council:

1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.
2. ASHRAE 62.1, Section 7.2.2.
3. ASHRAE 90.1, Section 6.2.3 System Balancing.

### 1.3 SUBMITTALS

A. Prior to commencing Work, submit proof of latest calibration date of each instrument.

B. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms.

C. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment.

D. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty.

E. Submit draft copies of report for review prior to final acceptance of Project.

F. Furnish printed reports (not hand-written) in binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced

drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

## 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

## 1.5 QUALITY ASSURANCE

A. Prior to commencing Work, calibrate each instrument to be used. Upon completing Work, recalibrate each instrument to assure reliability.

## 1.6 QUALIFICATIONS

A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum five years documented experience certified by AABC.

B. Perform Work under supervision of AABC Certified Test and Balance Engineer.

## 1.7 WARRANTY

A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.
3. Warranty Period: Five (5) years.

B. Special Guarantee: Provide a guarantee on AABC forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.
3. Warranty Period: Five (5) years.

## PART 2 - PRODUCTS

Not Used.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Verify systems are complete and operable before commencing work. Verify the following:

1. Systems are started and operating in safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place or in normal position.
15. Service and balancing valves are open.
16. Drains are flushed and clean.

### 3.2 PREPARATION

A. Furnish instruments required for testing, adjusting, and balancing operations.

B. Make instruments available to LAWA to facilitate spot checks during testing.

### 3.3 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

### 3.4 ADJUSTING

A. Verify recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.

D. Report defects and deficiencies noted during performance of services, preventing system balance.

E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

F. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by LAWA.

G. Check and adjust systems approximately six months after final acceptance and submit report.

## 3.5 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.

B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.

E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.

F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes if applicable to vary fan speed. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure near building entries.

M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

N. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.

O. On fan powered VAV boxes, adjust airflow switches for proper operation.

## 3.6 WATER SYSTEM PROCEDURE

A. Adjust water systems, after air balancing, to obtain design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system.

C. Adjust systems to obtain prescribed pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

## 3.7 PROCEDURES FOR SMOKE-CONTROL SYSTEM TESTING

A. Before testing smoke-control systems, verify that construction is complete and verify the integrity of each smoke-control zone boundary. Verify that windows and doors are closed and that applicable safing, gasket, and sealants are installed.

B. Measure and record wind speed and direction, outside-air temperature, and relative humidity on each test day.

C. Measure, adjust, and record airflow of each smoke-control system with all fans that are a part of the system.

D. Measure, adjust, and record the airflow of each fan. For ducted systems, measure the fan airflow by duct Pitot-tube traverse.

E. After air balancing is complete, perform the pressurization testing for each smoke-control zone.

F. Operational Tests:

1. Check the proper activation of each zoned smoke-control system in response to all means of activation, both automatic and manual.
2. Check automatic activation in response to fire alarm signals received from the building's fire alarm and detection system. Initiate a separate alarm for each means of activation to ensure that the proper operation of the correct zoned smoke-control system occurs.
3. Check and record the proper operation of fans, dampers, and related equipment for each separate zone of the smoke-control system.

G. Conduct additional tests required by authorities having jurisdiction. Unless required by authorities having jurisdiction, perform testing without the use of smoke or products that simulate smoke.

H. Prepare a complete report of observations, measurements, and deficiencies.

## 3.8 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:

1. Pumps.
2. Air Cooled Refrigerant Condensers/Condensing Units.
3. Packaged Roof Top Heating/Cooling Units.
4. Packaged Terminal Air Conditioning Units.
5. Unit Air Conditioners.
6. Computer Room Air Conditioning Units.
7. Air Coils.
8. Evaporative Humidifier.
9. Fan Coil Units.
10. Air Handling Units.
11. Fans.
12. Air Filters.
13. Air Terminal Units.
14. Air Inlets and Outlets.
15. Heat Exchangers.

B. Report Forms

1. Title Page:

a. Name of Testing, Adjusting, and Balancing Agency
b. Address of Testing, Adjusting, and Balancing Agency
c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency

d. Project name
e. Project location
f. Project Architect
g. Project Engineer
h. Project Contractor
i. Project altitude
j. Report date

2. Summary Comments:

a. Design versus final performance
b. Notable characteristics of system
c. Description of systems operation sequence
d. Summary of outdoor and exhaust flows to indicate building pressurization
e. Nomenclature used throughout report
f. Test conditions

3. Instrument List:

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

4. Electric Motors:

a. Manufacturer
b. Model/Frame
c. HP/BHP and kW
d. Phase, voltage, amperage; nameplate, actual, no load
e. RPM
f. Service factor
g. Starter size, rating, heater elements
h. Sheave Make/Size/Bore

5. V-Belt Drive:

a. Identification/location
b. Required driven RPM
c. Driven sheave, diameter and RPM
d. Belt, size and quantity
e. Motor sheave diameter and RPM
f. Center to center distance, maximum, minimum, and actual

6. Pump Data:

a. Identification/number
b. Manufacturer

c. Size/model
d. Impeller
e. Service
f. Design flow rate, pressure drop, BHP and kW
g. Actual flow rate, pressure drop, BHP and kW
h. Discharge pressure
i. Suction pressure
j. Total operating head pressure
k. Shut off, discharge and suction pressures
l. Shut off, total head pressure

7. Air Cooled Condenser/Condensing Unit:

a. Identification/number
b. Location
c. Manufacturer
d. Model number
e. Serial number
f. Entering DB air temperature, design and actual
g. Leaving DB air temperature, design and actual
h. Number of compressors

8. Heat Exchanger:

a. Identification/number
b. Location
c. Service
d. Manufacturer
e. Model number
f. Serial number
g. Steam pressure, design and actual
h. Primary water entering temperature, design and actual
i. Primary water leaving temperature, design and actual
j. Primary water flow, design and actual
k. Primary water pressure drop, design and actual
l. Secondary water leaving temperature, design and actual
m. Secondary water leaving temperature, design and actual
n. Secondary water flow, design and actual
o. Secondary water pressure drop, design and actual

9. Cooling Coil Data:

a. Identification/number
b. Location
c. Service
d. Manufacturer
e. Air flow, design and actual
f. Entering air DB temperature, design and actual
g. Entering air WB temperature, design and actual
h. Leaving air DB temperature, design and actual

i. Leaving air WB temperature, design and actual
j. Water flow, design and actual
k. Water pressure drop, design and actual
l. Entering water temperature, design and actual
m. Leaving water temperature, design and actual
n. Saturated suction temperature, design and actual
o. Air pressure drop, design and actual

10. Heating Coil Data:

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

11. Unit Ventilator and Fan Coil Data:

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

12. Air Moving Equipment:

    a. Location
    b. Manufacturer
    c. Model number
    d. Serial number
    e. Arrangement/Class/Discharge
    f. Air flow, specified and actual
    g. Return air flow, specified and actual
    h. Outside air flow, specified and actual
    i. Total static pressure (total external), specified and actual
    j. Inlet pressure

k. Discharge pressure
l. Sheave Make/Size/Bore
m. Number of Belts/Make/Size
n. Fan RPM

13. Return Air/Outside Air Data:

a. Identification/location
b. Design air flow
c. Actual air flow
d. Design return air flow
e. Actual return air flow
f. Design outside air flow
g. Actual outside air flow
h. Return air temperature
i. Outside air temperature
j. Required mixed air temperature
k. Actual mixed air temperature
l. Design outside/return air ratio
m. Actual outside/return air ratio

14. Exhaust Fan Data:

a. Location
b. Manufacturer
c. Model number
d. Serial number
e. Air flow, specified and actual
f. Total static pressure (total external), specified and actual
g. Inlet pressure
h. Discharge pressure
i. Sheave Make/Size/Bore
j. Number of Belts/Make/Size
k. Fan RPM

15. Duct Traverse:

a. System zone/branch
b. Duct size
c. Area
d. Design velocity
e. Design air flow
f. Test velocity
g. Test air flow
h. Duct static pressure
i. Air temperature
j. Air correction factor

16. Duct Leak Test:

a. Description of ductwork under test
b. Duct design operating pressure
c. Duct design test static pressure
d. Duct capacity, air flow
e. Maximum allowable leakage duct capacity times leak factor
f. Test apparatus

    1) Blower
    2) Orifice, tube size
    3) Orifice size
    4) Calibrated

g. Test static pressure
h. Test orifice differential pressure
i. Leakage

17. Air Monitoring Station Data:

    a. Identification/location
    b. System
    c. Size
    d. Area
    e. Design velocity
    f. Design air flow
    g. Test velocity
    h. Test air flow

18. Flow Measuring Station:

    a. Identification/number
    b. Location
    c. Size
    d. Manufacturer
    e. Model number
    f. Serial number
    g. Design Flow rate
    h. Design pressure drop
    i. Actual/final pressure drop
    j. Actual/final flow rate
    k. Station calibrated setting

19. Terminal Unit Data:

    a. Manufacturer
    b. Type, constant, variable, single, dual duct
    c. Identification/number
    d. Location
    e. Model number
    f. Size
    g. Minimum static pressure

h. Minimum design air flow
i. Maximum design air flow
j. Maximum actual air flow
k. Inlet static pressure

20. Air Distribution Test Sheet:

    a. Air terminal number
    b. Room number/location
    c. Terminal type
    d. Terminal size
    e. Area factor
    f. Design velocity
    g. Design air flow
    h. Test (final) velocity
    i. Test (final) air flow
    j. Percent of design air flow

21. Sound Level Report:

    a. Location
    b. Octave bands - equipment off
    c. Octave bands - equipment on
    d. RC level - equipment on

22. Vibration Test:

    a. Location of points:

        1) Fan bearing, drive end
        2) Fan bearing, opposite end
        3) Motor bearing, center (when applicable)
        4) Motor bearing, drive end
        5) Motor bearing, opposite end
        6) Casing (bottom or top)
        7) Casing (side)
        8) Duct after flexible connection (discharge)
        9) Duct after flexible connection (suction)

    b. Test readings:

        1) Horizontal, velocity and displacement
        2) Vertical, velocity and displacement
        3) Axial, velocity and displacement

    c. Normally acceptable readings, velocity and acceleration
    d. Unusual conditions at time of test
    e. Vibration source (when non-complying)

END OF SECTION 23 05 93

**SECTION 23 07 00-HVAC INSULATION**

**PART 1 - GENERAL**

**1.1 SUMMARY**

A. Section Includes:

1. HVAC piping insulation, jackets and accessories.
2. HVAC ductwork insulation, jackets, and accessories.
3. Equipment Insulation, jackets and accessories.

**1.2 REFERENCES**

A. ASTM International:

1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
6. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
7. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
8. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
9. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
10. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
11. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
12. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
13. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
14. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
15. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
16. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
17. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).

18. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
19. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
20. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
21. ASTM D4637 - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
22. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
23. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.

B. Sheet Metal and Air Conditioning Contractors':

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

C. California Title 24

1. Insulation shall meet requirements of CA Title 24.

## 1.3 SUBMITTALS

A. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

## 1.4 WARRANTY

A. Furnish five year manufacturer warranty for man made fiber.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURER

A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:

**1. CertainTeed.**
**2. Johns Manville.**
**3. Owens-Corning.**

B. Manufacturers for Closed Cell Elastomeric Insulation Products:

**1. Aeroflex. Aerocell.**
**2. Armacell, LLC. Armaflex.**
**3. Nomaco. K-flex.**

## 2.2 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

B. TYPE P-2: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Operating Temperature Range: 0 to 850 degrees F.

C. TYPE P-3: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket. Conform to ASTM C795 for application on Austenitic stainless steel.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: 0 to 650 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

D. TYPE P-4: ASTM C612; semi-rigid, fibrous glass board noncombustible. Conform to ASTM C795 for application on Austenitic stainless steel.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: 0 to 650 degrees F.

E. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

F. TYPE P-6: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.

1. Thermal Conductivity: 0.30 at 75 degrees F.
2. Maximum Service Temperature: 300 degrees F.
3. Operating Temperature Range: Range: Minus 58 to 300 degrees F.

G. TYPE P-7: ASTM C534, Type I, flexible, nonhalogen, closed cell elastomeric insulation, tubular.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Maximum Service Temperature: 250 degrees F.
3. Operating Temperature Range: Range: Minus 58 to 250 degrees F.

H. TYPE P-8: ASTM C547, Type I or II, mineral fiber preformed pipe insulation, noncombustible.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Maximum Service Temperature: 1200 degrees F.
3. Canvas Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric treated with fire retardant lagging adhesive.

## 2.3 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:

1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

B. PVC Plastic Pipe Jacket:

1. Product Description: ASTM D1785, One piece molded type fitting covers and sheet material, off-white color.
2. Thickness: 30 mil.
3. Connections: Brush on welding adhesive with VOC content of 50 g/l according to 40 CFR 59, subpart D (EPA Method 24).

C. ABS Plastic Pipe Jacket:

1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
3. Thickness: 30 mil.
4. Connections: Brush on welding adhesive.

D. Aluminum Pipe Jacket:

1. ASTM B209.
2. Thickness: 0.2 inch thick sheet.
3. Finish: Embossed.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.2 inch thick die shaped fitting covers with factory attached protective liner.

E. Stainless Steel Pipe Jacket:

1. ASTM ASTM A240/A240M OR ASTM 666 Type 304 stainless steel.
2. Thickness: 0.016 inch thick.
3. Finish: Smooth.

F. Field Applied Glass Fiber Fabric Jacket System:

1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:

    a. Cloth: Untreated; 9 oz/sq yd weight.

b. Blanket: 1.0 lb/cu ft density.

## 2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self-adhesive closure. Thickness to match pipe insulation.

F. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

I. Adhesives: Compatible with insulation.

## 2.5 DUCTWORK INSULATION

A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Maximum Operating Temperature: 250 degrees F.
3. Density: 0.75 pound per cubic foot.

B. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied all service facing meeting ASTM C1136, Type II.

1. Thermal Conductivity: 0.22 at 75 degrees F.
2. Density: 2.25 pound per cubic foot.

C. TYPE D-3: ASTM C612, Type IA or IB, rigid glass fiber, no facing.

1. Thermal Conductivity: 0.24 at 75 degrees F.
2. Density: 2.25 pound per cubic foot.

D. TYPE D-4: ASTM C1071, Type I, flexible, glass fiber duct liner with coated air side.

1. Thermal Conductivity: 0.25 at 75 degrees F.

2. Density: 1.5 pound per cubic foot.
3. Maximum Operating Temperature: 250 degrees F.
4. Maximum Air Velocity: 6,000 feet per minute.

E. TYPE D-5: ASTM C1071, Type II, rigid, glass fiber duct liner with coated air side.

1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Density: 3.0 pound per cubic foot.
3. Maximum Operating Temperature: 250 degrees F.
4. Maximum Air Velocity: 4,000 feet per minute.

F. TYPE D-6: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Service Temperature Range: Range: Minus 58 to 180 degrees F.

## 2.6 DUCTWORK INSULATION JACKETS

A. Aluminum Duct Jacket:

1. ASTM B209.
2. Thickness: 0.016 inch thick sheet.
3. Finish: Embossed.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

B. Vapor Retarder Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film 0.0032 inch vinyl.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
3. Secure with pressure sensitive tape.

C. Canvas Duct Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

D. Outdoor Duct Jacket: Asphalt impregnated and coated sheet, 36 lb/square.

## 2.7 DUCTWORK INSULATION ACCESSORIES

A. Vapor Retarder Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

B. Vapor Retarder Lap Adhesive: Compatible with insulation.

C. Adhesive: Waterproof, ASTM E162 fire-retardant type.

D. Liner Fasteners: Galvanized steel, self-adhesive pad with integral press-on head.

E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

F. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

H. Adhesives: Compatible with insulation.

I. Membrane Adhesives: As recommended by membrane manufacturer.

## 2.8 EQUIPMENT INSULATION

A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.

1. Thermal Conductivity: 0.24 at 75 degrees F .
2. Operating Temperature Range: 0 to 450 degrees F .
3. Density: 1.5 pound per cubic foot.

B. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied reinforced foil kraft jacket.

1. Thermal Conductivity: 0.24 at 75 degrees F .
2. Operating Temperature Range: 0 to 450 degrees F
3. Density: 3.0 pound per cubic foot.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

C. TYPE E-3: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: 0 to 650 degrees F .
3. Vapor Barrier Jacket: ASTM C1136, Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F .

D. TYPE E-4: ASTM C612; semi-rigid, fibrous glass board noncombustible.

1. Thermal Conductivity: 0.27 at 75 degrees F
2. Operating Temperature Range: 0 to 650 degrees F.

E. TYPE E-5: ASTM C552 Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Provide the following:

a. Cell-U-Foam Corporation; Ultra-CUF.

b. Pittsburgh Corning Corporation; Foamglas Super K.

2. Thermal Conductivity (k-value) at 75°F mean temperature is 0.27 Btu x in./hr. x ft. x degree F. or less.
3. Block Insulation: ASTM C 552, Type I.
4. Special-Shaped Insulation: ASTM C 552, Type III.
5. Board Insulation: ASTM C 552, Type IV.
6. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
7. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
8. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

F. TYPE E-7: ASTM C533; Type II, hydrous calcium silicate block insulation, asbestos free.

1. Thermal Conductivity: 0.45 at 200 degrees F
2. Operating Temperature Range: 140 to 1200 degrees F

G. TYPE E-9: ASTM C612, man made mineral fiber, noncombustible, Classes 1-4.

1. Thermal Conductivity: 0.25 at 100 degrees F
2. Maximum Service Temperature: 1200 degrees F
3. Density: 4 pound per cubic foot .

## 2.9 EQUIPMENT INSULATION JACKETS

A. PVC Plastic Equipment Jacket:

1. Product Description: ASTM D1785, sheet material, off-white color.
2. Minimum Service Temperature: -40 degrees
3. Maximum Service Temperature: 150 degrees F
4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms
5. Thickness: 10 mil.
6. Connections Pressure sensitive color matching vinyl tape.

B. Aluminum Equipment Jacket:

1. ASTM B209Thickness: 0.016 inch thick sheet.
2. Finish: Smooth
3. Joining: Longitudinal slip joints and 2 inch laps.
4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

C. Canvas Equipment Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

D. Vapor Retarder Jacket:

1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

E. Field Applied Glass Fiber Fabric Jacket System:

1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:

   a. Cloth: Untreated; 9 oz/sq yd weight.
   b. Blanket: 1.0 lb/cu ft density.
   c. Weave: 5 x 5.

3. Indoor Vapor Retarder Finish:

   a. Cloth: Untreated; 9 oz/sq yd weight.
   b. Vinyl emulsion type acrylic, compatible with insulation, white color.

## 2.10 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

E. Adhesives: Compatible with insulation.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Verify piping, and ductwork has been tested before applying insulation materials.

B. Verify surfaces are clean and dry, with foreign material removed.

## 3.2 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 84 00 for penetrations of assemblies with fire resistance rating greater than one hour.

C. Piping Systems Conveying Fluids Below Ambient Temperature:

1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:

1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Hot Piping Systems less than 140 degrees F:

1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

F. Hot Piping Systems greater than 140 degrees F:

1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
3. Insulate flanges and unions at equipment.

G. Inserts and Shields:

1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.

    a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
    b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.

3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

H. Insulation Terminating Points:

1. Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.
2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
3. Condensate Piping: Insulate entire piping system and components to prevent condensation.

I. Closed Cell Elastomeric Insulation:

1. Push insulation on to piping.
2. Miter joints at elbows.
3. Seal seams and butt joints with manufacturer's recommended adhesive.
4. When application requires multiple layers, apply with joints staggered.
5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

J. High Temperature Pipe Insulation:

1. Install in multiple layers to meet thickness scheduled.
2. Attach each layer with bands. Secure first layer with bands before installing next layer.
3. Stagger joints between layers.
4. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.

L. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

M. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

N. Heat Traced Piping Interior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer.

O. Heat Traced Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with aluminum stainless steel jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.

P. Prepare pipe insulation for finish painting.

## 3.3 INSTALLATION - DUCTWORK SYSTEMS

A. Insulated ductwork conveying air below ambient temperature:

1. Provide insulation with vapor retarder jackets.
2. Finish with tape and vapor retarder jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

B. Insulated ductwork conveying air above ambient temperature:

1. Provide with or without standard vapor retarder jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

C. Ductwork Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with canvas jacket sized for finish painting.

D. External Glass Fiber Duct Insulation:

1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
2. Secure insulation without vapor retarder with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

E. External Elastomeric Duct Insulation:

1. Adhere to clean oil-free surfaces with full coverage of adhesive.
2. Seal seams and butt joints with manufacturer’s recommended adhesive.
3. When application requires multiple layers, apply with joints staggered.
4. Insulate standing metal duct seams with insulation of like material and thickness as adjacent duct surface. Apply adhesive at joints with flat duct surfaces.
5. Lift ductwork off trapeze hangers and insert spacers.

F. Duct and Plenum Liner:

1. Adhere insulation with adhesive for 90 100 percent coverage.
2. Secure insulation with mechanical liner fasteners. Comply with SMACNA Standards for spacing.
3. Seal and smooth joints. Seal and coat transverse joints.
4. Seal liner surface penetrations with adhesive.

5. Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.

G. Ducts Exterior to Building:

1. Install insulation according to duct liner paragraph above.
2. Provide external insulation with vapor retarder jacket. Cover with outdoor jacket finished with caulked aluminum jacket with seams located on bottom side of horizontal duct section.
3. Finish with aluminum duct jacket.
4. Calk seams at flanges and joints. Located major longitudinal seams on bottom side of horizontal duct sections.

H. Prepare duct insulation for finish painting.

## 3.4 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:

1. Insulate entire equipment surfaces.
2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Fluids 140 degrees or Less:

1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

F. Equipment Containing Fluids Over 140 degrees F :

1. Insulate flanges and unions with removable sections and jackets.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

G. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting or PVC jacket and fitting covers.

H. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.

I. Cover insulation with aluminum jacket.

J. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

K. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

## 3.5 SCHEDULES

A. Cooling Services Piping Insulation Schedule:

| PIPING SYSTEM | INSULATION TYPE | PIPE SIZE | INSULATION THICKNESS inches |
|---|---|---|---|
| Chilled Water Supply and Return 40 to 60 degrees F | P-1 | 1 inch and smaller<br>1-1/2 inches to 4 inches<br>5 inches and larger | 1.5<br>1.5<br>3 |
| Chilled Water Supply and Return less than 40 degrees F | P-1 | 3/4 inch and smaller<br>1 inch to 6 inches<br>8 inches and larger | 1.5<br>2<br>3 |
| Condensate Piping from Cooling Coils | P-5 | All sizes | 0.5 |
| Refrigerant Suction | P-5 | All sizes | 1 |
| Refrigerant Hot Gas | P-5 | All sizes | 1 |

B. Heating Services Piping Insulation Schedule:

| PIPING SYSTEM | INSULATION TYPE | PIPE SIZE | INSULATION THICKNESS inches |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Heating Water Supply and Return 105 to 140 degrees F | P-1 | 2 inches and smaller<br>2-1/2 inches and larger | 1.0<br>1.5 |
| Heating Water Supply and Return 141 to 200 degrees F | P-1 | 2 inches and smaller<br>2-1/2 inches and larger | 1.0<br>1.5 |
| Over 200 degrees F | P-1 | 2 inches and smaller<br>2-1/2 inches and larger | 1.5<br>3 |
| Humidifier Supply Piping | P-1 | 2 inches and smaller<br>2-1/2 inches and larger | 1.5<br>2 |
| Humidifier Drain Piping | P-1 | All sizes | 1 |

C. Ductwork Insulation Schedule:

| DUCTWORK SYSTEM | INSULATION TYPE | INSULATION THICKNESS inches |
|---|---|---|
| Combustion Air | D-2 | 1.5 |
| Outside Air Intake | D-2 | 1.5 |
| Equipment Casings | D-2 | 1.0 |
| Supply Ducts (internally insulated) | D-4 or D-5 | 1.0 |
| Return Ducts (internally insulated) | D-4 or D-5 | 1.0 |
| Supply Ducts (externally insulated) Thickness indicated is installed thickness. | D-1 or D-2 | 1.0 |
| Return Ducts (externally insulated) Thickness indicated is installed thickness. | D-1 or D-2 | 1.0 |
| Duct Coils | D-1 | 1.0 |
| Supply Air, Return Air, (exterior to building on roof) | D-2 | 2.0 |
| Rectangular Supply Ducts Downstream of Variable Air Volume Boxes (internally insulated) | D-4 or D-5 | 1.0 |
| Rectangular Supply Ducts Downstream of Variable Air Volume Boxes (externally insulated) | D-1 or D-2 | 1.5 |
| Round Supply Ducts Downstream of Variable Air Volume Boxes (externally insulated) | D-1 or D-2 | 1.5 |

| | | |
|---|---|---|
| Transfer Air Ducts (internally insulated) | D-4 or D-5 | 1.0 |

D. Equipment Insulation Schedule:

| EQUIPMENT SYSTEM | INSULATION TYPE | INSULATION THICKNESS inches |
|---|---|---|
| Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, condenser bundles, heat-recovery bundles, suction piping, compressor inlets, tube sheets, water boxes, nozzles and other areas recommended by manufacturers | Cellular Glass (E-5)<br>Mineral-Fiber Board (E-2, 3 ,4)<br>Mineral-Fiber Pipe and Tank (E-9) | 2<br>1<br>1 |
| Heat-exchanger (water-to-water for cooling service) insulation | Cellular Glass (E-5)<br>Mineral-Fiber Board (E-2, 3)<br>Mineral-Fiber Pipe and Tank (E-9) | 2<br>1<br>1 |
| Heat-exchanger (water-to-water for heating service) insulation | Calcium Silicate (E-7)<br>Cellular Glass (E-5)<br>Mineral-Fiber Board (E-2,3)<br>Mineral-Fiber Pipe and Tank (E-9) | 3<br>3<br>2<br>2 |
| Chilled-water pump insulation | Cellular Glass (E-5)<br>Mineral-Fiber Board (E-2, 3) | 3<br>2 |
| Condenser-water pump insulation | Cellular Glass (E-5)<br>Mineral-Fiber Board (E-2, 3) | 3<br>2 |
| Heating-hot-water pump insulation | Calcium Silicate (E-7)<br>Cellular Glass (E-5)<br>Mineral-Fiber Board (E-2)<br>Mineral-Fiber Pipe and Tank (E-9) | 3<br>3<br>2<br>2 |

| | | |
|---|---|---|
| Chilled-water expansion/compression tank insulation | Cellular Glass (E-5)<br>Mineral-Fiber Board (E-2)<br>Mineral-Fiber Pipe and Tank (E-9) | 2<br>1<br>1 |
| Heating-hot-water expansion/compression tank insulation | Cellular Glass (E-5)<br>Mineral-Fiber Board (E-2) | 3<br>2 |
| Chilled-water air-separator insulation | Cellular Glass (E-5)<br>Mineral-Fiber Board (E-2)<br>Mineral-Fiber Pipe and Tank (E-9) | 2<br>1<br>1 |
| Condenser-water air-separator insulation | Cellular Glass (E-5)<br>Mineral-Fiber Board (E-2)<br>Mineral-Fiber Pipe and Tank (E-9) | 2<br>1<br>1 |
| Heating-hot-water air-separator | Cellular Glass (E-5)<br>Mineral-Fiber Board (E-2) | 3<br>2 |
| Thermal storage tank (ice insulation) | Calcium Silicate (E-7) | 3 |

END OF SECTION 23 07 00

# SECTION 23 08 00-COMMISSIONING OF HVAC

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. HVAC commissioning description.
2. HVAC commissioning responsibilities.

### 1.2 REFERENCES

A. Associated Air Balance Council:

1. AABC - AABC Commissioning Guideline.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE Guideline 1 - The HVAC Commissioning Process.

C. Cal Green Building Code.

### 1.3 COMMISSIONING DESCRIPTION

A. HVAC commissioning process includes the following tasks:

1. Testing and startup of HVAC equipment and systems.
2. Equipment and system verification checks.
3. Assistance in functional performance testing to verify testing and balancing, and equipment and system performance.
4. Provide qualified personnel to assist in commissioning tests, including seasonal testing.
5. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure equipment and systems are fully operational and ready for functional performance testing.
6. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
7. Provide operation and maintenance information and record drawings to Commissioning Authority for review verification and organization, prior to distribution.
8. Provide assistance to Commissioning Authority to develop, edit, and document system operation descriptions.
9. Provide training for systems specified in this Section with coordination by Commissioning Authority.

B. Equipment and Systems to Be Commissioned:

1. Pumps

2. Piping systems.
3. Ductwork.
4. Variable frequency drives.
5. Packaged roof top air conditioning units.
6. Split system air conditioning units.
7. Humidifiers.
8. Air handling units.
9. Packaged heat pump units.
10. Self-contained air conditioning units.
11. Fan Coil Units.
12. Heat exchangers.
13. Computer room units.
14. Constant volume terminal units.
15. Variable volume terminal units.
16. Fans.
17. Fire dampers.
18. Smoke dampers.
19. Indoor air quality.
20. Equipment sound control – if noted on drawings.
21. Equipment vibration control – if noted on drawings.
22. Automatic temperature control system.
23. Testing, Adjusting and Balancing work.

## 1.4 COMMISSIONING SUBMITTALS

A. Draft Forms: Submit draft of system verification form and functional performance test checklist.

B. Test Reports: Indicate data on system verification form for each piece of equipment and system as specified. Use AABC forms as guidelines.

C. Field Reports: Indicate deficiencies preventing completion of equipment or system verification checks equipment or system to achieve specified performance.

## 1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning.

B. Operation and Maintenance Data: Submit revisions to operation and maintenance manuals when necessary revisions are discovered during commissioning.

## 1.6 QUALITY ASSURANCE

A. Perform Work in accordance with AABC and ASHRAE Guideline 1.

## 1.7 COMMISSIONING RESPONSIBILITIES

A. Equipment or System Installer Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Ensure temperature controls installer performs assigned commissioning responsibilities as specified below.
3. Ensure testing, adjusting, and balancing agency performs assigned commissioning responsibilities as specified.
4. Provide instructions and demonstrations for LAWA's personnel.
5. Ensure subcontractors perform assigned commissioning responsibilities.
6. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
7. Develop startup and initial checkout plan using manufacturer’s startup procedures and functional performance checklists for equipment and systems to be commissioned.
8. During verification check and startup process, execute HVAC related portions of checklists for equipment and systems to be commissioned.
9. Perform and document completed startup and system operational checkout procedures, providing copy to Commissioning Authority.
10. Provide manufacturer’s representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.
11. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
12. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.
13. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.
14. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
15. Provide factory supervised startup services for equipment and systems where specified. Coordinate work with manufacturer and Commissioning Authority.
16. Perform verification checks and startup on equipment and systems as specified.
17. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
18. Perform operation and maintenance training sessions scheduled by Commissioning Authority.
19. Conduct HVAC system orientation and inspection.

B. Temperature Controls Installer Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Review design for ability of systems to be controlled including the following:

    a. Confirm proper hardware requirements exists to perform functional performance testing.
    b. Confirm proper safeties and interlocks are included in design.

c. Confirm proper sizing of system control valves and actuators and control valve operation will result capacity control identified in Contract Documents.
d. Confirm proper sizing of system control dampers and actuators and damper operation will result in proper damper positioning.
e. Confirm sensors selected are within device ranges.
f. Review sequences of operation and obtain clarification from Architect/Engineer.
g. Indicate delineation of control between packaged controls and building automation system, listing BAS monitor points and BAS adjustable control points.
h. Provide written sequences of operation for packaged controlled equipment. Equipment manufacturers' stock sequences may be included, when accompanied by additional narrative to reflect Project conditions.

3. Inspect, check, and confirm proper operation and performance of control hardware and software provided in other HVAC sections.
4. Submit proposed procedures for performing automatic temperature control system point-to-point checks to Commissioning Authority and Architect/Engineer.
5. Inspect check and confirm correct installation and operation of automatic temperature control system input and output device operation through point-to-point checks.
6. Perform training sessions to instruct LAWA's personnel in hardware operation, software operation, programming, and application in accordance with commissioning plan.
7. Demonstrate system performance and operation to Commissioning Authority during functional performance tests including each mode of operation.
8. Provide control system technician to assist during Commissioning Authority verification check and functional performance testing.
9. Provide control system technician to assist testing, adjusting, and balancing agency during performance of testing, adjusting, and balancing work.
10. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

C. Testing, Adjusting, and Balancing Agency Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Participate in verification of testing, adjusting, and balancing report for verification or diagnostic purposes. Repeat sample of percent of measurements contained in testing, adjusting, and balancing report as indicated in commissioning plan.
3. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

## 1.8 COMMISSIONING MEETINGS

A. Attend initial commissioning meeting and progress commissioning meetings as required by Commissioning Authority.

## 1.9 SCHEDULING

A. Prepare schedule indicating anticipated start dates for the following:

1. Piping system pressure testing.

2. Piping system flushing and cleaning.
3. Ductwork cleaning.
4. Ductwork pressure testing.
5. Equipment and system startups.
6. Automatic temperature control system checkout.
7. Testing, adjusting, and balancing.
8. HVAC system orientation and inspections.
9. Operation and maintenance manual submittals.
10. Training sessions.

B. Schedule seasonal tests of equipment and systems during peak weather conditions to observe full-load performance.

C. Schedule occupancy sensitive tests of equipment and systems during conditions of both minimum and maximum occupancy or use.

## 1.10 COORDINATION

A. Notify Commissioning Authority minimum of four weeks in advance of the following:

1. Scheduled equipment and system startups.
2. Scheduled automatic temperature control system checkout.
3. Scheduled start of testing, adjusting, and balancing work.

B. Coordinate programming of automatic temperature control system with construction and commissioning schedules.

# PART 2 - PRODUCTS

## 2.1 DESIGN DOCUMENT AND SUBMITTAL REVIEWS

A. General:

1. Submit design documents.

## 2.2 SEQUENCE OF OPERATIONS OF HVAC SYSTEM

A. General:

1. Sequences of Operation submitted shall describe in detail operation of building control system and its components. The sequences provided in the contract drawings and specifications provide a good overview, but they shall be supplemented by finalized sequences used to program the system. Sequences of operation should address all critical system interactions in detail to enable their verification and troubleshooting.
2. Control system components and hardware.

## 2.3 START-UP AND TESTING, ADJUSTING AND BALANCING REPORTS

A. Startup and testing reports shall be generated by the installing contractor for all equipment/systems and submittted to Contractor who provides a copy to CxA.

B. TAB reports shall be created for designated systems by a certified TAB provider and submitted to Contractor who provides a copy to CxA.

## 2.4 FUNCTIONAL PERFORMANCE TESTS

A. General:

1. See attached FPT samples below.

## 2.5 OPERATION & MAINTENANCE MANUAL AND PERSONNEL TRAINING REVIEWS

A. Submit O&M Manuals and Personnel Training Reviews.

## 2.6 SYSTEMS MANUAL

A. Submit Systems Manual.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install additional balancing dampers, balancing valves, access doors, test ports, and pressure and temperature taps required by Commissioning Authority or commissioning plan.

B. Place HVAC systems and equipment into full operation and continue operation during each working day of commissioning.

C. Install replacement sheaves and belts to obtain system performance, as requested by Commissioning Authority.

D. Install test holes in ductwork and plenums as requested by Commissioning Authority for taking air measurements.

E. Prior to start of functional performance test, install replacement filters in equipment.

## 3.2 COMMISSIONING

A. Seasonal Sensitive Functional Performance Tests (as far as possible and in consultation with LAWA:

1. Test heating equipment at winter design temperatures.
2. Test cooling equipment at summer design temperatures.

B. Be responsible to participate in initial and alternate peak season test of systems required to demonstrate performance.

C. Occupancy Sensitive Functional Performance Tests:

1. Test equipment and systems affected by occupancy variations at minimum and peak loads to observe system performance.
2. Participate in testing delayed beyond Final Completion to test performance with actual occupancy conditions.

END OF SECTION 23 08 00

# SECTION 23 11 23 FACILITY NATURAL-GAS PIPING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Natural gas piping buried within 5 feet of building.
2. Natural gas piping above grade.
3. Unions and flanges.
4. Strainers.
5. Natural gas pressure regulators.
6. Natural gas pressure relief valves.
7. Underground pipe markers.
8. Bedding and cover materials.

### 1.2 REFERENCES

A. General: Comply with appropriate standards.

1. American National Standards Institute: ANSI.
2. American Society of Mechanical Engineers: ASME.
3. American Society for Testing and Materials: ASTM.
4. American Welding Society: AWS.
5. American Water Works Association: AWWA.
6. Manufacturers Standardization Society of the Valve and Fittings Industry: MSS.
7. National Fire Protection Association: NFPA.
8. Underwriters Laboratories Inc.: U.L.
9. Los Angeles Plumbing Code: LAPC.
10. Los Angeles Department of Building and Safety: LADBS.
11. American Gas Association: AGA.

### 1.3 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.

B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded connections to valves, equipment.

C. Provide pipe hangers and supports in accordance with other sections.

D. Use plug, ball, or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.

## 1.4 SUBMITTALS

A. Product Data:

1. Submit data on all pipe materials, fittings specialties, and accessories.

B. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangersSubmit data on all materials, fittings, accessories and equipment.

C. Manufacturers Installation Instructions: Submit installation instructions for material and equipment.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

E. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

F. Shop Drawings Provide product data for each type of the following:

1. Piping
2. Fittings
3. Joints.
4. Piping specialties
5. Corrugated, stainless-steel tubing with associated components.
6. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
7. Pressure regulators. Indicate pressure ratings and capacities.
8. Service meters including supports
9. Dielectric fittings.
10. Mechanical sleeve seals.
11. Escutcheons.
12. Supports.
13. Remote meter reading accessories.
14. Seismic gas shut off valves.

G. Seismic-Design Submittal: Provide for natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

H. Operation and Maintenance Data: Submit for valves and gas pressure regulators installation instructions, spare parts lists, and exploded assembly views.

## 1.5 WARRANTY

A. Furnish one-year minimum warranty.

## PART 2 - PRODUCTS

### 2.1 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.

1. Fittings: ASTM A234/A234M forged steel welding type.
2. Joints: ASME B31.9, welded. For 3" and larger; threader for 2" and smaller.
3. Jacket: AWWA C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

B. Plastic Pipe: ASTM D-2513 Schedule 40 Polyethylene.

1. Fittings: PE 2406 butt-fused.
2. Joints: PE 2406 butt-fused.

### 2.2 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.

1. Fittings: ASME B16.3, malleable iron, 150 psig.
2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

### 2.3 PIPING

A. Inside steel piping:

1. For low pressure 0.5 PSIG or less use standard weight black steel pipe with 150 PSIG threaded malleable iron fittings for piping 4 in. and smaller.
2. For pressure above 5 PSIG, all piping shall be welded.

B. Underground piping:

1. Steel pipe with Dresser type and steel welding fittings. Pre-wrap with Mill-wrapped corrosion protection extruded polyolefin coating in accordance with Gas Company requirements, equal to Energy Coating Co. or PlexCo.
2. High density polyethylene pipe and fittings in accordance with ASTM D-2513, Grades 2306, 3306, and 3408 with fusion joints only, equal to Driscopipe 8100-DRII Series.

C. Underground drips shall be AGA and local gas company approved and shall be cast iron or tar coated welded steel pots with adjustable tar coated cast iron extension shaft and flush box with lock type extra heavy cast iron cover marked GAS DRIP.

D. In no case shall any gas pipe be less than ¾ inch.

## 2.4 REGULATOR VENT PIPING, ABOVE GRADE

A. Indoors: Same as natural gas piping, above grade.

B. Outdoors: PVC pipe, tubing, and fittings, UL 651.

## 2.5 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:

1. Ferrous Piping: Class 150, malleable iron, threaded.
2. Copper Piping: Class 150, bronze unions with soldered brazed joints.
3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Flanges for Pipe 2-1/2 inches and Larger:

1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
2. Copper Piping: Class 150, slip-on bronze flanges.
3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

## 2.6 STRAINERS

A. Manufacturers:

**1. Mueller Steam Specialty.**
**2. O.C. Keckley Company.**
**3. Spirax Sarco, Inc.**

B. 2 inch and Smaller: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. 2-1/2 inch to 4 inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. 5 inch and Larger: Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

## 2.7 NATURAL GAS PRESSURE REGULATORS

A. Manufacturers:

**1. Equimeter.**
**2. American.**
**3. Sensus.**

B. Product Description: Spring loaded, general purpose, self-operating service regulator including internal relief type diaphragm assembly and vent valve. Diaphragm case can be rotated 360 degrees in relation to body.

1. Comply with ANSI Z21.80.
2. Temperatures: minus 20 degrees F to 150 degrees F.
3. Body: Cast iron with neoprene gasket.
4. Spring case, lower diaphragm casing, union ring, seat ring and disk holder: Aluminum.
5. Disk, diaphragm, and O-ring: Nitrile.
6. Minimum Inlet Pressure: 5 P.S.I.
7. Furnish sizes 2 inches and smaller with threaded ends. Furnish sizes 2-1/2 inches and larger with flanged ends.

C. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers:

**a. Equimeter.**
**b. American.**
**c. Sensus.**

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 60 psig.

## 2.8 NATURAL GAS PRESSURE RELIEF VALVES

A. Manufacturers:

**1. Fisher.**
**2. American.**

B. Product Description: Spring loaded type relief valve.

1. Body: Aluminum.
2. Diaphragm: Nitrile.
3. Orifice: Stainless steel.

4. Maximum operating temperature: 150 degrees F.
5. Inlet Connections: Threaded.
6. Outlet or Vent Connection: Same size as inlet connection.

## 2.9 UNDERGROUND LABELING & IDENTIFYING

A. Detectable Warning Tape: Acid and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

## 2.10 GAS VENT TERMINALS

A. ¾ in. and one (1) in. aluminum threaded vent terminal with 16 x 16 mesh 0.018 gauge stainless steel screen.

B. 1¼ in. to 4 in. standard pipe threaded elbow with 12 x 12 mesh stainless steel screen.
   1. Equal to Upsco Inc.

C. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
   2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
   3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
   4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

      a. Material Group: 1.1.
      b. End Connections: Threaded or butt welding to match pipe.
      c. Lapped Face: Not permitted underground.
      d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
      e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

   5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

      a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

## 2.11 VALVES

A. Manual Shut-off Valves Inside Building.

B. Manufacturer:

1. Nordstrom.

C. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves where required by Con. Ed.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
7. Threaded cast iron body, 125 PSIG wog

D. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves where required by Con. Ed.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
5. 2½ in. to 4-in.: Flanged cast iron body lubricated tapered plug type, 175 PSIG wog.
6. 6 in. and larger: Flanged cast iron body lubricated tapered plug type, 200 PSIG wog, worm gear operated.

E. Provide 2 wrenches for each size used.

1. Attach wrench to each valve.

F. Ball Valves

1. On local branches three inches and smaller, provide threaded three piece full port wafer-type ball valve with bronze body, ball stem, Teflon seats, and level handles, 300 PSIG wog.

2. Manufacturer:

**a. Contromatics.**

G. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. 2 inch and smaller: Threaded brass ball valves with full port TFE sears and blowout proof stem, 600 psig wog.

2. Manufacturers:

**a. BrassCraft.**
**b. Conbraco.**

c. **NIBCO.**

3. Body: Bronze, complying with ASTM B 584.
4. Ball: Chrome-plated bronze.
5. Stem: Bronze; blowout proof.
6. Seats: Reinforced TFE; blowout proof.
7. Packing: Threaded-body packnut design with adjustable-stem packing.
8. Ends: Threaded, flared, or socket.
9. CWP Rating: 600 psig.
10. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
11. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

H. Check Valves:

1. Provide bronze body swing disc check valve.

a. Manufacturer:

**1) Eclipse Series 1000.**

I. Bronze Plug Valves: MSS SP-78.

1. Manufacturers:

**a. Hammond.**
**b. Lee Brass Company.**
**c. NIBCO.**

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

J. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

1. Manufacturers:

**a. McDonald.**
**b. Mueller Co.**
**c. Xomox Corporation.**

2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.

6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

K. Cast Lubricated Plug Valves Inside Building:

1. 2-inch and smaller: Cast iron body, threaded, equal to Nordstrom Valves, Inc. Figure 114.
2. 2½ inch to 4-inch: Flanged cast iron body lubricated tapered plug type, 175 PSIG wog, equal to Nordstrom Valves, Inc. Figure 115.
3. 6 inch and larger: Flanged cast iron body lubricated tapered plug type, 200 PSIG wog, worm gear operated, equal to Nordstrom Valves, Inc. Figure 165.
4. Valves 2 ½ inch and larger shall be flanged.
5. Provide 2 wrenches for each size used.
6. Attach wrench to each valve.
7. Gas Cocks:

    a. Gas cocks shall be for use only as manual gas shut-off valves at each piece of gas burning equipment; shall be of the plug type, bronze construction with check, nut and washer bottom and tee handle.
    b. Gas cocks shall be Figure 10596 as manufactured by A.Y. McDonald Mfg. Co., or Series 52 as manufactured by Conbraco Industries, Inc.
    c. Gas cocks shall only be used on piping 1 inch and smaller.

L. Valves Underground (Curb Type)

1. Provide welding end steel body tapered lubricated plug type with iron plug high head extension.

    a. 2 inch to 4 inch: 200 PSIG wog, equal to Nordstrom No. 1943.
    b. 6 inch and larger: 275 PSIG wog, equal to Nordstrom No. 4185.

2. Provide with adjustable tar coated cast iron extension shaft and flush box with lock type extra heavy cast iron cover marked GAS. Provide two operating wrenches.

M. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

## 2.12 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

1. Manufacturers:

**a. Pacific Seismic Products, Inc.**
**b. Quake Defense, Inc.**
**c. Strand Earthquake.**

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure:
4. Cast-aluminum body with stainless-steel internal parts.
5. Nitrile-rubber, reset-stem o-ring seal.
6. Valve position, open or closed, indicator.
7. Composition valve seat with clapper held by spring or magnet locking mechanism.
8. Level indicator.
9. End Connections: Threaded for valves NPS ¾ 2 and smaller; flanged for valves NPS 2-1/2 and larger.
10. City of Los Angeles approved.

## 2.13 GAS SAFETY SHUTOFF VALVES

A. Gas safety shut-off valves shall be FM & UL listed, electric motor operated, normally closed, manual reset type. Valves shall be rising stem design with a straight through flow path with metal-to-metal seat and disc arrangement. The valve seat shall be stainless steel and the disc ductile iron. Valves shall be provided with a NEMA 4 enclosure modified for Class I, Division II hazardous locations, be provided with an electrical terminal block and shall operate on 120 Volt, A.C., 60 Cycles, single phase. Valves shall meet ANSI Class VI leakage standard and shall be provided with a visual indicator to note the position of the valve whether "OPEN" or "SHUT"

B. Gas safety shut-off valves 2" and smaller shall be threaded, 2 1/2" and larger shall be flanged. Flanged valves shall be provided with companion flange set by valve manufacturer.

1. Gas safety shut-off valves 2" and smaller

a. Manufacturer:

**1) Maxon Corporation Series 808.**

2. 2 1/2" and larger. All valves shall be provided with trim package 1-1.

a. Manufacturer:

**1) Series 808-CP.**

C. Gas safety shut-off valves shall be installed in the following locations:

1. On the firm gas line downstream of its meter and before any branch take-offs.

D. Gas safety shut-off valves shall be wired to the gas leak detection system and shall function to shut off all gas supply to the building upon:

1. Action of the gas leak detection system (alarm condition), and,
2. Loss of normal electrical power.

## 2.14 GAS TENANT METERS

A. Body and cover:

1. Die cast aluminum alloy factory painted.

B. Temperature compensation

1. Bi-metallic element that automatically corrects changes in gas temperature.

C. Gas Meter Register

1. UV stabilized clear polycarbonate index box to measure in cubic feet.
2. Gas register transmitter for remote reading to the building automation system.

D. Manufacturers:

**1. Equimeter.**
**2. Sensus.**
**3. American Meter.**

## 2.15 DIELECTRIC FITTINGS

A. Dielectric Unions:

1. Manufacturers:

**a. Hart Industries.**
**b. Watts.**
**c. Zurn - Wilkins.**

2. Minimum Operating-Pressure Rating: 125 psig (862 kPa).
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for natural gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

## 2.16 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

## 2.17 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

**a. Advance Products & Systems, Inc.**
**b. Calpico Inc.**
**c. Metraflex Company.**

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

## 2.18 MECHANICAL GAS SLEEVES

A. Carbon steel, zinc chromate bolts and nuts with corrosion inhibiting coating.

B. Seal material EPDM, black in color.

C. Pressure pates of reinforced nylon polymer.

D. Equal to Thunderline Link Seal Model ‘C’.

## 2.19 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.

1. Finish: Polished chrome-plated or rough brass.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.

1. Finish: Polished chrome-plated or rough brass.

E. One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw, and chrome-plated finish.

G. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

## 2.20 PRESSURE GUAGES

A. 4½ in. diameter, black enamel coated steel case ring with shatterproof glass, ½ in. bronze bellows with brass socket, blow out on back of case, ¼ in. bottom outlet connection, similar to Trerice No. 860 or Weksler Instruments Corp. No. BL14-PWE4-LWXX with 0 to 27 in. of water column dial, brass pressure snubber and brass tee-handle cock.

B. Locate pressure gauges on inlet and outlet of gas booster pressure pump, at farthest point in system and as noted.

## 2.21 REMOTE METER READING EQUIPMENT

A. Electronic hard wire transmitter to provide gas consumption readings for every individual tenant and concession to the building management system.

## 2.22 CATHODIC PROTECTION

A. Provide a complete electrically isolated, cathodic protection system for entire length of underground gas line, including all components, suitable for temperatures and pressures involved.

B. Prior to installation, conduct a corrosion site survey using a qualified corrosion engineer to evaluate soil conditions and establish system requirements.

C. System shall be the sacrificial magnesium anode type with 17 lb anodes, spacing based upon soil resistivity readings, with a maximum spacing of 300 feet Pack anodes in permeable cloth bag in backfill: 75% ground hydrated gypsum, 20% powdered Wyoming bentonite, 5% anhydrous sodium sulfate.

D. Magnesium anodes shall be high current type with magnesium wall having the following composition:

1. Aluminum: 5.3 to 6.7%.
2. Manganese: 0.15% minimum.
3. Zinc: 2.5 to 3.5%.
4. Silicone: 0.3% maximum.
5. Copper: 0.02% maximum.
6. Nickel: 0.003% maximum.

7. Iron: 0.003% maximum.
8. Other impurities: 0.3% maximum.
9. Magnesium: Remaining.

E. Anodes shall be cast with perforated galvanized steel strap core. One end of anode shall be recessed so one end of strap is accessible for lead wire connection. Anode lead wires shall be 25 feet long, silver soldered to strap core and with a minimum 1 turns of wire at connection. Fill anode recess connection with electrical potting compound. Conductors shall be No. 12 AWG Type TW copper wire.

F. Connectors shall be Cadwel Thermite brazing type elements for mechanically bonding conductors to steel pipe. Moisture proof all connections to piping. Splices shall be made with split bolt compression connectors and suitable protection tape.

G. For pipe installed in sleeves, provide insulators, equal to Maloney Model 57, spaced 10-feet on centers, installed in accordance with manufacturer's recommendations. Provide insulating coupling for pipe penetrating building wall.

H. Provide test stations housed in electrical conduit terminated in cast iron, waterproof junction boxes at ground surface. Embed in 12-inches x 12-inches x 6-inches concrete marker.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

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

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. Field verify that connection to existing piping systems sizes, locations, and invert are as required.

F. Establish elevations of buried piping with not less than allowed per code.

G. Establish minimum separation of from other piping services in accordance with code.

### 3.2 NATURAL FUEL GAS SYSTEMS INSTALLATION

A. Install piping free from traps and with drain pocket consisting of nipple and cap at low points for inside building and drip pot for underground piping.

B. Install shut-off valves at connection to each piece of equipment. Provide union or right and left nipple and coupling at equipment side of individual shut-off valve.

C. Install gas meter in a well ventilated and accessible location. Gas meter room (3 hr. rated enclosure) with explosion-proof fixtures.

D. Threaded Joints:

1. Make-up joints with U.L. listed gas resistant Teflon tape or Teflon paste, suited for gas piping.

E. Provide a two elbow-swing on all branches taken from a riser.

F. Provide valve tags for piping systems indicating the operating system pressure.

G. Color code piping at different pressures within the gas meter room. Paint fifteen (15) to five (5) psi system brown and reduced pressure piping yellow.

H. Welders must be qualified in accordance with either API 1104 or A.S.M.E. IX Boiler and Pressure Vessel Code and as required by local code.

I. Provide sign on the exterior of the gas meter door shall be provided with bold lettering at least 1 in. high and properly spaced with lettering and background in contrasting colors reading "Gas Meter Room - No Storage Permitted."

J. Support horizontal gas piping as follows:

1. ½ in. - 6 ft. on center.
2. ¾ in. or 1 in. - 8 ft. on center.
3. 1¼ in. or larger - 10 ft. on center.
4. Vertical piping at every floor.

K. Provide remote meter reading communication wiring to connect to building automation system. Wire gauge per manufacturer recommendation for distance required.

## 3.3 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 22 inches below finished grade as required.

1. If natural-gas piping is installed less than 72 inches below finished grade, install it in ductile iron pipe containment conduit.
2. Coordinate with site paving contractor for finished grade location.
3. Protect exterior underground pipe from damage due to heavy equipment traffic during construction.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.

2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

E. Install fittings for changes in direction and branch connections.

F. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

G. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

H. Install pressure gauge upstream and downstream from each service regulator as required.

## 3.4 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

1. Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
c. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
d. Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw.

e. Piping in Equipment Rooms: One-piece, cast-brass type.
f. Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
g. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

H. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials as required.

I. Verify final equipment locations for roughing-in.

J. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

K. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

L. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

M. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

N. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

a. Exception: Tubing passing horizontally through partitions or walls does not require striker barriers.

3. Prohibited Locations:

a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or ventilating ducts, or dumbwaiter or elevator shafts.
b. Do not install natural-gas piping embedded in concrete walls or partitions.

O. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

P. Connect branch piping from top or side of horizontal piping.

Q. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

R. Do not use natural-gas piping as grounding electrode.

S. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

T. Install pressure gauge upstream and downstream from each line regulator as required.

## 3.5 SERVICE METER ASSEMBLY INSTALLATION

A. Install service-meter assemblies aboveground, on concrete bases.

B. Install metal shutoff valves upstream from service regulators.

C. Install strainer on inlet of service-pressure regulator and meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.

F. Install service meters downstream from pressure regulators.

G. Install metal bollards to protect meter assemblies as required.

H. Install meters on full size gas headers.

## 3.6 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

## 3.7 HANGER & SUPPORT INSTALLATION

A. Install seismic restraints on piping as required.

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

C. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

END OF SECTION 22 70 00

# SECTION 23 21 13-HYDRONIC PIPING

## PART 1 -GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Heating water piping, above ground.
2. Chilled water piping and condenser water piping, above grade.
3. Equipment drains and over flows.
4. Unions and flanges.

### 1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.4 - Gray Iron Threaded Fittings.
3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
5. ASME B31.1 - Power Piping.
6. ASME B31.9 - Building Services Piping.
7. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
4. ASTM A536 - Standard Specification for Ductile Iron Castings.
5. ASTM B32 - Standard Specification for Solder Metal.
6. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
7. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

C. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

## 1.3 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

B. Provide flanges, union, and couplings at locations requiring servicing. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

C. Provide pipe hangers and supports in accordance with these specifications and drawings.

D. Flexible Connectors: Use at or near pumps and motor driven equipment where piping configuration does not absorb vibration.

## 1.4 SUBMITTALS

A. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.

B. Welding certificates.

C. Qualification Data: For installer.

## 1.5 QUALITY ASSURANCE

A. Qualification for 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."

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. When piping 1-1/2 in. and smaller is butt or socket welded, submit three samples of test welds for approval.

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

## PART 2 - PRODUCTS

### 2.1 HEATING WATER PIPING, ABOVE GROUND

A. Steel Pipe: ASTM A53/A53M, Schedule 40, 0.375 inch wall for sizes 12 inch and larger, black.

1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

B. Steel Pipe: ASTM A53/A53M, Schedule 40, 0.375 inch wall for sizes 12 inch and larger, black, grooved ends.

1. Fittings: ASTM A234/A234M carbon steel, grooved ends.
2. Joints: Grooved mechanical couplings meeting ASTM F1476.

a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, compatible with steel piping sizes.
b. Gasket: Elastomer composition for operating temperature range from -30 degrees F to 230 degrees F.
c. Accessories: Steel bolts, nuts, and washers.

C. Copper Tubing: ASTM B88, Type L drawn.

1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
2. Joints: Solder, lead free, ASTM B32, Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

### 2.2 CHILLED WATER PIPING, ABOVE GROUND

A. Steel Pipe: ASTM A53/A53M, Schedule 40, 0.375 inch wall for sizes 12 inch and larger, black.

1. Fittings: ASME B16.3, malleable iron or ASTM A234/A234M, forged steel welding type.
2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

B. Steel Pipe: ASTM A53/A53M Schedule 40, black, cut rolled grooved ends.

1. Fittings: ASTM A395/A395M and ASTM A536 ductile iron, or ASTM A234/A234M carbon steel, grooved ends.
2. Joints: Grooved mechanical couplings meeting ASTM F1476.

    a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, compatible with steel piping sizes, rigid type.
    b. Gasket: Elastomer composition for operating temperature range from -30 degrees F to 230 degrees F.
    c. Accessories: Steel bolts, nuts, and washers.

C. Copper Tubing: ASTM B88, Type L drawn.

1. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
2. Joints: Solder, lead free, ASTM B32, Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

## 2.3 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized.

1. Fittings: ASME B16.3, malleable iron or ASME B16.4, cast iron.
2. Joints: Threaded for pipe 2 inch and smaller; flanged for pipe 2-1/2 inches and larger.

B. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized, grooved ends.

1. Fittings: ASTM A395/A395M and ASTM A536 ductile iron, grooved ends.
2. Joints: Grooved mechanical couplings meeting ASTM F1476.

    a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, compatible with steel piping sizes, rigid type.
    b. Gasket: Elastomer composition for operating temperature range from -30 degrees F to 230 degrees F.
    c. Accessories: Steel bolts, nuts, and washers.

C. Copper Tubing: ASTM B88, Type DWV, drawn.

1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
2. Joints: Solder, lead free, ASTM B32.

## 2.4 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:

1. Ferrous Piping: Class 150, malleable iron, threaded.
2. Copper Piping: Class 150, bronze unions with soldered joints.
3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Flanges for Pipe 2-1/2 inches and Larger:

1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
2. Copper Piping: Class 150, slip-on bronze flanges.
3. Gaskets: 1/16 inch thick preformed neoprene gaskets.

## PART 3 - EXECUTION

### 3.1 INSTALLATION - INSERTS

A. Provide inserts for placement in concrete forms.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

### 3.2 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Support horizontal piping per table - Copper & Steel.

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

C. Place hangers within 12 inches of each horizontal elbow.

D. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

E. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

F. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.

G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

### 3.3 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Route piping parallel to building structure and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space.

C. Group piping whenever practical at common elevations.

D. Sleeve pipe passing through partitions, walls and floors.

E. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.

F. Install pipe identification.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

H. Provide access where valves and fittings are not exposed.

I. Slope hydronic piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe aligned.

J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

K. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

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

M. Insulate piping as required.

## 3.4 FIELD QUALITY CONTROL

A. Test all piping to at least 150% of working pressure for minimum of two hours.

## 3.5 FIELD QUALITY CONTROL

A. Perform the following tests on hydronic piping:

1. Verify that pipe cleaning has been completed.
2. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
3. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
4. Isolate expansion tanks and determine that hydronic system is full of water.
5. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
6. After hydrostatic test pressure has been applied for at least 2 hours, with system valves capped and pressure apparatus disconnected, and no change in test pressure, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

7. Prepare written report of testing.

## 3.6 ADJUSTMENT AND CLEANING

A. Cleaning:

1. During construction, prevent entry of foreign matter, clean pipe, fittings, and valves internally and hammer welds to remove all loose dirt, mill scale, metal chips, weld beads rust and harmful substances. Flush piping system with clear water prior to connection to coils, control valves and equipment. Install temporary by-pass piping around factory cleaned components such as coils, control valves and equipment where piping system is hot flushed prior to connection.
2. After erection, flush with clear water and seal ends after cleaning.
3. Water Systems:

    a. Open all valves, drains, vents and strainers at all system levels.
    b. Remove plugs, caps, spool pieces and components to facilitate early debris discharge from system.
    c. Isolate or protect clean systems components including pumps and pressure vessels and remove any component that may be damaged. Install temporary strainer where necessary.
    d. Flush bottoms of risers.
    e. After start-up flushing, fill with clean water, add products recommended by water treatment supplier to remove adherent organic soil, hydrocarbon flux, pipe mill varnish, joint compounds, rust and harmful substances not removed by initial flushing.
    f. Circulate water of each system at respective design flow rates for at least 8 hours.
    g. At end of 8 hour period, remove and clean strainers and blow off low point, then completely drain out entire systems of cleaning solution and clean out cooling tower basins and hose down for final flushing.
    h. Refill systems with clean water and circulate for an additional 4 hour period and, at the end of that interval, completely drain systems, operate all valves to dislodge debris.
    i. Drain, refill with clear water and circulate, and provide water treatment as directed by water treatment company.

4. Do not circulate water to the CUP until the CUP water treatment contractor has certified the water quality on both sides.

Copper and Steel Pipe Hanger Spacing Table

| PIPE SIZE Inches | COPPER TUBING MAXIMUM HANGER SPACING Feet | STEEL PIPE MAXIMUM HANGER SPACING Feet | COPPER TUBING HANGER ROD DIAMETER Inches | STEEL PIPE HANGER ROD DIAMETER Inches |
|---|---|---|---|---|
| 1/2 | 5 | 7 | 3/8 | 3/8 |
| 3/4 | 5 | 7 | 3/8 | 3/8 |
| 1 | 6 | 7 | 3/8 | 3/8 |
| 1-1/4 | 7 | 7 | 3/8 | 3/8 |
| 1-1/2 | 8 | 9 | 3/8 | 3/8 |
| 2 | 8 | 10 | 3/8 | 3/8 |
| 2-1/2 | 9 | 11 | 1/2 | 1/2 |
| 3 | 10 | 12 | 1/2 | 1/2 |
| 4 | 12 | 14 | 1/2 | 5/8 |
| 5 | 13 | 16 | 1/2 | 5/8 |
| 6 | 14 | 17 | 5/8 | 3/4 |
| 8 | 16 | 19 | 3/4 | 3/4 |
| 10 | 18 | 22 | 3/4 | 7/8 |
| 12 | 19 | 23 | 3/4 | 7/8 |
| 14 | 22 | 25 | 7/8 | 1 |
| 16 | 23 | 27 | 7/8 | 1 |
| 18 | 25 | 28 | 1 | 1 |
| 20 | 27 | 30 | 1 | 1-1/4 |
| 24 | 28 | 32 | 1-1/4 | 1-1/4 |

END OF SECTION 23 21 13

# SECTION 23 21 16-HYDRONIC PIPING SPECIALTIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Pressure gages.
2. Pressure gage taps.
3. Thermometers.
4. Termometer supports.
5. Test plugs.
6. Air vents.
7. Strainers.
8. Flow controls.

### 1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

B. ASTM International:

1. ASTM E1 - Standard Specification for ASTM Thermometers.
2. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.

### 1.3 SUBMITTALS

A. Product Data: Submit for manufactured products and assemblies used in this Project.

1. Manufacturer’s data and list indicating use, operating range, total range, accuracy, and location for manufactured components.
2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
4. Submit electrical characteristics and connection requirements where appriopriate.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

## 1.5 DELIVERY, STORAGE, AND HANDLING

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

B. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

# PART 2 - PRODUCTS

## 2.1 PRESSURE GAGES

A. Manufacturers:

1. **Trerice.**
2. **Peterson Equipment.**
3. **Watts Industries.**

B. Gage: ASME B40.1, UL Listed with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.

1. Case: Steel.
2. Bourdon Tube: Brass.
3. Dial Size: 2 inch diameter minimum.
4. Mid-Scale Accuracy: One percent.
5. Scale: Psi.

## 2.2 PRESSURE GAGE TAPS

A. Manufacturers:

1. **Trerice.**
2. **Peterson Equipment.**
3. **Watts Industries.**

B. Needle Valve: Brass, 1/4 inch NPT for minimum 300 psi.

C. Ball Valve: Brass 1/4 inch NPT for 250 psi.

D. Pulsation Damper: Pressure snubber, brass with 1/4 inch NPT connections.

## 2.3 STEM TYPE THERMOMETERS

A. Manufacturers:

1. **Trerice.**
2. **Peterson Equipment.**
3. **Watts Industries.**

B. Thermometer: ASTM E1, red appearing mercury, lens front tube, cast aluminum case with enamel finish.

1. Size: 9 inch scale.
2. Window: Clear glass or Lexan.
3. Stem: Brass, 3/4 inch NPT long.
4. Accuracy: ASTM E77 2 percent.
5. Calibration: Degrees F.

C. Thermometer: ASTM E1, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.

1. Size: 9 inch scale.
2. Window: Clear glass or Lexan.
3. Stem: Brass, 3/4 inch NPT long.
4. Accuracy: ASTM E77 2 percent.
5. Calibration: Degrees F.

## 2.4 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions, and with cap and chain.

B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

## 2.5 TEST PLUGS

A. Manufacturers:

**1. Trerice.**
**2. Peterson Equipment.**
**3. Watts Industries.**

B. 1/4 inch NPT or 1/2 inch NPT brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with:

1. Neoprene core for temperatures up to 200 degrees F.
2. Nordel core for temperatures up to 350 degrees F.
3. Viton core for temperatures up to 400 degrees F.

C. Test Kit:

1. Carrying case, internally padded and fitted containing:

a. Two 2-1/2 inch diameter pressure gages.

## 2.6 AIR VENTS

A. Manufacturers:

1. **Trerice.**
2. **Peterson Equipment.**
3. **Watts Industries.**

B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

C. Float Type:

1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

D. Washer Type:

1. Brass with hydroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

## 2.7 STRAINERS

A. Manufacturers:

1. **Nibco.**
2. **Milwaukee.**
3. **Zurn-Wilkins.**

B. Size 2 inch and Smaller:

1. Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch:

1. Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. Size 5 inch and Larger:

1. Flanged iron body for 175 psig working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

## 2.8 FLOW CONTROLS

A. Manufacturers:

1. **Griswold.**
2. **Bell & Gossett.**
3. **Flowcon.**

B. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet combination blow-down and back-flush drain.

C. Calibration: Control within 5 percent of design flow over entire operating pressure.

D. Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.

E. Accessories: In-line strainer on inlet and ball valve on outlet.

# PART 3 - EXECUTION

## 3.1 INSTALLATION - THERMOMETERS AND GAGES

A. Install one pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.

B. Install gage taps in piping

C. Install pressure gages with pulsation dampers. Provide needle valve or ball valve to isolate each gage. Extend nipples to allow clearance from insulation.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.

E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, pipe mounted thermometers are not required.

F. Coil and conceal excess capillary on remote element instruments.

G. Provide instruments with scale ranges selected according to service with largest appropriate scale.

H. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

I. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

## 3.2 INSTALLATION - HYDRONIC PIPING SPECIALTIES

A. Where large air quantities accumulate, provide enlarged air collection standpipes.

B. Install manual air vents at system high points.

C. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.

D. Provide drain and hose connection with valve on strainer blow down connection.

## 3.3 PROTECTION OF INSTALLED CONSTRUCTION

A. Do not install hydronic pressure gauges until after systems are pressure tested.

END OF SECTION 23 21 16

**SECTION 23 21 23-HYDRONIC PUMPS**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. In-line circulators.
2. Close coupled pumps.

### 1.2 REFERENCES

A. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

B. Underwriters Laboratories Inc.:

1. UL 778 - Motor Operated Water Pumps.

### 1.3 PERFORMANCE REQUIREMENTS

A. Provide pumps to operate at system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

### 1.4 SUBMITTALS

A. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.

## PART 2 - PRODUCTS

### 2.1 IN-LINE CIRCULATORS

A. Manufacturers:

1. **Bell & Gossett.**
2. **Armstrong.**
3. **Taco.**

B. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psig maximum working pressure.

C. Casing: Cast iron, with flanged pump connections.

D. Impeller: Stamped brass or cast bronze, keyed to shaft.

E. Bearings: Two, oil lubricated bronze sleeves.

F. Shaft: Alloy or stainless steel with copper or bronze sleeve, integral thrust collar.

G. Seal: Carbon rotating against stationary ceramic seat.

H. Drive: Flexible coupling.

| GUARANTEED MINIMUM FULL LOAD EFFICIENCY OF MOTORS | | |
|---|---|---|
| Rated HP | Nominal 1200 RPM | Nominal 1800 RPM |
| 1 | 82.5 | 85.5 |
| 1.5 | 86.5 | 86.5 |
| 2 | 87.5 | 86.5 |
| 3 | 89.5 | 89.5 |
| 5 | 89.5 | 89.5 |
| 7.5 | 91.7 | 91.0 |
| 10 | 91.7 | 91.7 |
| 15 | 92.4 | 93.0 |
| 20 | 92.4 | 93.0 |
| 25 | 93.0 | 93.6 |
| 30 | 93.6 | 94.1 |
| 40 | 94.1 | 94.1 |
| 50 | 94.1 | 94.5 |
| 60 | 95.0 | 95.0 |
| 75 | 95.0 | 95.0 |
| 100 | 95.0 | 95.4 |
| 125 | 95.4 | 95.4 |
| 150 | 95.8 | 95.8 |
| 200 | 95.4 | 95.8 |

## 2.2 CLOSE COUPLED PUMPS

A. Manufacturers:

1. Bell & Gossett.
2. Armstrong.
3. Taco.

B. Type: Horizontal shaft, single stage, close coupled, radial split casing, for 175 psig maximum working pressure.

C. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.

D. Impeller: Bronze, fully enclosed, keyed to motor shaft extension.

E. Shaft: Stainless steel.

## 2.3 ELECTRICAL

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings. For close coupled or base mounted pumps, install supports under elbows on pump suction and discharge line sizes 4 inches and over.

C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump so no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and larger.

D. Provide air cock and drain connection on horizontal pump casings.

E. Provide drains for bases and seals.

F. Check, align, and certify alignment of base mounted pumps prior to start-up.

G. Provide 1 year warranty.

H. Provide O & M Manuals to LAWA.

END OF SECTION 23 21 23

**SECTION 23 23 00-REFRIGERANT PIPING**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Refrigerant piping.
2. Unions, flanges, and couplings.
3. Pipe hangers and supports.
4. Refrigerant moisture and liquid indicators.
5. Valves.
6. Refrigerant strainers.
7. Refrigerant pressure regulators.
8. Refrigerant pressure relief valves.
9. Refrigerant filter-driers.
10. Refrigerant solenoid valves.
11. Refrigerant expansion valves.
12. Electronic expansion valves.
13. Refrigerant receivers.
14. Underground pipe markers.
15. Bedding and cover materials.

### 1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 495 - Refrigerant Liquid Receivers.
2. ARI 710 - Liquid-Line Driers.
3. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Dryers.
4. ARI 750 - Thermostatic Refrigerant Expansion Valves.
5. ARI 760 - Solenoid Valves for Use with Volatile Refrigerants.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

C. American Society of Mechanical Engineers:

1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
3. ASME B31.5 - Refrigeration Piping.
4. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
5. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
6. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.

E. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

F. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

G. Underwriters Laboratories Inc.:

1. UL 429 - Electrically Operated Valves.

## 1.3 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.

B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.

C. Provide receivers on systems if recommended by equipment supplier.

D. Flexible Connectors: Use at or near compressors where piping configuration does not absorb vibration.

## 1.4 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-407C:

1. Suction Lines for Air-Conditioning Applications: 230 psig.
2. Suction Lines for Heat-Pump Applications: 380 psig.
3. Hot-Gas and Liquid Lines: 380 psig.

B. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

## 1.5 SUBMITTALS

A. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.

B. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories.
2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
4. Refrigerant Specialties: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes for the following:

a. Refrigerant. Type.
b. Refrigerant moisture and liquid indicators.
c. Refrigerant strainers.
d. Refrigerant pressure regulators.
e. Refrigerant pressure relief valves.
f. Refrigerant filter-driers.
g. Refrigerant solenoid valves.
h. Refrigerant expansion valves.
i. Electronic expansion valves.

C. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

D. Test Reports: Indicate results of refrigerant leak test.

E. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

F. Welding Certificates.

# PART 2 - PRODUCTS

## 2.1 REFRIGERANT PIPING

A. Copper Tubing: ASTM B280, drawn.

1. Fittings: ASME B16.22 wrought copper.

2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

## 2.2 UNIONS, FLANGES, AND COUPLINGS

A. 2 inches and Smaller:

1. Ferrous Piping: 150 psig malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

## 2.3 PIPE HANGERS AND SUPPORTS

A. Manufacturers:

1. B-Line.
2. Tolco.
3. PHD.

B. Conform to ASME B31.5.

C. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron Carbon steel, adjustable swivel, split ring.

D. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.

E. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.

F. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

G. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.

H. Vertical Support: Steel riser clamp.

I. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

J. Floor Support for Hot Pipe 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

K. Copper Pipe Support: Carbon steel rings, adjustable, copper plated.

L. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

M. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

N. Sheet Lead: ASTM B749.

## 2.4 REFRIGERANT MOISTURE AND LIQUID INDICATORS

A. Manufacturers:

1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Indicators:

1. Port: Single or Double, UL listed.
2. Body: Copper or brass, flared or solder ends.
3. Sight glass: Color-coded paper moisture indicator with removable element cartridge and plastic cap.
4. Maximum working pressure: 500 psig
5. Maximum working temperature: 200 degrees F.

## 2.5 VALVES

A. Manufacturers:

1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Diaphragm Packless Valves:

1. UL listed, globe or angle pattern, forged brass body and bonnet solder or flared ends.
2. Phosphor bronze and stainless steel diaphragms, rising stem and hand wheel.
3. Stainless steel spring, nylon seats, disc with positive back seating.
4. Maximum working pressure: 500 psig.
5. Maximum working temperature: 275 degrees F.

C. Packed Angle Valves:

1. Forged brass or nickel-plated forged steel, solder or flared ends.
2. Forged brass seal caps with copper gasket, rising stem and seat, molded stem packing.
3. Maximum working pressure: 500 psig.
4. Maximum working temperature: 275 degrees F.

D. Ball Valves:

1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals, soldered or threaded ends.
2. Maximum working pressure: 500 psig.
3. Maximum working temperature: 325 degrees F.

E. Service Valves:

1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends.
2. Maximum working pressure: 500 psig.

F. Refrigerant Check Valves:

1. Manufacturers:

a. Alco Controls Div, Emerson Electric Co.
b. Parker Hannifin Corp., Refrig. & Air Cond. Div.
c. Sporlan Valve Co.

2. Globe Type:

a. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc.
b. Maximum working pressure: 500 psig.
c. Maximum working temperature: 300 degrees F.

3. Straight Through Type:

a. Spring, neoprene seat.
b. Maximum working pressure: 500 psig.
c. Maximum working temperature: 250 degrees F.

## 2.6 REFRIGERANT STRAINERS

A. Manufacturers:

1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Straight Line or Angle Line Type:

1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass.
2. Maximum working pressure: 430 psig.

C. Straight Line, Non-Cleanable Type:

1. Steel shell, copper plated fittings, stainless steel wire screen.

## 2.7 REFRIGERANT PRESSURE REGULATORS

A. Manufacturers:

1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.

3. Sporlan Valve Co.

B. Brass body, stainless steel diaphragm, direct acting or pilot operated with remote pressure pilot, adjustable over 0 to 80 psig range, for maximum working pressure of 450 psig.

## 2.8 REFRIGERANT PRESSURE RELIEF VALVES

A. Manufacturers:

1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB; for standard 425 psig setting; selected to ASHRAE 15.

## 2.9 REFRIGERANT FILTER-DRIERS

A. Manufacturers:

1. Alco Controls Div, Emerson Electric Co. Mo
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Replaceable Cartridge Angle Type:

1. Shell: ARI 710, UL listed, brass, steel, removable cap, for maximum working pressure of 500 psig, inches outside diameter size connections.
2. Filter Cartridge: Pleated media with integral end rings, stainless steel support, ARI 730 rating.
3. Filter/Dryer Cartridge: Pleated media with solid core sieve with activated alumina, ARI 730 rating.
4. Wax Removal Cartridge: Molded bonded core of activated charcoal with integral gaskets, ARI 710 moisture rating.

## 2.10 REFRIGERANT SOLENOID VALVES

A. Manufacturers:

1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Valve: ARI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly, integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psig. Stem designed to allow manual operation in case of coil failure.

C. Coil Assembly: UL 429 listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box.

## 2.11 REFRIGERANT EXPANSION VALVES

A. Manufacturers:

1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Angle or Straight Through Type: ARI 750; design suitable for refrigerant, brass body, internal or external equalizer.

C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and oversized at part load.

## 2.12 ELECTRONIC EXPANSION VALVES

A. Manufacturers:

1. Alco Controls Div, Emerson Electric Co.
2. Parker Hannifin Corp., Refrig. & Air Cond. Div.
3. Sporlan Valve Co.

B. Valve:

1. Brass bodies with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.
2. Capacity: Nominal as shown on drawings.

C. Evaporation Control System:

1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, pre-selection allowance for electrical defrost and hot gas bypass.

D. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

## 2.13 REFRIGERANT RECEIVERS

A. Internal Diameter 6 inch and Smaller: ARI 495, UL listed, steel, brazed; 400 psig maximum pressure rating, with taps for inlet, outlet, and pressure relief valve.

B. Internal Diameter 6 inch and Larger: ARI 495, welded steel, tested and stamped in accordance with ASME Section VIII; 400 psig with taps for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

## PART 3 - EXECUTION

### 3.1 INSTALLATION - INSERTS

A. Provide inserts for placement in concrete forms.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

### 3.2 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

B. Place hangers within 12 inches of each horizontal elbow.

C. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

D. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

E. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.

F. Prime coat exposed steel hangers and supports in accordance with specifications herein. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

### 3.3 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

A. Route piping parallel to building structure and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space.

C. Group piping whenever practical at common elevations.

D. Provide sleeve for pipe passing through partitions, walls and floors.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Provide access where valves and fittings are not exposed.

G. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

H. Flood refrigerant piping system with nitrogen when brazing.

I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

J. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

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

L. Insulate piping and equipment per these specifications.

M. Provide replaceable cartridge filter-dryers, with isolation valves and bypass with valve.

N. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

O. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

P. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

Q. Provide electrical connection to solenoid valves.

R. Fully charge completed system with refrigerant after testing.

S. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.

T. Install insulation as required.

## 3.4 INSTALLATION - REFRIGERANT SPECIALTIES

A. Refrigerant Liquid Indicators:

1. Install line size liquid indicators in main liquid line downstream of condenser.

2. When receiver is provided, install line size liquid indicators in liquid line downstream of receiver.
3. Install line size liquid indicators downstream of liquid solenoid valves.

B. Refrigerant Valves:

1. Install service valves on compressor suction and discharge.
2. Install gage taps at compressor inlet and outlet.
3. Install gage taps at hot gas bypass regulators, inlet and outlet.
4. Install check valves on compressor discharge.
5. Install check valves on condenser liquid lines on multiple condenser systems.
6. Install refrigerant charging valve in liquid line between receiver shut-off valve and expansion valve.

C. Strainers:

1. Install line size strainer upstream of each automatic valve.
2. Where multiple expansion valves with integral strainers are used, install single main liquid-line strainer.
3. On steel piping systems, install strainer in suction line.
4. Install shut-off valves on each side of strainer.

D. Install pressure relief valves on ASME receivers. Install relief valve discharge piping to terminate outdoors.

E. Filter-Dryers:

1. Install permanent filter-dryers in low temperature systems.
2. Install permanent filter-dryer in systems containing hermetic compressors.
3. Install replaceable cartridge filter-dryer vertically in liquid line adjacent to receivers.
4. Install replaceable cartridge filter-dryer upstream of each solenoid valve.

F. Solenoid Valves:

1. Install in liquid line of systems operating with single pump-out or pump-down compressor control.
2. Install in liquid line of single or multiple evaporator systems.
3. Install in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.

## 3.5 FIELD QUALITY CONTROL

A. Test refrigeration system in accordance with ASME B31.5.

B. Pressure test refrigeration system with dry nitrogen to 200 psig.

C. Repair leaks.

D. Retest until no leaks are detected.

END OF SECTION 23 23 00

**SECTION 23 25 00-HVAC WATER TREATMENT**

**PART 1 -GENERAL**

**1.1 SUMMARY**

A. This Section includes the following:

1. HVAC water-treatment systems.
2. Chemical treatment test equipment.
3. HVAC water-treatment chemicals.

**1.2 PERFORMANCE REQUIREMENTS**

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available, HVAC system equipment material characteristics and functional performance characteristics.

C. Provide temporary water treatment for chilled, hot and condenser water until facility has final connections.

D. After connection to the Central Utilities Plant direct connected systems (chilled water and high temperature hot water), those systems will be treated from the Central Plant. Provide ongoing annual water treatment for the hot water heating system. Treatment shall consist of monthly site visits with analysis of water conditions and adjustment of chemical treatment to maintain specified levels. In glycol systems, glycol concentration, inhibitors and reserve alkalinity, as recommended by the glycol manufacturer.

E. Closed hydronic systems, including low temperature, hot-water heating, chilled water and glycol cooling and/or heating, shall have the following water qualities:

1. pH: Maintain a value within 9.0 to 10.5.
2. Turbidity: Maintain a value less than 15 NTU.
3. Boron: Maintain a value within 100 to 200 ppm.
4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
6. TDS: Maintain a maximum value of 3000 ppm.
7. Ammonia: Maintain a maximum value of 5 ppm.
8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
9. Microbiological Limits:

    a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
    b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
    c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.

d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

10. Treatment:

a. Low temperature hot water, closed cooling and chilled water -Mixture of sodium nitrite, borax and molybdate with other copper alloy inhibitor; non-oxidizing, non cationic biocide.
b. Glycol low temperature – Ethylene glycol with buffered phosphate based corrosion inhibitor with copper alloy inhibitor in deionized water, if water chloride levels are 750 ppm and contains hard water ions.

F. Open hydronic systems, including condenser water, shall have the following water qualities:

1. pH: Maintain a value within 7.0 to 9.0.
2. Langelier Saturation Index: Maintain a maximum value of +2.5 ppm.
3. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
4. Soluble Copper: Maintain a maximum value of 0.20 ppm.
5. Conductivity: Maintain a maximum value of 1500 uS/cm.
6. Ammonia: Maintain a maximum value of 20 ppm.
7. Free "OH" Alkalinity: Maintain a maximum value of 0 ppm
8. Silica: Maintain a maximum value of 125 ppm
9. Microbiological Limits:

a. Total Aerobic Plate Count: Maintain a maximum value of 10,000 organisms/ml.
b. Total Anaerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

10. Polymer Testable: Maintain a minimum value within 10 to 40.
11. Treatment: organic phosphonate and polymeric dispersant with copper alloy inhibitor, or other chromate- free treatment in liquid form; suitable for pumping from containers directly to water system.

a. Alternate two biocides, one oxidizer and one non-oxidizer; increase dosage when significant amount of algae or slime are detected after system operations.
b. Compounds of mercury, copper or arsenic shall not be permitted.

12. Bleed off:

a. Automatic control by condenser water conductivity and water meter signals.
b. To maintain maximum chloride concentration to 7 times concentration of make-up water to minimize corrosion and scale formation.

## 1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:

1. Water meters.
2. Inhibitor injection timers.
3. pH controllers.
4. TDS controllers.
5. Chemical solution tanks.
6. Injection pumps.
7. Chemical test equipment.
8. Chemical material safety data sheets.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.

1. Record actual locations of equipment and piping, including sampling points and locations of chemical injectors.
2. Wiring Diagrams: Power and control wiring.

C. Field quality-control test reports to indicate inhibitor levels, pH, conductivity, equipment conditions, chemical inventory and water usage data.

D. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

E. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
2. Water Analysis: Illustrate water quality available at Project site.
3. Certification of compliance: Submit certificate of compliance from authority having jurisdiction indicating approval of chemicals and their proposal disposal.

## 1.4 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider with certified water technologists, capable of analyzing water qualities, installing water-treatment equipment.

## 1.5 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for cooling, chilled-water piping, heating, hot-water piping, condenser-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:

1. Initial makeup and system water analysis with HVAC water-treatment recommendations.

2. Startup assistance for Contractor to flush the systems, clean with disinfectant detergents, and initially fill systems with required chemical treatment prior to operation.
3. Minimum 4 hours of on-site training of plant engineers to use water treatment equipment, to handle and administer treatment chemicals.
4. Monthly field service and consultation.
5. Customer report charts and log sheets.
6. Laboratory technical analysis.
7. Analyses and reports of all chemical items concerning safety and compliance with government regulations.
8. Summary review reports with graphs every six months.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following airport wide water treatment vendor:

**1. ONDEO Nalco Company.**

### 2.2 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Inhibitor Injection Timers:

1. Microprocessor-based controller with LCD display in NEMA 4X, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at BAS.
2. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
3. Test switch.
4. Hand-off-auto switch for chemical pump.
5. Illuminated legend to indicate feed when pump is activated.
6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
7. LCD makeup totalizer to measure amount of makeup and bleed-off water from two water meter inputs.
8. Timer mode includes: Choice of percent timer, water meter timer, limit timer and 28-day programmable timer.

B. pH Integral Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital LCD display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at BAS.
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal pH indication.

5. High or low pH alarm light, trip points field adjustable; with silence switch.
6. Hand-off-auto switch for acid pump.
7. Internal adjustable hysteresis or deadband.

C. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: 30 gal. (114 L).

D. Chemical Solution Injection Pumps:

1. Self-priming, positive-displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor.

E. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

F. Injection Assembly:

1. Quill: Minimum NPS 1/2 (DN 15) with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: Two-piece, stainless steel.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum 600 psig (4137 kPa) at 200 deg F (93 deg C).
5. Materials of construction: Stainless steel 316, Nickel alloy, Carpenter 20, PVC.

G. Fail-Safes and Alarms

1. Corrosion safety interlock: Alarm indication, lock-out all chemical feed, open bleed-off valve to flush corrosive water from system.
2. PH interlock: Alarm indication, lock-out all chemical feed, open bleed-off valve to reduce total dissolved solids in cooling tower water.
3. Flow interlock (on loss of flow): Alarm indication, lock-out all control outputs and chemical feeds.

H. Low Level Alarms

1. Low level alarm system to monitor chemical solution level in inhibitor, ph modifier (acid or alkali), biocide, and dispersant drums.
2. Alarm probes, suitable for use in 55 gal (207 L) drum and connected with flexible cable.
3. Signal output suitable for remote alarm function in addition to local alarm.

## 2.3 CHEMICAL TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, phosphate, silica and hardness; sulfite, diethylhydorxylamine, hydroquinone, ketoximes and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.

B. Sample Cooler:
   1. Shell: Cooling water.
      a. Material: ASTM A 666, Type 304 stainless steel.
      b. Pressure Rating: Minimum 250 psig (1725 kPa).
      c. Temperature Rating: Minimum 450 deg F (232 deg C).
   2. Capacities and Characteristics:
      a. Tube: Sample.
         1) Flow Rate: 0.25 gpm (0.016 L/s).
         2) Entering Temperature: 400 deg F (204 deg C).
         3) Leaving Temperature: 88 deg F (31 deg C).
         4) Pressure Loss: 6.5 psig (44.8 kPa).
      b. Shell: Cooling water.
         1) Flow Rate: 3 gpm (0.19 L/s).
         2) Entering Temperature: 70 deg F (21 deg C).
         3) Pressure Loss: 1.0 psig (6.89 kPa).

C. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons in accordance with ASTM D2688. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
   1. Two-station rack for closed-loop systems.
   2. Four-station rack for open systems.

## 2.4 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified herein.

## 2.5 GLYCOL SYSTEMS – HEATING AND COOLING

A. Use "Environmentally Friendly" glycol.

B. Coordinate compatibility of glycol with materials used in piping, valves, equipment and accessories.

C. Provide glycol feed system.

## PART 3 - EXECUTION

### 3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

### 3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure.

C. Install water testing equipment on wall near water chemical application equipment.

D. Install interconnecting control wiring for chemical treatment controls and sensors.

E. Mount sensors and injectors in piping circuits.

F. Install automatic chemical-feed equipment for condenser water and include the following:

1. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter.

    a. Pumps shall operate for timed interval on contact closure at water meter in makeup water supply connection. Injection pump shall discharge into condenser water piping.

2. Install test equipment and provide test-kit to LAWA. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
3. Install TDS controller with sensor and bleed valves.

    a. Bleed valves shall cycle to maintain maximum TDS concentration.

4. Install pH, conductivity and orp sensors with integral controller, injection pumps and solution tanks.

    a. Injector pumps shall operate to maintain required pH and orp.

5. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks.

    a. Injection pumps shall operate to feed biocide on an alternating basis.

G. Install corrosion resistant drip pan, a minimum of 3 in (75 mm) high, under tanks and pumps. Intent is to contain minor leaks.

## 3.3 CONNECTIONS

A. Install piping adjacent to equipment to allow service and maintenance.

B. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings.

C. Install unions, shutoff valves on HVAC water-treatment equipment inlet and outlet.

D. Provide backflow preventers.

E. Provide appropriate equipment grounding.

## 3.4 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.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Install and retrieve corrosion coupons every 90 days to generate quarterly reports on corrosion rates of steel and copper with photographic images of the coupons.

C. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test

source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.

8. Repair leaks and defects with new materials and retest piping until no leaks exist.

D. Remove and replace malfunctioning units and retest as specified above.

E. At four-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified herein. Submit written reports of water analysis advising LAWA of changes necessary.

F. Comply with ASTM D 3370 and with the following standards:

1. Silica: ASTM D 859.
2. Acidity and Alkalinity: ASTM D 1067.
3. Iron: ASTM D 1068.
4. Water Hardness: ASTM D 1126.
5. Chloride: ASTM D4458
6. Copper: ASTM D1688
7. pH: ASTM D5464

## 3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

B. Training: Provide a minimum of 4 hours of training on handling and testing of treatment chemicals with "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

## 3.6 FINAL CONNECTION TO SITE UTILITIES

A. Do not circulate any water from the site chilled and high temperature hot water mains until the CUP water treatment contractor has certified the water quality of both sides of the site utility isolation valves.

B. After connection to plant utilities are achieved remove temporary bypass pipes and cap.

END OF SECTION 23 25 00

# SECTION 23 31 00-HVAC DUCTS AND CASINGS

## PART 1 – GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Flush flat seam rectangular ducts and fittings.
4. Sheet metal materials.
5. Flexible Ducts.
6. Insulated flexible ducts.
7. Casings.
8. Duct Sealants and Gaskets.
9. Hangers and Supports
10. Seismic Restraint Devices.

### 1.2 REFERENCES

A. ASTM International: Provide appropriate references.

B. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

C. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Air Duct Leakage Test Manual.
2. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

D. Underwriters Laboratories Inc.:

1. UL 181 - Factory-Made Air Ducts and Connectors.

E. City of Los Angeles codes.

### 1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with the latest edition of the City of Los Angeles Mechanical Code and SMACNA's "HVAC Duct Construction Standards -

Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" section of this specification.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in the California Building Code to meet a 1.5 importance factor. Subject to compliance, SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems" may be followed.

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48. Refer to structural specification for additional seismic forces and allowable movement.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

## 1.4 SUBMITTALS

A. Product Data: For each type of the following products:

1. Sealants and gaskets.
2. Other factory made items specified herein.

B. LEED Submittals:

1. Product Data for Prerequisite EQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."
3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1-2004, Section 6.4.4.2.2 - "Duct Leakage Tests."
4. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1-2004, Section 7.2.4 - "Ventilation System Start-Up."
5. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
3. Elevation of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Penetrations through fire-rated and other partitions.
7. Equipment installation based on equipment being used on Project, including curbs and bases.
8. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

D. Delegated-Design Submittal:

1. Factory- and shop-fabricated ducts and fittings min. scale 1/4".
2. Reinforcement and spacing.
3. Seam and joint construction.
4. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
5. Sheet metal thicknesses.
6. Joint and seam construction and sealing.
7. Reinforcement details and spacing.
8. Materials, fabrication, assembly, and spacing of hangers and supports.
9. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

E. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Perimeter moldings.

F. Welding certificates.

G. Field quality-control reports.

## 1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.

3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

## PART 2 - PRODUCTS

### 2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Rectangular Duct Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

### 2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. McGill AirFlow LLC.
    b. SEMCO Incorporated.
    c. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Seams - Round Duct and Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.3 FLUSH FLAT SEAM RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class, except use sheet metal 2 gauge numbers heavier than required for classification with normal standing seam construction.

B. Transverse Joints: Fabricate joints in accordance with transverse joint detail shown on drawings. Provide all joints and seams, smooth, and alighted with no projections. In other aspects conform to SMACNA’s “HVAC Duct Construction Standards” for applicable sealing requirements, duct-support intervals and other provisions.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Install ducts with longitudinal seams at lop of ducts.

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Rectangular Duct Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Reinforcing: Install vertical stays for interval reinforcement at transverse joints and at 2 foot intervals along run of duct, as follows:

1. Ducts up to 60 inches wide: Provide 1 vertical stay at mid-point of duct.
2. Ducts 61 inches to 90 inches wide: Provide 2 vertical stays at third points of duct.
3. Ducts over 90 inches wide: Provide 3 vertical stays at quarter points of duct.
4. Vertical Stays: 10 USSG galvanized steel, free of burrs and rough edges, with both ends bent and fastened to the top and bottom of ducts.

## 2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with the City of Los Angeles Mechanical Code and 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.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. 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.

D. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

E. 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.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.5 FLEXIBLE DUCTS

A. Manufacturers:

1. Flexmaster USA, Inc.
2. McGill AirFlow LLC.
3. Ward Industries; a division of Hart & Cooley Inc.

B. Product Description: Two ply vinyl film supported by helical wound spring steel wire.

1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
2. Maximum Velocity: 4000 fpm.

3. Temperature Range: -10 degrees F to 160 degrees F.

## 2.6 INSULATED FLEXIBLE DUCTS

A. Manufacturers:

1. Flexmaster USA, Inc.
2. McGill AirFlow LLC.
3. Ward Industries; a division of Hart & Cooley Inc.

B. Product Description: Two ply vinyl film supported by helical wound spring steel wire; fiberglass insulation; polyethylene vapor barrier film.

1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
2. Maximum Velocity: 4000 fpm.
3. Temperature Range: -10 degrees F to 160 degrees F.
4. Thermal Resistance: Comply with ASHRAE 90.1-2004 or most recent version.

## 2.7 CASINGS

A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and construct for required operating pressures.

B. Reinforce access door frames with steel angles tied to horizontal and vertical plenum supporting angles. Furnish hinged access doors where indicated or required for access to equipment for cleaning and inspection. Furnish clear wire glass observation ports, minimum 6 x 6 inch size.

C. Fabricate acoustic casings with reinforcing turned inward. Furnish 16 gage back facing and 22 gage perforated front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inches thick packed with 4.5 lb./cu ft minimum glass fiber media, on inverted channels of 16 gage.

## 2.8 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).

7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer, 1/8 inch thick of width to match angle connection.

E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.9 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Duct Attachments: All duct attachments and anchors to structure shall be designed and selected to meet a 1.5 importance factor per the California Building Code.

E. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## 2.10 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Ductmate Industries, Inc.
3. Hilti Corp.
4. Kinetics Noise Control.
5. Loos & Co.; Cableware Division.
6. Mason Industries.
7. TOLCO; a brand of NIBCO INC.
8. Unistrut Corporation; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

# PART 3 - EXECUTION

## 3.1 DUCT INSTALLATION

A. Install round ducts in maximum practical lengths.

B. Install ducts with fewest possible joints.

C. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

D. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

E. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

F. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

G. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

H. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

I. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

J. Ducts that traverse smoke zones shall be fabricated of sheet metal gauges conforming to NFPA 90A.

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

L. Duct Openings:

1. Provide openings in ducts where required to accommodate thermometers, smoke detectors, control devices, sensors, and devices. Install same though airtight rubber grommets.
2. Provide pilot tube openings where required for testing of systems. Each opening shall be complete with a metal cap, with a spring device or screw to ensure against air leakage.
3. At openings in insulated ducts, install insulation material inside metal ring.

## 3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets. Use drive-slip joints, except in mechanical rooms.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

## 3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.

B. Install fire-rated access panel assemblies at each change in direction, at junctions and at maximum intervals of 12 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches from bottom of duct.

C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

## 3.4 INSTALLATION OF DUCTS OUTDOORS

A. Ducts shall be made completely watertight.

B. Construct ducts as follows to assure water run-off.

1. Arrange standing seams so as not to act as dams.
2. Erect ducts with longitudinal seams at bottom of duct.
3. Slope entire top of duct down towards side.
4. Provide vertical struts within duct to bow tap panels of duct into convex shape.
5. Erect ducts with mastic sealant within sheet metal joints.

## 3.5 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.

8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

## 3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection. Extend strap supports down both sides of ducts and turn under bottom at least 1 inch. Secure hanger to sides and bottom of ducts with sheet metal screws.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

G. Avoid penetrations of ducts. Provide airtight rubber grommets at unavoidable penetrations of hanger rods.

## 3.7 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
2. Brace a change of direction longer than 12 feet.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

## 3.8 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

## 3.9 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

## 3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

    a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
    b. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
    c. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
    d. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
    e. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

## 3.11 DUCT CLEANING

A. Clean new ductwork that fails the cleanliness test before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
2. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
3. Coils and related components.
4. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
5. Supply-air ducts, dampers, actuators, and turning vanes.
6. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

## 3.12 START UP

A. Air Balance: Comply with requirements in Section "Testing, Adjusting, and Balancing for HVAC."

## 3.13 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Outdoor, Exposed to Weather Ducts: Type 304, stainless steel sheet, watertight.
2. Cooling Tower Discharge Ducts: Type 304 stainless steel sheet, watertight.
3. Ductwork at Humidifiers: Type 316 stainless steel sheet, watertight, for a minimum of 2 feet upstream and 10 feet downstream.
4. Shower Exhaust Ducts: Stainless steel sheet, watertight, for 15 feet from registers.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

    a. Pressure Class: Positive 1-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 12.
    d. SMACNA Leakage Class for Round: 12.

2. Ducts Connected to Constant-Volume Air-Handling Units:

    a. Pressure Class: Positive 2-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round: 6.

3. Ducts Connected to Variable-Air-Volume Air-Handling Units:

    a. Pressure Class: Positive 4-inch wg (sheet metal gages as per City of Los Angeles Mechanical Code.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 3.
    d. SMACNA Leakage Class for Round and Flat Oval: 3.

4. Ducts Connected to Equipment Not Listed Above:

    a. Pressure Class: Positive 2-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 3.
    d. SMACNA Leakage Class for Round and Flat Oval: 3.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

    a. Pressure Class: Positive or negative 1-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 12.
    d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:

    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Equipment Not Listed Above:

    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 3.
    d. SMACNA Leakage Class for Round and Flat Oval: 3.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

    a. Pressure Class: Negative 1-inch wg.
    b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
    c. SMACNA Leakage Class for Rectangular: 12.
    d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 3.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive or negative 1-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 3.

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 3.
d. SMACNA Leakage Class for Round and Flat Oval: 3.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. PVC-Coated Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Galvanized.

G. Liner:

1. Supply Air Ducts: Fibrous glass, Type I, 1 inch thick.
2. Return Air Ducts: Fibrous glass, Type I, 1 inch thick.
3. Exhaust Air Ducts: Fibrous glass, Type I, 1 inch thick.
4. Supply Fan Plenums: Fibrous glass, Type II, 1 inch thick.
5. Return- and Exhaust-Fan Plenums: Fibrous glass, Type II, 2 inches thick.
6. Transfer Ducts: Fibrous glass, Type I, 1 inch thick.

H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

b. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 00

# SECTION 23 33 00-AIR DUCT ACCESSORIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Back-draft dampers.
2. Backdraft and pressure relief dampers.
3. Barometric relief dampers.
4. Combination fire/smoke dampers.
5. Duct access doors.
6. Static fire dampers.
7. Ceiling fire dampers.
8. Volume control dampers.
9. Flexible duct connections.
10. Dial thermometers.
11. Static pressure gages.
12. Motorized control dampers.
13. Louvers.
14. Air flow measuring stations.
15. Turning vanes.

### 1.2 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. ASTM International:

1. ASTM E1 - Standard Specification for ASTM Thermometers.

C. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
3. NFPA 92A - Recommended Practice for Smoke-Control Systems.

D. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

E. Underwriters Laboratories Inc.:

1. UL 555 - Standard for Safety for Fire Dampers.

2. UL 555C - Standard for Safety for Ceiling Dampers.
3. UL 555S - Standard for Safety for Smoke Dampers.

F. City of Los Angeles Codes.

## 1.3 SUBMITTALS

A. Product Data: Submit data for shop fabricated assemblies and hardware used.

B. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.

1. Fire dampers including locations and ratings.
2. Comination Fire-Smoke dampers including locations and ratings.
3. Backdraft dampers.
4. Flexible duct connections.
5. Volume control dampers.
6. Duct access doors.
7. Duct test holes.

C. Product Data: For fire dampers and combination fire/smoke dampers submit the following:

1. Include UL ratings, dynamic ratings, leakage, pressure drop and maximum pressure data.
2. Indicate materials, construction, dimensions, and installation details.
3. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

D. Manufacturer's Installation Instructions: Submit for Fire and Combination Smoke/Fire Dampers.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

# PART 2 - PRODUCTS

## 2.1 BACK-DRAFT DAMPERS

A. Manufacturers:

**1. Air Balance, Inc.**
**2. Ruskin.**
**3. Pottorf.**

B. Product Description: Multi-Blade, back-draft dampers: Parallel-action, gravity-balanced, Galvanized 16 gage thick steel, or extruded aluminum. Blades, maximum 6 inch width, with felt or flexible vinyl sealed edges. Blades linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin. Furnish dampers with adjustment device to permit setting for varying differential static pressure.

## 2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc
2. Ruskin
3. Pottorf.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm (10 m/s).

D. Maximum System Pressure: 2-inch wg (0.5 kPa).

E. Frame: 0.063-inch- (1.6-mm-) thick extruded aluminum, with welded corners and mounting flange.

F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch (150-mm) width, 0.050-inch- (1.2-mm-) thick aluminum sheet noncombustible, tear-resistant, neoprene-coated fiberglass with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Neoprene, mechanically locked.

I. Blade Axles:

1. Material: Stainless steel.
2. Diameter: 0.20 inch (5 mm).

J. Tie Bars and Brackets: Galvanized steel.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball or synthetic pivot bushings.

M. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.

    a. Sleeve Thickness: 20-gage (1.0-mm) minimum.
    b. Sleeve Length: 6 inches (152 mm) minimum.

6. Screen Mounting: Rear mounted.
7. Screen Material: Aluminum.
8. Screen Type: Insect.

9. 90-degree stops.

## 2.3 BAROMETRIC RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.
2. Ruskin.
3. Pottorf.

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 2000 fpm (10 m/s).

D. Maximum System Pressure: 2-inch wg (0.5 kPa).

E. Frame: 0.063-inch- (1.6-mm-) thick extruded aluminum, with welded corners and mounting flange.

F. Blades:

1. Multiple, 0.050-inch- (1.2-mm-) thick aluminum sheet.
2. Maximum Width: 6 inches (150 mm).
3. Action: Parallel.
4. Balance: Gravity.
5. Eccentrically pivoted.

G. Blade Seals: Neoprene.

H. Blade Axles: Galvanized steel.

I. Tie Bars and Brackets:

1. Material: Aluminum.
2. Rattle free with 90-degree stop.

J. Return Spring: Adjustable tension.

K. Bearings: Stainless steel.

L. Accessories:

1. Flange on intake.
2. Adjustment device to permit setting for varying differential static pressures.

## 2.4 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Ruskin.
3. Pottorf.

B. Fire Resistance: 1-1/2 hours or 3 hours.

C. Leakage Rating: Class I, maximum of 8 cfm at 4 inches wg differential pressure.

D. Damper Temperature Rating: 250 degrees F.

E. Frame: 16 gage, galvanized steel.

F. Blades:

1. Style: Airfoil-shaped, single piece, double skin.
2. Action: Opposed.
3. Orientation: Horizontal.
4. Material: Minimum 14 gage equivalent thickness, galvanized steel.
5. Width: Maximum 6 inches.

G. Bearings: Stainless steel pressed into frame.

H. Seals: Silicone blade edge seals and flexible stainless steel jamb seals.

I. Linkage: Concealed in frame.

J. Release Device: Close in controlled manner and allow damper to be automatically reset.

K. Actuator:

1. Type: Electric 120 volt, 60 hertz, two-position, fail close or Electric 24 volt, 60 hertz, two-position, fail close as shown on drawings.
2. Mounting: External or Internal.

L. Fusible Link Release Temperature: 165 degrees F.

M. Finish: Mill galvanized.

N. Factory installed sleeve and mounting angles. Furnish silicone caulk factory applied to sleeve at damper frame to comply with leakage rating requirements.

## 2.5 DUCT ACCESS DOORS

A. Manufacturers:

1. American Warming and Ventilating.
2. Pottorf.
3. McGill.

B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch thick insulation with sheet metal cover.

1. Less than 12 inches square, secure with sash locks.
2. Up to 18 inches Square: Furnish two hinges and two sash locks.
3. Up to 24 x 48 inches: Three hinges and two compression latches.
4. Larger Sizes: Furnish additional hinge.
5. Access panels with sheet metal screw fasteners are not acceptable.

## 2.6 FIRE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Ruskin.
3. Pottorf.

B. Fire Rating: UL 555 classified and labeled as a 1-1/2 or 3 hour static fire damper.

C. Air Flow Rating: UL approved for dual directional air flow.

D. Integral Sleeve Frame: Minimum 20 gage by 12 inches roll formed, galvanized steel.

1. Factory Sealant: Apply to dampers in HVAC systems with pressures to maximum 4 inches wg.

E. Blades:

1. Style: Curtain type, in airstream.
2. Action: Spring or gravity closure upon fusible link release.
3. Orientation: Horizontal.
4. Material: Minimum 24 gage roll formed, galvanized steel.

F. Closure Springs: Type 301 stainless steel, constant force type, if required.

G. Temperature Release Device:

1. Fusible link, 165 degrees F.
2. Mounting: Vertical or Horizontal as shown on the drawings.

H. Finish: Mill galvanized.

I. Picture Frame Mounting Angles:

1. One-piece, roll formed retaining angles as detailed.
2. Factory matched and shipped attached to damper.

## 2.7 CEILING FIRE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Ruskin.
3. Pottorf.

B. Fire Rating: UL 555C classified and labeled as a 1-1/2 hour ceiling damper.

C. Air Flow Rating: UL approved for dual directional air flow.

D. Frame: Galvanized steel with roll formed ridge for blade stop.

E. Blades:

1. Style: Two-piece, single-thickness with blade insulation, hinged in center, and held open with fusible link.
2. Action: Butterfly.
3. Orientation: Horizontal.
4. Material: Minimum 20 gage galvanized steel.

F. Hinge: Spring stainless steel, mechanically attached to blades.

G. Mounting: Horizontal.

H. Temperature Release Device: Fusible link, 165 degrees F.

I. Finish: Mill galvanized.

J. Performance Data:

1. Pressure Drop: Maximum 0.1 inches w.g. at 500 fpm across 18 x 18 inch damper.

K. Fusible Volume Adjust: UL classified.

## 2.8 VOLUME CONTROL DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Ruskin.
3. Pottorf.

B. Splitter Dampers:

1. Material: Same gage as duct to 24 inches size in both dimensions, and two gages heavier for sizes over 24 inches.
2. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.

3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
4. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.

C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware.

D. Quadrants:

1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches furnish regulator at both ends.

## 2.9 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:

1. Duro Dyne Inc.
2. Ventfabrics.
3. Ward Industries

B. Connector: Fabric crimped into metal edging strip.

1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
2. Net Fabric Width: Approximately 3 inches wide.
3. Metal: 3 inch wide, 24 gage galvanized steel.

C. Leaded Vinyl Sheet: Minimum 0.55 inch thick, 0.87 lbs. per sq ft, 10 dB attenuation in 10 to 10,000 Hz range.

## 2.10 DIAL THERMOMETERS

A. Manufacturers:

1. Ashcroft.
2. Trerice.
3. Watts.

B. Thermometer: ASTM E1, stainless steel case, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.

1. Size: 3 inch diameter dial.
2. Lens: Clear Lexan.
3. Accuracy: 1 percent.
4. Calibration: Degrees F.

## 2.11 STATIC PRESSURE GAGES

A. Manufacturers:

1. Ashcroft.
2. Trerice.
3. Watts.

B. Dial Gages: 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front calibration adjustment, 2 percent of full scale accuracy.

C. Inclined Manometer: Plastic with red liquid on white background with black figures, front calibration adjustment, 3 percent of full scale accuracy.

D. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

## 2.12 MOTORIZED CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Ruskin Company.
3. Pottorf.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. Hat shaped.
2. Stainless-steel channels, 0.064 inch (1.62 mm) thick.
3. Mitered and welded corners.

D. Blades:

1. Multiple blades with maximum blade width of 8 inches (200 mm).
2. Opposed-blade design.
3. Stainless steel.
4. 0.064 inch (1.62 mm) thick.
5. Blade Edging: Closed-cell neoprene edging.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

E. Blade Axles: 1/2-inch- (13-mm-) diameter; stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).

F. Bearings:

1. Stainless-steel sleeve.
2. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

G. Damper Motors: Modulating action.

## 2.13 LOUVERS

A. Connect to louvers furnished under General Construction work.

## 2.14 AIR FLOW MEASURING STATIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ruskin, IAQ Measuring Damper.
2. Air Monitor Corp.
3. Wetmaster Co.

B. Description: Factory fabricated unit with casing, velocity traverse section and sensors, companion volume meter, and interconnection to volume meter.

C. Casing: 0.064 inch (1.62 mm) thick welded galvanized sheet steel, with flanged ends to match connecting ductwork.

D. Velocity Traverse Section:

1. Copper static pressure sensors.
2. Copper total pressure sensing manifolds and control averaging manifold.
3. Operation: Equalizing and integrating all sensor measurements into one total pressure and one static pressure metering port.
4. Sensors positioned on equal-area traverse principle.
5. Aluminum honeycomb air straightener.

E. E. Volume Meter:

1. Dry dial and diaphragm-actuated type.
2. Calibrated in CFM (cu cm/sec) and FPM (m/s).
3. Provided with mounting bracket.

F. Install nameplate for each station to indicate:

1. Unit size and unit designation.
2. Design air quantity.
3. Design air flow.
4. Design air velocity.

## 2.15 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Metailaire.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized steel, aluminum or stainless steel sheet, to match duct material; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

E. Vane Construction: Double wall.

# PART 3 - EXECUTION

## 3.1 INSTALLATION.

A. Install back-draft dampers on exhaust fans or exhaust ducts nearest to outside.

B. Access Doors:

1. Install access doors at the following locations:

a. On both sides of duct coils.
b. Upstream and downstream from duct filters.
c. At outdoor-air intakes and mixed-air plenums.
d. At drain pans and seals.
e. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
f. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
g. At each change in direction and at maximum 50-foot spacing.

h. Upstream and downstream from turning vanes.
i. Upstream or downstream from duct silencers.
j. Control devices requiring inspection, including smoke detection heads.
k. At fan bearings enclosed in ducts.
l. Inlet side of each single width centrifugal fan.
m. Install at locations for cleaning kitchen exhaust ductwork in accordance with NFPA 96.

2. Install access doors with swing against duct static pressure.
3. Access Door Sizes:

a. One-Hand or Inspection Access: 8 by 5 inches.
b. Two-Hand Access: 12 by 6 inches.
c. Head and Hand Access: 18 by 12 inches.
d. Head and Shoulders Access: 21 by 14.
e. Body Access: 25 by 14 inches.
f. Body plus Ladder Access: 25 by 17 inches.

4. Label access doors according to Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
5. Mark access doors for fire and smoke dampers on outside surface, with minimum 1/2 inch high letters reading: FIRE/SMOKE DAMPER, SMOKE DAMPER, OR FIRE DAMPER.

C. Flexible Connectors.

1. Install flexible connectors at duct connections to equipment, at building expansion joints, at connections between ducts of dissimilar metals and at penetrations of mechanical equipment room walls.
2. Install flexible connections with 2 inches slack in fabric and minimum movement of 1 inch.
3. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

D. Flexible Ducts

1. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
2. Connect diffusers or light troffer boots to ducts with maximum 18-inch lengths of flexible duct clamped or strapped in place.
3. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws. Attach to supply air duct with low entrance lass, bellmouth type connector at air inlet end.

E. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.

F. Install wire mesh screen grilles at return air ducts in hung ceilings and in other places where indicated. Bolt grilles to flanged connections or ducts at terminations.

G. Install louvers in building construction at locations where indicated. Coordinate mounting details with particular building construction and/or window framing details. Install blank-off panels at unused portions of louvers; secured with bolts and/or screws.

H. Air Flow Measuring Stations

1. Install air flow measuring stations where indicated, or as directed by engineer.
2. Install all interconnecting tubing between measuring station, companion meter and control systems, in accordance with the manufacturer's printed instructions.

I. Install temporary duct test holes and required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

J. Install fire dampers and combination fire and smoke dampers at required locations. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

1. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
2. Install dampers square and free from racking with blades running horizontally.
3. Do not compress or stretch damper frame into duct or opening.
4. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jack shaft.
5. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

K. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

L. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts and as indicated. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install volume dampers at the following locations:

    a. At all splits, except grease exhaust ducts.
    b. In ducts serving single supply, return and exhaust outlets.
    c. In open return ducts above ceiling.
    d. In ducts connecting to a common plenum.
    e. Where required for balancing.

2. Install remote damper operators for volume dampers above ceilings which are non-accessible or without access panels.
3. Install steel volume dampers in steel ducts.
4. Install aluminum volume dampers in aluminum ducts.
5. Do not install volume dampers in grease ducts.

## 3.2 NSTALLATION - THERMOMETERS

A. Install thermometers in air duct systems on flanges where possible.

B. Locate duct-mounted thermometers minimum 10 feet downstream of mixing-dampers, coils, or other devices causing air turbulence.

C. Install static pressure gages to measure across filters and filter banks, (inlet to outlet). On multiple banks, provide manifold and single gage.

D. Provide instruments with scale ranges selected according to service with largest appropriate scale.

E. Install thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

F. Adjust thermometers to final angle, clean windows and lenses, and calibrate to zero.

END OF SECTION 23 33 00

**SECTION 23 34 00 - HVAC FANS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

A. Section Includes:

1. Centrifugal fans.
2. Propeller fans.
3. Downblast centrifugal roof fans.
4. Upblast centrifugal roof fans.
5. Ceiling fans.
6. Inline ceiling fans.
7. Duct blowers or cabinet fans.
8. Centrifugal square inline fans.

**NOTE:** Exhaust system for restrooms shall provide a minimum of 15 air changes per hour. Positive pressured exhaust ducts shall not pass through supply or return air plenums, and shall be appropriately isolated from plenums. Supply air systems shall have a minimum of 6 air changes per hour.

All roof top mounted exhaust fans shall be mushroom shaped.

**1.2 REFERENCES**

A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.:

1. AMCA 99 - Standards Handbook.
2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

C. ASTM International:

1. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.

D. National Electrical Manufacturers Association:

1. NEMA MG 1 - Motors and Generators.
2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. Underwriters Laboratories Inc.:

1. UL 705 - Power Ventilators.

## 1.3 SUBMITTALS

A. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.

# PART 2 - PRODUCTS

## 2.1 CENTRIFUGAL FANS

A. Manufacturers:

**1. Penn-Barry.**
**2. Greenheck.**
**3. Cook.**

B. Wheel and Inlet:

1. Backward Inclined: Steel construction with smooth curved inlet flange, back plate, backward curved blades welded or riveted to flange and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.
2. Forward Curved: Galvanized steel construction with inlet flange, back plate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and back plate; steel hub swaged to back plate and keyed to shaft with set screw.
3. Airfoil Wheel: Steel construction with smooth curved inlet flange, back plate die formed hollow airfoil shaped blades continuously welded at tip flange, and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.

C. Housing:

1. Steel, spot welded for AMCA 99 Class I and II fans, and continuously welded for Class III, braced, designed to minimize turbulence with spun inlet bell and shaped cut-off.
2. Factory finish before assembly to manufacturer's standard.
3. Fabricate plug fans without volute housing, in lined steel cabinet.

D. Bearings and Sleeves:

1. Bearings: Pillow block type, self-aligning, grease-lubricated ball bearings, with ABMA 9 L-10 life at 50,000 hours roller bearings, ABMA 11, L-10 life at 120,000 hours.

2. Shafts: Hot rolled steel, ground and polished, with key way, protectively coated with lubricating oil, and shaft guard.
3. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp and under, selected so required rpm is obtained with sheaves set at mid-position. Fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.
4. Belt Guard: Fabricate to SMACNA Standard; 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

## 2.2 PROPELLER FANS

A. Manufacturers:

1. Penn-Barry.
2. Greenheck.
3. Cook.

B. Construction:

1. Impeller: Shaped steel or steel reinforced aluminum blade with hubs, statically and dynamically balanced, locked to shaft, directly connected to motor or furnished with V-belt drive.
2. Frame: One piece, square steel with die formed venturi orifice, mounting flanges and supports, with baked enamel finish.

## 2.3 DOWNBLAST CENTRIFUGAL ROOF FANS

A. Manufacturers:

1. Penn-Barry.
2. Greenheck.
3. Cook.

B. Fan Unit: Downblast type. V-belt or direct drive.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

D. Disconnect Switch: Factory wired, non-fusible, in fan housing for thermal overload protected motor.

## 2.4 UPBLAST CENTRIFUGAL ROOF FANS

A. Manufacturers:

1. Penn.
2. Barry.
3. Greenheck.
4. Cook.

B. Fan Unit: Upblast type. V-belt or direct drive, spun aluminum housing with grease tray; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

D. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor.

## 2.5 CEILING FANS AND INLINE CEILING FANS

A. Manufacturers:

1. Penn-Barry.
2. Greenheck.
3. Cook.

B. Centrifugal Fan Unit: Direct driven with galvanized steel housing lined with 1/2 inch acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge opening, integral outlet duct collar. Discharge position convertible by moving interchangeable panels.

C. Disconnect Switch: Fan mounted toggle switch for thermal overload protected motor.

D. Motor: Open drip proof type with permanently lubricated sealed bearings and thermal overload protection.

## 2.6 DUCT BLOWER OR CABINET FANS

A. Manufacturers:

1. Penn-Barry.
2. Greenheck.
3. Cook.

B. Product Description: V-belt drive with galvanized steel housing lined with 1/2 or 1 inch acoustic glass fiber insulation as scheduled, removable side panel for access, inlet and outlet duct collar, gravity backdraft damper in discharge, horizontal hanging brackets.

C. Fan Wheel: Double width-double inlet backward inclined forward curved centrifugal type.

D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

## 2.7 CENTRIFUGAL SQUARE INLINE FANS

A. Manufacturers:

**1. Penn-Barry.**
**2. Greenheck.**
**3. Cook.**

B. Product Description: V-belt or Direct drive with galvanized steel housing lined with 1/2 or 1 inch acoustic glass fiber insulation, integral inlet cone, removable access doors on 3 sides, inlet and outlet duct collar, gravity backdraft damper in discharge, horizontal hanging brackets.

C. Fan Wheel: Backward inclined centrifugal type, aluminum construction.

D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

E. Motor and Drive Mounting: Out of air stream.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install per manufacturer’s instructions.

B. Install backdraft dampers where required by code.

C. Install safety screen where inlet or outlet is exposed.

## 3.2 TRAINING

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 23 34 00

# SECTION 23 36 00 - AIR TERMINAL UNITS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Constant volume terminal units.
2. Variable volume terminal units.
3. Fan powered terminal units.

> **NOTE:** Terminal Units shall be provided with electronic Direct Digital Controller with BACnet open protocol communications and electronic actuators for damper and reheat coil control valve.

### 1.2 REFERENCES

A. American Refrigeration Institute:

1. ARI 880 - Air Terminals.
2. ARI 885 -Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.

B. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

D. Underwriters Laboratories Inc.:

1. UL 181 - Factory-Made Air Ducts and Connectors.

E. ASHRAE Standard 62.1 – Ventilation for Acceptable Indoor Air Quality.

### 1.3 SUBMITTALS

A. Product Data: Submit data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings indicating airflow, static pressure, heating

coil capacity and NC designation. Include electrical characteristics and connection requirements. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 inch to 4 inches wg.

B. Manufacturer's Installation Instructions: Submit support and hanging details, and service clearances required.

## 1.4 CLOSEOUT SUBMITTALS

A. Execution and Closeout Requirements:

B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

## 1.5 WARRANTY

A. Minimum one-year warranty.

# PART 2 – PRODUCTS

## 2.1 SINGLE DUCT CONSTANT AND VARIABLE VOLUME AIR TERMINAL UNITS

A. Manufacturers:

**1. Anemostat.**
**2. Price**
**3. Titus.**

B. Product Description: Variable air volume terminal units for connection to central air systems, with electronic controls and hot water heating coils.

C. Identification: Furnish each air terminal unit with identification label and airflow indicator. Include unit nominal airflow, maximum factory-set airflow and minimum factory-set airflow and coil type.

D. Basic Assembly:

1. Casings: Minimum 22 gage galvanized steel.
2. Lining: Minimum 3/4 inch thick neoprene or vinyl coated glass fiber insulation, 1.5 lb./cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements.
3. Plenum Air Outlets: S slip-and-drive connections.

E. Basic Unit:

1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
2. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings; maximum damper leakage: 2 percent of design air flow at 3 inches inlet static pressure.

F. Attenuation Section: Line attenuation sections with 1 or 2 inches thick insulation.

G. Round Outlet: Discharge collar matching inlet size.

H. Hot Water Heating Coil:

1. Construction: 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed.
2. All coils shall be minimum 2-pass.

## 2.2 FAN POWERED VARIABLE VOLUME UNITS

A. Manufacturers:

**1. Anemostat.**
**2. Price.**
**3. Titus.**

B. Product Description: Variable air volume terminals for connection to central air systems with electronic controls and hot water heating coils.

C. Identification: Furnish each air terminal unit with identification label and airflow indicator. Include unit nominal airflow, maximum factory-set airflow and minimum factory-set airflow and coil type.

D. Basic Assembly:

1. Casings: Minimum 22 gage galvanized steel.
2. Lining: Minimum 3/4 inch thick neoprene or vinyl coated glass fiber insulation, 1.5 lb./cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements.
3. Plenum Air Outlets: S-slip and drive connections.

E. Basic Unit:

1. Configuration: Air volume damper assembly and fan in series or parallel arrangement inside unit casing. Locate control components inside protective metal shroud.
2. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings; maximum damper leakage: 2 percent of design air flow at 3 inches inlet static pressure.

F. Fan Assembly:

1. Fan: Forward curved centrifugal type with direct drive permanent-split-capacitor type, thermally protected motor.

2. Speed Control: Infinitely adjustable with electric/pneumatic and electronic controls.
3. Isolation: Fan/motor assembly on rubber isolators.

G. Wiring:

1. Factory mount and wire controls. Mount electrical components in control box with removable cover. Incorporate single point electrical connection to power source.
2. Factory mount transformer for control voltage on electric and electronic control units. Furnish terminal strip in control box for field wiring of thermostat and power source.
3. Wiring Terminations: Wire fan and controls to terminal strip. Furnish terminal lugs to match branch-circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box.
4. Disconnect Switch: Factory mount disconnect switch.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install ceiling access doors or locate units above easily removable ceiling components.

B. Support units individually from structure. Do not support from adjacent ductwork.

END OF SECTION 23 36 00

# SECTION 23 37 00-AIR OUTLETS AND INLETS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Diffusers.
2. Registers
3. Grilles.
4. Louvered penthouses.

### 1.2 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.

C. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

### 1.3 SUBMITTALS

A. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, noise level, and performance data.

## PART 2 - PRODUCTS

### 2.1 ROUND CEILING DIFFUSERS

A. Manufacturers:

**1. Anemostat.**
**2. Price.**
**3. Titus.**

B. Product Description: Type: Round, adjustable pattern, stamped or spun, multi-core diffuser to discharge air in 360 degree pattern, with sector baffles where indicated. Diffuser collar not more than 1 inch above ceiling. In plaster ceilings, furnish plaster ring and ceiling plaque.

C. Fabrication: Steel or aluminum with baked enamel off-white finish.

## 2.2 RECTANGULAR CEILING DIFFUSERS

A. Manufacturers:

**1. Anemostat.**
**2. Price.**
**3. Titus.**

B. Type: Square and rectangular, adjustable pattern, multi-louvered diffuser.

C. Frame: To match the architectural surface.

D. Fabrication: Steel or Aluminum with baked enamel off-white finish.

## 2.3 PERFORATED FACE CEILING DIFFUSERS

A. Manufacturers:

**1. Anemostat.**
**2. Price.**
3. **Titus**.

B. Type: Perforated face with fully adjustable pattern and removable face.

C. Frame: To match architectural surface.

D. Fabrication: Steel or aluminum with steel frame and baked enamel off-white finish.

## 2.4 CEILING SLOT DIFFUSERS (LINEAR)

A. Manufacturers:

**1. Anemostat.**
**2. Price.**
**3. Titus.**

B. Type: Continuous with size and number of slots and adjustable vanes for left, right or vertical discharge.

C. Fabrication: Aluminum extrusions or Steel with factory finish and color to be selected by architect.

D. Frame: To match architectural surface.

## 2.5 CEILING SUPPLY REGISTERS/GRILLES

A. Manufacturers:

**1. Anemostat.**
**2. Price.**
**3. Titus.**

B. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, two-way deflection.

C. Frame: 1 inch margin with countersunk screw mounting and gasket.

D. Fabrication: Steel or aluminum extrusions with factory off-white enamel finish unless noted otherwise.

E. Damper: Integral, gang-operated, opposed-blade type with removable key operator, operable from face.

## 2.6 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

A. Manufacturers:

**1. Anemostat.**
**2. Price.**
**3. Titus.**

B. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees.

C. Frame: 1 inch margin with countersunk screw mounting.

D. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory off-white baked enamel finish.

E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.

## 2.7 CEILING GRID CORE EXHAUST AND RETURN REGISTERS/GRILLES

A. Manufacturers:

**1. Anemostat.**
**2. Price.**
**3. Titus.**

B. Type: Fixed grilles of 1/2 x 1/2 x 1 inch louvers.

C. Fabrication: Steel or aluminum with off-white finish.

D. Frame: 1 inch margin with countersunk screw mounting. Channel lay-in frame for suspended grid ceilings.

## 2.8 CEILING LINEAR EXHAUST AND RETURN GRILLES

A. Manufacturers:

**1. Anemostat.**
**2. Price.**
**3. Titus.**

B. Type and materials to match those provided for supply air.

## 2.9 WALL SUPPLY REGISTERS/GRILLES

A. Manufacturers:

**1. Anemostat.**
**2. Price.**
**3. Titus.**

B. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, double deflection.

C. Frame: 1 inch margin with countersunk screw mounting and gasket.

D. Fabrication: Steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory off-white baked enamel finish.

E. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

## 2.10 WALL EXHAUST AND RETURN REGISTERS/GRILLES

A. Manufacturers:

**1. Anemostat.**
**2. Price.**
**3. Titus.**

B. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, horizontal face.

C. Frame: 1 inch margin with countersunk screw mounting.

D. Fabrication: Steel or aluminum with 20 gage minimum frames and 22 gage minimum blades, with factory off-white baked enamel finish.

E. Damper (only if specifically called for on drawings): Integral, gang-operated, opposed-blade type with removable key operator, operable from face.

## 2.11 LINEAR WALL REGISTERS/GRILLES

A. Manufacturers:

**1. Anemostat.**
**2. Price.**
**3. Titus.**

B. Type: Streamlined blades with 15 degree deflection, 1/8 x 3/4 inch on 1/4 inch centers.

C. Frame: 1 inch margin with countersunk screw mounting and gasket.

D. Fabrication: Steel or aluminum extrusions, with factory off-white enamel finish.

E. Damper: Integral gang-operated opposed blade hinged single blade damper with removable key operator, operable from face.

## 2.12 LOUVERED PENTHOUSE

A. Manufacturers:

**1. Greenheck.**
**2. Industrial Louvers Inc.**
**3. Ruskin.**

B. Fabrication: Completely welded assembly. Fabricate with mitered corners. Structural supports rated for 20 psf wind and snow loading. Furnish sill water catch with 2 inch high water stop and depth to enclose structural supports.

C. Roof: Aluminum construction, standing seam type with formed water baffle plates open at corners for drainage.

D. Bird Screen: Interwoven wire mesh of aluminum, 0.063 inch diameter wire, 1/2 inch open weave.

E. Roof Curb: 12 inch inch high self-flashing galvanized steel construction with continuously welded seams 1 inch insulation and curb bottom, hinged curb adapter.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify LAWA for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

D. Carefully install all ceiling mounted air distribution devices back pan insulation and vapor barrier. Where pre-molded insulation and vapor barrier is not furnished as an accessory to the air distribution device by the manufacturer the Contractor is responsible for field installation of insulation and vapor barrier for ceiling air distribution device back pans.

E. All visible interior surfaces of all grilles and air device accessories and components visible through the face of the outlet shall be factory painted flat black.

F. Install a manual volume damper in the branch duct to the air distribution device or at the conical bell-mouth spin-in fitting for connection of round flexible duct to the rectangular duct for balancing purposes.

G. Provide all required blank off for directional pattern.

H. Diffusers Utilizing a Plenum Box: Provide plenum box fabricated of 24 USBG galvanized steel, with internal surfaces lined with minimum 1/2 inch thick duct liner.

I. Install return and exhaust registers with blades oriented to prevent sight though outlets.

J. Transfer Grilles: Provide 2 grilles, one on each side of wall with connecting sheet metal collar.

K. Transfer Ducts: Provide 2 grilles, one at each end of duct.

### 3.2 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles before starting air balancing.

END OF SECTION 23 37 00

# SECTION 23 40 00-HVAC AIR CLEANING DEVICES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Activated carbon filters.
2. Disposable, extended area panel filters.
3. Disposable panel filters.
4. Filter gages.
5. Bipolar Ionization

### 1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 850 - Commercial and Industrial Air Filter Equipment.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

C. Military Standardization Documents:

1. MIL MIL-STD-282 - Filter Units, Protective Clothing, Gas-Mask Components, and Related Products: Performance-Test Methods.

D. Underwriters Laboratories Inc.:

1. UL 586 - High-Efficiency. Particulate, Air Filter Units.
2. UL 867 - Electrostatic Air Cleaners.
3. UL 900 - Air Filter Units.

### 1.3 SUBMITTALS

A. Shop Drawings: Indicate filter assembly and filter frames, dimensions, motor locations, and electrical characteristics and connection requirements.

B. Product Data: Submit data on filter media, filter performance data, dimensions, and electrical characteristics.

C. Submit performance data for this application including initial pressure drop, recommended replacement pressure drop, and maximum pressure drop.

D. Manufacturer's Installation Instructions: Submit assembly and change-out procedures.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

## 1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

# PART 2 - PRODUCTS

## 2.1 ACTIVATED CARBON FILTERS

A. Manufacturers:

**1. Flanders.**
**2. Camfil-Farr.**
**3. American Air Filter.**

B. Assembly: Galvanized steel unit incorporating extruded aluminum tracks to accommodate filter servicing trays in deep V arrangement arranged for upstream downstream side servicing with disposable panel pre-filter.

1. Nominal Size: 12 x 24 x 29 inches 24 x 24 x 29 inches.

C. Media:

1. Activated Carbon Density: 34 lb./cu ft, pellets or granular to 6 x 10 Tyler mesh screen.
2. Carbon Tetrachloride Activity: Minimum 60 percent; in thin bed.
3. Trays: Nominal size 24 x 24 x 5/8 inches thick.
4. Carbon: 1.42 cu ft per 1000 cfm nominal airflow capacity.

D. Rating: 500 fpm face velocity, 0.45 inch wg resistance.

## 2.2 DISPOSABLE, EXTENDED AREA PANEL FILTERS

A. Description: Factory-fabricated, ASHRAE Standard 50-60 percent efficiency (MERV 13), dry, extended-surface, self-supporting filters with holding frames. Quality Assurance Test Report required.

B. Manufacturers:

**1. Flanders.**
**2. Farr.**
**3. American Air Filter.**

C. Media: UL 900 Class 2, pleated, lofted, non-woven, reinforced synthetic fabric or fine, glass fiber laminated to synthetic backing.

1. Frame: Galvanized steel.
2. Nominal size: 24 x 24 inches.
3. Nominal thickness: As required for scheduled efficiency rating.

D. Rating, ASHRAE 52.1:

1. Dust spot efficiency: See schedule on drawings.
2. Weight arrestance: See schedule on drawings.
3. Initial resistance at 500 fpm face velocity: See schedule on drawings.
4. Recommended final resistance: See schedule on drawings.

## 2.3 DISPOSABLE PANEL FILTERS

A. Description: Factory-fabricated, dry, extended-surface filters with stainless steel holding frames.

B. Manufacturers:

**1. Tridem.**
**2. Camfil-Farr.**
**3. American Air Filter.**

C. Media: Synthetic glass fibrous material and other media pleated, UL Class II, 25-30 percent efficiency (MERV 8) formed into deep-V-shaped pleats and held by self-supporting wire grid.

1. Nominal Size: 24 x 24 inches.
2. Thickness: 1 or 2 inch.

D. Media and Media-Grid Frame: Nonflammable glass fiber, synthetics and other media to ensure adequacy for jet fuel.

E. Performance Rating:

1. Face Velocity: 500 fpm
2. Initial Resistance: 0.15 inch wg
3. Recommended Final Resistance: 0.50 inches wg.

F. Duct-Mounting Frames: Stainless steel with gaskets and fasteners, and suitable for bolting together into built-up filter banks.

1. Manufacturer:
   a. Pyramid Filters,
   b. Perkins Thermal Systems.
   c. Guru Filtration System.

## 2.4 FILTER GAGES

A. Manufacturers:

1. **Dwyer.**
2. **Trerice.**
3. **Weiss.**

B. Direct Reading Dial: 3-1/2 inch diameter diaphragm actuated dial in metal case. Furnish vent valves, black figures on white background, front calibration adjustment, range 0-3.0 inch wg 2 percent of full scale accuracy.

C. Accessories: Static pressure tips with integral compression fittings, 1/4 inch plastic tubing, 2-way or 3-way vent valves.

## 2.5 BIPOLAR IONIZATION

A. Manufacturers

1. **Plasma Air International.**
2. **Aerisa.**
3. **AtmosAir.**

B. Performance Criteria

1. The bipolar ionization system shall be capable of controlling gas phase contaminants generated from human occupants as well as products of combustion of jet fuel.
2. Capable of reducing static space charges.
3. Capable of reducing common VOC's encountered in schools, office buildings and commercial facilties.
4. Equipment shall be capable of performing in non condensing atmospheres at temperatures up to 140 degrees F.
5. Provide 5 year warranty.

C. Equipment Requirements

1. The bipolar ionization units shall include all power supplies, ion generating tubes, gaskets, indicators, switches, fuses, and accessories necessary for safe an deficient operation.
2. All duct mounted applications shall include a mounting frame permanently attached to the duct. Ionization units shall be attached to the mounting frame.
3. Ionization Tubes shall be UL or ETL listed and bear the UL or ETL mark.
4. The manufacturer shall provide ionization tubes of appropriate size and quantity for each air handling system to meet the requirements for the system.
5. All exposed metallic parts of ionization tubes shall be stainless steel.
6. Ionization units shall be suitable for duct mounting or air handling unit plenum mounting.
7. Ionization units shall be plenum rated per UL 2043.
8. Ionization unit output shall be user adjustable from approximately 50-100%. There shall be a minimum of five levels of adjustment.

9. An integral differential pressure switch shall be provided on duct mounted one-and two-tube units. Additional controls such as field mounted pressure switches or control relays shall be included as part of the ionization equipment scope.

D. Installation Requirements

1. Ionization units shall be installed per manufacturer's installation instructions.

E. Electrical Requirements

1. The electrical power wiring to the ionization units shall be detached without the use of tools to facilitate servicing of the equipment.
2. Ionization units shall be available for 120 and 240 volt applications.
3. The maximum power required for multi tube ionization units shall be 50 watts.
4. The electrical contractor shall provide shall a junction box with single outlet within 4 feet of the ionization equipment.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install filters with felt, rubber, or neoprene gaskets to prevent passage of unfiltered air around filters.

B. Install filter gage static pressure tips upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum, in accessible position. Adjust and level.

C. Do not operate fan system until temporary filters are in place. Replace temporary filters used during construction and testing, with clean set.

D. Install filter gages on filter banks with separate static pressure tips upstream and downstream of filters.

E. Install filters in accordance with manufacturer's recommendations.

F. Provide maintenance training to LAWA, as required.

END OF SECTION 23 40 00

# SECTION 23 42 00 - ULTRA VIOLET GERMICIDAL IRRADIATION (UVGI) SYSTEM

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes the following:

1. UL listed indoor air quality system (UVGI) mounted inside air handling units and packaged units.

### 1.2 SUBMITTALS

A. Product Data: Manufacturer's literature for UVGI Systems indicated.

1. Dimensions, weights, capacities and ratings.
2. Wiring diagrams, fixtures and control panel.
3. UVGI system components and accessories.
4. Heat output of UVGI system into air handling unit or air stream for each size of air handling unit scheduled.

B. Catalog cuts, engineering data sheets, list of unit numbers, UVGI output and power consumption. The following shall also be included with submittals:

1. Indoor air quality systems: Calculated intensity profile of entire irradiated surface demonstrating minimum intensity ($mW/cm^2$).

C. Operation and Maintenance Data: For UVGI systems to include in emergency operation and maintenance manuals:

1. Provide catalog cuts of equipment and components.
2. Include instructions for emitter replacement and component replacement.
3. Provide spare parts list.
4. Provide wiring diagram.
5. Provide installation, operation and maintenance manuals.

### 1.3 QUALITY ASSURANCE

A. System to be factory tested and the design, construction and installation to be in accordance with all state, local, federal or other regulations having jurisdiction.

B. Competency of Supplier/Manufacturer/Installer

1. The supplier/manufacturer/installer of the UVGI system to have a qualified service organization in active operation for a minimum of five (5) years. The organization to have had a history of competent service experience in designing,

installing and maintaining the specific types of systems described in the specifications, and has on its payroll sufficient qualified experienced personnel to guarantee satisfactory performance of the installation. All maintenance personnel used in fulfilling the requirements of the installation shall be qualified to maintain this type of equipment.

## 1.4 WARRANTY

A. The UVGI system shall be warranted to be free from defects in material and workmanship for a period of five (5) years.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, acceptable manufacturers are:

**1. Steril-Aire.**
**2. Vigilair**
**3. Strion Air.**

## 2.2 ULTRAVIOLET DISINFECTION

A. Provide ultraviolet disinfection for bacteria, mold and odor control inside each equipment it is installed in. The UV dosage shall be calculated for theoretical 99% air disinfection at air velocity and temperature and shall be adequate to deactivate microbial growth on all exposed surfaces.

B. Construction. The UV System shall be of Stainless Steel, Galvanized and Aluminum Construction. Any exposed screws or fasteners shall be Stainless Steel. Safety limit switches and Exterior SPST On/Off switches shall be pre-wired and factory installed in a weatherproof junction box. All exterior safety signage shall be permanently silk-screened with UL warning requirements. Lamp supports shall be Stainless Steel. The lamps shall easily be removed for service without the use of tools or the disconnection of any wiring connections. UV System shall be complete with all miscellaneous accessories required to form a complete unit.

C. Independent Testing. The device submitted shall be classified by UL (Underwriters Laboratories) as an Air Duct Mounted Accessory (ABQK). Also meets the UL Standards 1598, UL 153, UL 1995. Manufacturers UL file number shall be permanently marked on the exterior of the product.

D. Ultra Violet Lamps. The lamp shall be available on the open market and not be prioritized in relationship to the UV equipment. Lamps shall be 60 Nominal Watt, 18 UV Watt High Output, Wind-chill Corrected 253.7 nanometer. The lamp shall be single

ended bi-tube design so that no external wires are exposed in the air path to provide power to the opposing end of the lamp. The lamp shall withstand a 5 minute 10 lb. direct pull Stress Load Test and not become disengaged from the socket. Mercury content of the lamp shall be stated in submittal data and MSDS sheets stating lamp mercury content of less than 4.5 mg. mercury shall be an integral part of the submittal data. Current replacement lamp costs shall be an integral part of submittal data. The lamp shall provide 175 microwatts/cm squared at 400fpm/50 degrees F, measured at a 1-meter distance from the lamp. The lamp shall provide 12.5 microwatts/cm squared per inch of arc length. The Lamp Change shall be performed without UV fixture disassembly and without the use of tools. The product shall not require maintenance personal to enter the wiring compartment of in order to facilitate lamp change. Manufacturer shall provide gloves appropriate for proper handling of the UV lamp. The manufacturer shall rate lamp life at minimum life of 8000 hours based on 3-hour start/stop cycles with a lamp depreciation not to exceed 15% at rated life.

1. Manufacturer. **Philips, GE or Sylvania.**

E. Ballasts. The ballast shall be available on the open market and not be prioritized in relationship to the UV equipment. Ballasts shall be UL Listed for the lamp provided. Ballasts shall be high power factor, class P, Sound Rating A, Type 1 Outdoor, Electronic. Ballasts shall be suitable for air handling spaces and shall have harmonic distortion in accordance with ANSI standards and a minimum operating temperature of B20 degrees F. Ballasts shall be warranted for a period of 5 years.

1. Manufacturer. **Advance, Magnetek or Robertson.**

F. Safety. The assembly shall employ a safety interlock switches, which interrupts power when the Air Handler is opened for servicing. The product employs germicidal lamps, which emit UV-C radiation, thereby posing a potential risk of exposure to eyes and bare skin during maintenance. Access doors shall be have a glass visual examination port as provided by equipment manufacturer. Warning signage provided by UV equipment manufacturer shall be silk-screened on stainless steel with UL requirements as to safety aspects. Manufacturer shall provide safety glasses to protect installers' eyes in case of accidental startup of lamps during installation process.

G. Warranty. UV Air Disinfection System, less lamps, shall be warranted to be free of defects in workmanship and material for a period of Five Years from date of shipment.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install per manufacturer's recommendation.

END OF SECTION 23 42 00

# SECTION 23 64 11- PACKAGED WATER CHILLERS - RECIPROCATING, SCROLL, AND SCREW

## PART 1 – GENERAL

**NOTE:** This section is for temporary equipment only with a fixed date for removal.

### 1.1 SUMMARY

A. Section includes chiller package, charge of refrigerant and oil, controls and control connections, chilled water connections, condenser water connections, refrigerant connections, auxiliary water connections, starters.

B. This applies to chillers smaller than 100 tons.

### 1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 550/590 - Water Chilling Packages Using the Vapor Compression Cycle.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. American Society of Mechanical Engineers:

1. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

### 1.3 SUBMITTALS

A. Shop Drawings: Indicate components, assembly, dimensions, weights and loads, required clearances, and location and size of field connections. Indicate valves, strainers, and thermostatic valves required for complete system.

B. Product Data: Submit rated capacities, weights, specialties and accessories, electrical requirements, wiring diagrams, and control diagrams.

C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include startup instructions.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements including those furnished but not produced by manufacturer.

E. Manufacturer’s Field Reports: Submit start-up report. Indicate results of leak test and refrigerant pressure test.

## 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide.

## 1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

## 1.6 WARRANTY

A. Furnish five year manufacturer warranty to include coverage for complete assembly including materials and labor.

## 1.7 MAINTENANCE SERVICE

A. Furnish service and maintenance of chiller for five years from Date of Substantial Completion.

B. Examine unit components monthly. Clean, adjust, and lubricate equipment.

C. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.

D. Perform work without removing units from service during building normal occupied hours.

E. Provide emergency call back service at all hours for this maintenance period.

F. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

G. Perform maintenance work using competent and qualified personnel under supervision and in direct employ of manufacturer or original installer.

## 1.8 MAINTENANCE MATERIALS

A. Furnish two containers of lubricating oil.

## PART 2 - PRODUCTS

### 2.1 PACKAGED WATER CHILLERS

A. Manufacturers:

1. **York.**
2. **Carrier.**
3. **Trane.**

B. Product Description: Factory assembled and tested, packaged, water cooled, liquid chillers consisting of compressors, compressor motor, condenser, evaporator, refrigeration accessories, instrument and control panel including gages and indicating lights, auxiliary components and accessories, and motor starters.

C. Refrigerant shall be R-410A or R-407C.

### 2.2 HERMETIC COMPRESSORS

A. Reciprocating Compressors:

1. Unit: Hermetically sealed motor-compressor with crankcase heater, suction and discharge service valves, rubber-in-shear isolators, and control panel.
2. Motor: Constant speed 3600 rpm, suction gas cooled with overheating protection.
3. Crankcase Heater: Energize continuously.

B. Scroll Compressors:

1. Unit: Direct drive, hermetic, 3600 RPM, fixed compression, scroll motor-compressor with control panel.
2. Features: Centrifugal oil pump, sump oil heater, oil level sight glass, oil charging valve, two point lubrication for each motor bearing, flooded lubrication for journal and thrust bearings, check valve on scroll discharge port.
3. Motor: Suction-gas cooled, hermetically sealed, squirrel cage induction.
4. Automatic Capacity Reduction: Electronic logic controller and air temperature sensor controls unit and hot gas bypass regulator valve.

### 2.3 SEMI-HERMETIC COMPRESSORS

A. Reciprocating Compressors:

1. Unit: Serviceable hermetic reciprocating motor-compressor with positive displacement oil pump lubrication system, spring loaded heads and replaceable cylinder liners, crankcase heater, suction inlet screen, discharge service valves, and control panel.
2. Automatic Capacity Reduction Equipment solenoid gas pressure operated. Furnish capability for unloaded compressor start.
3. Motor: Constant speed 1800 rpm, suction gas cooled with electronic overheating protection in each phase, reduced voltage starting.

4. Crankcase Heater: Energize continuously.

B. Screw Compressors:

1. Unit: Direct drive, semi-hermetic 3600 RPM, fixed compression, rotary screw compressor with control panel.
2. Features: Differential refrigerant pressure oil pump, oil heater, oil separator and filter and oil charging valve.
3. Motor: Suction gas-cooled, hermetically sealed, squirrel cage induction.
4. Automatic Capacity Reduction: Continuously variable slide valve with infinitely variable control to 25 percent of full load.

## 2.4 EVAPORATOR

A. Shell and tube type, seamless steel construction with fabricated steel, heads, seamless copper tubes with integral fins, rolled into tube sheets. Furnish multiple refrigerant circuits on multiple compressor units.

B. Design, test, and stamp refrigerant side for 225 psig working pressure and water side for 150 psig working pressure, in accordance with ASME Section VIII.

C. Insulate with 0.75 inch minimum thick flexible expanded polyvinyl chloride insulation with maximum K factor of 0.26.

D. Furnish water drain connection and thermometer wells for temperature controller and low temperature cutout.

## 2.5 CONDENSERS

A. Shell and tube type, seamless steel construction with fabricated steel heads, seamless copper tubes with integral fins, rolled into tube sheets.

B. Design, test, and stamp refrigerant side for 450 psig working pressure in accordance with ASME Section VIII.

C. Furnish integral sub-cooling circuit.

D. Furnish 450 psig safety relief valve on condenser shell.

E. Design, test, and stamp water side for 150 psig working pressure in accordance with ASME Section VIII.

## 2.6 CONDENSER COILS, FANS AND MOTORS

A. Coils: Copper fins mechanically bonded to seamless copper tubing. Furnish sub-cooling circuits as applicable. Air test under water to 425 psig, and vacuum dehydrate. Seal with holding charge of nitrogen.

B. Coil Guard: Louvered with lint screens.

C. Vertical propeller type condenser fans with fan guard on discharge.

D. Weatherproof motors suitable for outdoor use, with permanent lubricated ball bearings and built-in current and thermal overload protection.

## 2.7 REFRIGERANT CIRCUIT

A. Factory furnished and piped.

B. Furnish for each refrigerant circuit:

1. Liquid line solenoid valve.
2. Filter dryer (replaceable core type).
3. Liquid line sight glass and moisture indicator.
4. Thermal expansion for maximum operating pressure.
5. Charging valve.
6. Insulated suction line.
7. Discharge line check valve.
8. Compressor discharge service valve.
9. Pressure relief device.

## 2.8 CONTROLS

A. On or near chiller, mount steel control panel with NEMA 3R (NEMA 4X for outdoors location) enclosure, containing starters, power and control wiring, molded case disconnect switch, factory wired with single point power connection.

B. For each compressor, furnish part winding starter, non-recycling compressor overload, starter relay, and control power transformer or terminal for control power. Furnish manual reset, current overload protection.

C. Furnish devices on control panel face:

1. Compressor, run lights.
2. System start-stop switch.
3. Control power fuse of circuit breaker.
4. Compressor lead-lag switch.
5. Demand limit switch.

D. Furnish safety controls with indicating lights arranged so machine is shut down and requires manual reset:

1. Low chilled water temperature switch.
2. High discharge pressure switch for each compressor.
3. Low suction pressure switch for each compressor.
4. Oil pressure switch.

5. Flow switch in chilled water line.
6. Flow switch in condenser water line.
7. Relay for remote mounted emergency shutdown.

E. Furnish the following operating controls:

1. Multi-step chilled water temperature controller to cycle compressor and activate capacity controls, with remote thermostat.
2. Five minute off timer prevents compressor from short cycling.
3. Part winding start timer.
4. Periodic pump-out-timer to pump down on chilled water flow and high evaporator refrigerant pressure.
5. Load limit thermostat to limit compressor loading on high return water temperature.
6. Three phase monitor to protect unit by stopping compressor on phase loss, phase reversal, phase unbalance, or under voltage.
7. Hot gas bypass sized for minimum compressor loading, bypasses hot refrigerant gas to evaporator.
8. Cycle counter and operating hour meter.

F. Furnish pre-piped gage board with pressure gages for suction and discharge refrigerant pressures, and oil pressures.

G. Furnish alarm package with test button and lights indicating control circuit is energized, compressor is running, and sounds audible alarm and activates indicating light upon detection of compressor malfunction, low chilled water temperature, or evaporator water flow failure.

## 2.9 SOURCE QUALITY CONTROL (AND TESTS)

A. Furnish testing of package chillers.

B. Furnish shop inspection and testing for package chillers.

C. Make completed chillers available for inspection at manufacturer's factory prior to packaging for shipment. Furnish at least seven days notice before packaging is scheduled.

D. Allow witnessing of factory inspections and tests at manufacturers test facility with 2 LAWA personnel. Furnish at least seven days notice before inspections and tests are scheduled.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install indoor chiller on concrete housekeeping pad minimum 3-1/2 inches high and 6 inches wider than equipment base on each side. Install packaged outdoor chiller on concrete foundation minimum 6 inches thick and 6 inches wider than equipment base on each side.

B. Provide seismic restraints as required.

C. Install the following piping accessories on evaporator chilled water piping connections.

1. On inlet:

a. Thermometer well for temperature controller.
b. Thermometer.
c. Strainer.
d. Flow switch.
e. Flexible pipe connection.
f. Pressure gage.
g. Shut-off valve.

2. On outlet:

a. Thermometer.
b. Flexible pipe connection.
c. Pressure gage.
d. Balancing valve.

D. Install auxiliary water piping for oil cooling units and purge condensers.

E. Install the following piping accessories on condenser water piping connections.

1. On inlet:

a. Thermometer well for temperature limit controller.
b. Thermometer well and thermometer.
c. Strainer.
d. Flow switch.
e. Flexible pipe connection.
f. Pressure gage.
g. Shut-off valve.

2. On outlet:

a. Thermometer well and thermometer.
b. Flexible pipe connection.
c. Pressure gage.
d. Balancing valve.

F. Arrange piping for easy dismantling to permit tube cleaning.

G. Install refrigerant piping connections to air-cooled condensing units.

H. Install piping from chiller safety relief valve to outdoors. Size as recommended by manufacturer.

I. Install chiller accessories furnished loose for field mounting.

J. Install electrical devices furnished loose for field mounting.

K. Install control wiring between chiller control panel and field mounted control devices.

L. Provide connection to electrical service.

## 3.2 FIELD QUALITY CONTROL

A. Furnish cooling season start-up, winter season shutdown service, for first year of operation. When initial start-up and testing takes place in winter and machines are to remain inoperative, repeat start-up and testing operation at beginning of first cooling season.

## 3.3 MANUFACTURER'S FIELD SERVICES

A. Furnish services of factory trained representative for minimum of three days to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct Owner on operation and maintenance.

B. Furnish initial charge of refrigerant and oil.

## 3.4 DEMONSTRATION AND TRAINING

A. Demonstrate system operations and verify specified performance. Demonstrate low ambient operation during winter testing for air-cooled condensers.

B. Training to include minimum of 15 personnel for 40 hours training, 16 hours shall be classroom training and 24 hours shall be hands-on training.

C. Training shall occur after the system is fully operational.

## 3.5 FACTORY PERFORMANCE TESTS

A. Manufacturer shall conduct factory performance test for each chiller in accordance with ARI 550/590 98, to verify design capacity and part load capacity points indicated on Bid form. LAWA and/or LAWA's representative (2 persons) may elect to witness tests. Notify LAWA and/or LAWAs representative of test date at least 2 weeks in advanced. There will be zero tolerance on capacity and NPLV, other parameters are per ARI 550/590 tolerance.

B. Before shipment of chillers, all records and certifications approving testing requirements shall be submitted to and approved by LAWA.

C. Defective work or material shall be replaced or repaired, as necessary, and inspection and test repeated. Repairs shall be made with new materials. Run new performance test in accordance with ARI standard.

D. If chiller assembly fails to meet design capacity and a minimum of 15% more capacity at lower condenser water temperature, LAWA may elect not to accept delivery until chiller is modified at manufacturer's expense to meet design capacity.

E. If chiller assembly fails to meet any of part load performance data supplied by manufacturer with his bid, LAWA may elect not to accept delivery until chiller is modified at manufacturer's expense to meet all of design and part load performance data or to assess penalty charge equal to 10 years operating cost differential. This differential is to be determined by using part load data included in bid form and data obtained from performance test, subtracting bid data annual operating cost from test data annual operating cost, and multiplying difference by ten. Penalty charge shall apply to all chillers.

F. All design conditions and part load performance data shall be evaluated with 480 volt, 3 phase, 60 hertz power supplied to chiller.

G. Conduct test at approved ARI certified test facility of the manufacturer.

H. Instrumentation used for testing must be calibrated within 6 months of test date and traceable to National Bureau of Standards. Documentation verifying NBS traceability shall be submitted to LAWA.

1. Performance test shall be two point test for one chiller. Points will be selected at time of test. Points will be selected from submitted performance from 25 to 100% of capacity.

## 3.6 COMMISSIONING

A. The manufacturer shall be present during all commissioning events. The anticipated schedule is for commissioning to occur during the least six to eight weeks of construction just prior to the anticipated end of construction date of. Include 40 hours of field time to perform the commissioning requirements.

B. A factory authorized representative shall perform the startup service.

1. Fill out startup checklists and attach copy with Contractor Startup Report.

C. Complete installation and startup checks according to manufacturer's written instructions and check for the following items:

1. No physical damage to unit.
2. Unit is level.
3. Chiller vibration isolation and flexible pipe connections are installed.
4. Clearances have been maintained and piping is installed for easy removal for service and tube cleaning.
5. Chilled and condenser water pipes have been connected to correct ports.
6. Labels and safety instructions are clearly visible.
7. Oil levels are as recommended by manufacturer.
8. Refrigerant charge is sufficient and chiller has been leak tested.
9. Shipping skids, blocks and straps are removed.
10. Refrigerant pressure relief is vented to outside.
11. Thermometers and pressure gauges are installed.
12. Controls and safety interlocks are installed and connected.
13. Pumps are installed, connected and operational.

D. Check and record performance of chiller protection devices.

E. Check and record performance of chilled and condenser water flow and low temperature interlocks.

F. Operate chiller for run in period as recommended by manufacturer.

G. Check static deflection of vibration isolators, including deflection during chiller startup and shutdown.

1. Check refrigerant charge. Check oil level.

## 3.7 CLEANING

A. After completion of system installation, start up, testing and prior to commissioning, completely and thoroughly clean up the chillers from any foreign material and construction dirt and dust.

END OF SECTION 23 64 11

# SECTION 23 64 16 - CENTRIFUGAL WATER CHILLERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Packaged, water-cooled, electric-motor-driven centrifugal chillers.
2. Packaged, portable refrigerant recovery units.
3. Heat-exchanger, brush-cleaning system.
4. Motor controllers.
5. Charge of refrigerant and oil.
6. Accessories.

B. This applies to chillers that are greater than or equal to 100 tons.

### 1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME):

1. Boiler and Pressure Vessel Code, Section VIII, Division 1, “Rules for Construction of Pressure Vessels”.
2. Boiler and Pressure Vessel Code, Section IX, “Welding and Brazing Qualifications”.
3. B31.1, “Power Piping”.
4. B31.5, “Refrigeration Piping and Heat Transfer Components”.

B. Air-Conditioning and Refrigeration Institute (ARI):

1. Standard 550/590, “Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle”.
2. Standard 575, “Method of Measuring Machinery Sound Within an Equipment Space”.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

1. Standard 15, “Safety Standard for Refrigeration Systems”.
2. Standard 147, “Reducing the Release of Halogenated Refrigerants from Refrigerating and Air Conditioning Equipment and Systems”.
3. Standard 90.1, “Energy Standard for Buildings Except Low-Rise Residential Buildings”.

D. National Fire Protection Association (NFPA)

1. Standard 70, National Electrical Code (NEC)

E. American Gear Manufacturers Association (AGMA)

F. American National Standards Institute (ANSI)

G. American Society for Testing and Materials (ASTM)

H. Institute of Electrical and Electronics Engineers (IEEE)

1. National Electrical Manufacturers Association (NEMA)

I. Underwriters Laboratories (UL)

J. Occupational Safety & Health Act (OSHA) I International Building Code (IBC) 2009

## 1.3 PERFORMANCE REQUIREMENTS

A. Each chiller shall produce a capacity as scheduled on plans when operating on a fluid mixture of 30% propylene glycol.

B. The coolers shall be selected for 0.00010 fouling factor. Water side shall be designed for 150 psig working pressure. The condenser shall be selected for 0.00025 fouling factor. Water side shall be designed for 150 psig working pressure.

C. Chillers shall give 15 to 25% more capacity with better efficiency when condenser water temperature is lowered.

D. Seismic Performance: Centrifugal chillers shall withstand the effects of earthquake motions determined according to California Building Code.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

E. Condenser-Fluid Temperature Performance:

1. Startup Condenser-Fluid Temperature: Chiller shall be capable of starting with an entering condenser-fluid temperature of 40 deg F and providing stable operation until the system temperature is elevated to the minimum operating entering condenser-fluid temperature.
2. Minimum Operating Condenser-Fluid Temperature: Chiller shall be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of 55 deg F.
3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.
4. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.
5. Performance Tolerance: Comply with the following in lieu of ARI 550/590:

a. Allowable Capacity Tolerance: Zero percent.
b. Allowable IPLV/NPLV Performance Tolerance: Zero percent.

c. Flow and temperature to follow ARI 550/590 Standards

## 1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:

a. Complete chiller including refrigerant and oil charge.
b. Complete compressor and drive assembly including refrigerant and oil charge.
c. Refrigerant and oil charge.
d. Parts and labor including the refrigerant.
e. Loss of refrigerant charge for any reason.

2. Warranty Period: Five (5) years.

## 1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

1. Performance at ARI standard conditions and at conditions indicated.
2. Performance at ARI standard unloading conditions.
3. Minimum evaporator flow rate.
4. Refrigerant capacity of chiller.
5. Oil capacity of chiller.
6. Fluid capacity of evaporator, condenser, and heat-reclaim condenser.
7. Characteristics of safety relief valves.
8. Minimum entering condenser-fluid temperature.
9. Performance at varying capacities with constant design condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in 5 deg F increments.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural supports.

2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

D. Certificates: Provide certificate from manufacturer.

E. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Source quality-control reports.

G. Startup service reports.

H. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals. Include start-up instructions, maintenance data, parts lists, controls, accessories, and troubleshooting guide.

### 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

**A. Carrier.**

**B. Trane.**

**C. York.**

### 2.2 MANUFACTURED UNIT

A. Description: Factory-assembled and -tested chiller complete with compressor, compressor motor, compressor motor controller, lubrication system evaporator, condenser, controls, interconnecting unit piping and wiring, and indicated accessories.

1. For chillers with dual compressors, provide each compressor with a dedicated

motor and motor controller, and provide for continued operation when either compressor-drive assembly fails or is being serviced.

B. Seismic Fabrication Requirements:

1. Fabricate chiller mounting base with reinforcement strong enough to resist chiller movement during a seismic event when chiller is anchored to field support structure.

## 2.3 COMPRESSOR-DRIVE ASSEMBLY

A. Description: Single-stage or multistage, variable-displacement, centrifugal-type compressor driven by an electric motor.

B. Compressor:

1. Casing: Cast iron, precision ground.
2. Impeller: High-strength cast aluminum or cast-aluminum alloy on carbon- or alloy-steel shaft.

C. Drive: Direct- or gear-drive, open or hermetic design using an electric motor as the driver.

1. Gear Drives: For chillers with gear drives, provide single- or double-helical gear design continuously coated with oil while chiller is operating. Gears shall comply with American Gear Manufacturer Association standards. Temperature rise of gears shall not exceed 70 deg F above ambient at full load.
2. Drive Coupling: For chillers with open drives, provide flexible disc with all-metal construction and no wearing parts to ensure long life without the need for lubrication.
3. Seals: Seal drive assembly to prevent refrigerant leakage.

D. Compressor Motor:

1. Continuous-duty, squirrel-cage, induction-type, two-pole motor with energy efficiency required to suit chiller energy efficiency indicated.
2. Factory mounted, aligned, and balanced as part of compressor assembly before shipping.
3. Motor shall be of sufficient capacity to drive compressor throughout entire operating range without overload and with sufficient capacity to start and accelerate compressor without damage.
4. For chillers with open drives, provide motor with open-dripproof enclosure.
5. Provide motor with thermistor or RTD in single motor winding to monitor temperature and report information to chiller control panel.
6. Provide motor with thermistor or RTD to monitor bearing temperature and report information to chiller control panel.
7. Provide lifting lugs or eyebolts attached to motor.

E. Vibration Balance: Balance chiller compressor and drive assembly to provide a precision balance that is free of noticeable vibration over the entire operating range. Operating

speed shall be below the first critical speed.

1. Overspeed Test: 25 percent above design operating speed.

F. Service: Easily accessible for inspection and service.

1. Compressor's internal components shall be accessible without having to remove compressor-drive assembly from chiller.
2. Provide lifting lugs or eyebolts attached to casing.

G. Economizers: For multistage chillers, provide interstage economizers.

H. Sound Attenuation: Compressors shall be provided with Sound Attenuation package to reduce the low frequency noise levels.

I. Capacity Control: Modulating, VFD and variable-inlet, guide-vane assembly combined with hot-gas bypass, if necessary, to achieve performance indicated.

1. Maintain stable operation that is free of surge, cavitation, and vibration throughout range of operation. Configure to achieve most energy-efficient operation possible.
2. Operating Range: From 100 to 15 percent of design capacity.
3. Condenser-Fluid Unloading Requirements over Operating Range: Constant-design entering condenser-fluid temperature.
4. Chillers with variable frequency controllers shall modulate compressor speed with variable-inlet, guide-vane control to achieve optimum energy efficiency.
5. Provide external electric guide-vane operator and linkage.
6. Seal points where guide-vane operating mechanism passes through the compressor casing to prevent refrigerant leakage.

J. Oil Lubrication System: Consisting of oil reservoir pump, filtration, cooler, factory-wired power connection, motor controllers and controls.

1. Provide lubrication to bearings, gears, and other rotating surfaces at all operating, startup, coastdown, and standby conditions including power failure.
2. Manufacturer's standard method to remove refrigerant from oil.
3. Oil filter shall be the easily replaceable cartridge type, minimum 0.5-micron efficiency, with means of positive isolation while servicing.
4. Refrigerant- or water-cooled oil cooler.
5. Factory-installed and pressure-tested piping with isolation valves and accessories.
6. Oil compatible with refrigerant and chiller components.
7. Positive visual indication of oil level.
8. Oil flow must be proven for compressor to run.
9. Oil pump shall be submerged in the oil reservoir to assure a positive oil supply.

## 2.4 REFRIGERATION

A. Refrigerant:

1. Type: R-134a; ASHRAE 34, Class A1.
2. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

B. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.

C. Pressure Relief Device:

1. For Chillers Using R-134a: ASME-rated, spring-loaded, pressure relief valve; single- or multiplereseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Condenser shall have dual valves with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.

D. Refrigerant Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system.

E. Refrigerant Isolation for Chillers Using R-134a: Factory install positive shutoff, manual isolation valves in the compressor discharge line to the condenser and the refrigerant liquid line leaving the condenser to allow for isolation and storage of full refrigerant charge in the chiller condenser shell. In addition, provide isolation valve on suction side of compressor from evaporator to allow for isolation and storage of full refrigerant charge in the chiller evaporator shell. Purge System:

1. System shall be a thermal purge design, refrigerant or air cooled, equipped with a carbon filter that includes an automatic regeneration cycle.
2. Factory wire to chiller's main power supply and system complete with controls, piping, and refrigerant valves to isolate the purge system from the chiller.
3. Construct components of noncorrodible materials.
4. Controls shall interface with chiller control panel to indicate modes of operation, set points, data reports, diagnostics, and alarms.
5. Efficiency of not more than 0.02 lb of refrigerant per pound of air when rated according to ARI 580.
6. Operation independent of chiller.

F. Positive-Pressure System:

1. During nonoperational periods, positive-pressure system shall automatically maintain a positive pressure for atmosphere in the refrigerant pressure vessel of not less than 0.5 psig (adjustable) up to a pressure that remains within the vessel design pressure limits.
2. System shall be factory wired and include controller, electric heat, pressure transmitter, or switch.

## 2.5 EVAPORATOR

A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes

within shell. Shell is separate from condenser.

B. Shell Material: Carbon-steel rolled plates with seamless pipe.

C. Designed to prevent liquid refrigerant carryover from entering compressor.

D. Provide evaporator with sight glass or other form of positive visual verification of liquid-refrigerant level.

E. Tubes:

1. Individually replaceable from either end and without damage to tube sheets and other tubes.
2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
3. Material: Copper.
4. Nominal OD: Per manufacturer.
5. Minimum Wall Thickness: Per manufacturer.
6. External Finish: Per manufacturer.
7. Internal Finish: Enhanced or smooth.

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

H. Water Box:

1. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Standard type for water box with piping connections. Standard type for water box without piping connections.
3. Provide water boxes with lifting lugs or eyebolts.
4. Nozzle Pipe Connections: Grooved with mechanical-joint coupling and flange adapter.
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. Fit each water box with 3/4-inch drain connection at low point and vent connection at high point, each with threaded plug.

I. Additional Corrosion Protection. See FINISH later.

## 2.1 CONDENSER

A. Description: Shell-and-tube design with water in tubes and refrigerant surrounding tubes within shell. Shell is separate from evaporator.

B. Shell Material: Carbon-steel rolled plates with seamless pipe.

C. Designed to prevent direct impingement of high-velocity hot gas from compressor discharge on tubes.

D. Provide condenser with sight glass or other form of positive visual verification of refrigerant charge and condition.

E. Tubes:

1. Individually replaceable from either end and without damage to tube sheets and other tubes.
2. Mechanically expanded into end sheets and physically attached to intermediate tube sheets.
3. Material: Copper.
4. Nominal OD: Per manufacturer.
5. Minimum Wall Thickness: Per manufacturer.
6. External Finish: Per manufacturer.
7. Internal Finish: Enhanced or smooth.

F. End Tube Sheets: Continuously welded to each end of shell; drilled and reamed to accommodate tubes with positive seal between fluid in tubes and refrigerant in shell.

G. Intermediate Tube Sheets: Installed in shell and spaced along length of tube at intervals required to eliminate vibration and to avoid contact of tubes resulting in abrasion and wear.

H. Water Box:

1. Carbon-steel construction; arranged to provide visual inspection and cleaning of tubes from either end without disturbing refrigerant in shell.
2. Standard type for water box with piping connections. Standard type for water box without piping connections.
3. Provide water boxes with lifting lugs or eyebolts.
4. Nozzle Pipe Connections: Grooved with mechanical-joint coupling and flange adapter.
5. Thermistor or RTD temperature sensor factory installed in each nozzle.
6. Fit each water box with 3/4-inch drain connection at low point and vent connection at high point, each with threaded plug.

I. Additional Corrosion Protection. See FINISH later.

## 2.1 INSULATION

A. Closed-cell, flexible elastomeric thermal insulation complying with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Thickness: 1-1/2 inches.

B. Adhesive: As recommended by insulation manufacturer.

C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator shell and end tube sheets, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

1. Apply adhesive to 100 percent of insulation contact surface.
2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
3. Seal seams and joints to provide a vapor barrier.
4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
5. Provide removable insulations covers for water boxes.

## 2.2 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Single-point, field-power connection to fused disconnect switch. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.

1. Branch power circuit to each motor, electric heater, dedicated electrical load, and controls with disconnect switch or circuit breaker.

    a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.

2. NEMA ICS 2-rated motor controller for auxiliary motors, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller for each variable-speed motor furnished.
3. Control-circuit transformer with primary and secondary side fuses.

C. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.

D. Factory-installed wiring outside of enclosures shall be in metal raceway except make terminal connections with not more than a 24-inch length of liquid tight or flexible metallic conduit.

## 2.3 VARIABLE FREQUENCY CONTROLLER

A. Motor controller shall be factory mounted and wired on the chiller to provide a single-point, field-power termination to the chiller and its auxiliaries.

B. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.

C. Enclosure: Unit mounted, NEMA 250, Type 14X, with hinged full-front access door with lock and key.

D. General: Comply with the requirements of Division 26.

E. Integral Disconnecting Means: Door-interlocked, NEMA AB 1, instantaneous-trip circuit breaker with lockable handle. Minimum withstand rating shall be as required by electrical power distribution system, but not less than 65,000 A.

F. Technology: Pulse width modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.

G. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.

1. Rectifier section shall be a full-wave diode bridge that changes fixed-voltage, fixed-frequency, ac line power to a fixed dc voltage. Silicon controller rectifiers, current source inverters, and paralleling of devices are unacceptable. Rectifier shall be insensitive to phase rotation of the ac line.
2. Regulator shall provide full digital control of frequency and voltage.
3. Inverter section shall change fixed dc voltage to variable-frequency, variable ac voltage, for application to a squirrel-cage motor. Inverter shall produce a sine-coded, pulse width modulated (PWM) output wave form and shall conduct no radio-frequency interference back to the input power supply.

H. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.

I. Operating Requirements:

1. Input AC Voltage Tolerance: 460-V ac, plus 10 percent or 506 V maximum.
2. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
3. Capable of driving full load, without derating, under the following conditions:

    a. Ambient Temperature: 0 to 50 deg C.
    b. Relative Humidity: Up to 90 percent (noncondensing).
    c. Altitude: sea level.

4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 95 percent without harmonic filter, 98 percent with harmonic filter.
6. Overload Capability: 1.05 times the full-load current for 7 seconds.
7. Starting Torque: As required by compressor-drive assembly.
8. Speed Regulation: Plus or minus 1 percent.
9. Isolated control interface to allow controller to follow control signal over a 10:1 speed range.
10. To avoid equipment resonant vibrations, provide critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.

11. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

J. Internal Adjustability Capabilities:

1. Minimum Output Frequency: 6 Hz.
2. Maximum Output Frequency: 60 Hz.
3. Acceleration: 2 seconds to a minimum of 60 seconds.
4. Deceleration: 2 seconds to a minimum of 60 seconds.
5. Current Limit: 30 percent to a minimum of 100 percent of maximum rating.

K. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:

1. Overtemperature.
2. Short circuit at controller output.
3. Ground fault at controller output. Variable frequency controller shall be able to start a grounded motor.
4. Open circuit at controller output.
5. Input undervoltage.
6. Input overvoltage.
7. Loss of input phase.
8. Reverse phase.
9. AC line switching transients.
10. Instantaneous overload, line to line or line to ground.
11. Sustained overload exceeding 100 percent of controller rated current.
12. Starting a rotating motor.

L. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.

M. Automatic Reset and Restart: Capable of three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Controller shall be capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

N. Visual Indication: On face of controller enclosure or chiller control enclosure; indicating the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.
7. Motor speed (percent).
8. Fault or alarm status (code).
9. DC-link voltage.
10. Motor output voltage.
11. Input kilovolt amperes.

12. Total power factor.
13. Input kilowatts.
14. Input kilowatt-hours.
15. Three-phase input voltage.
16. Three-phase output voltage.
17. Three-phase input current.
18. Three-phase output current.
19. Three-phase input voltage total harmonic distortion.
20. Three-phase input current total harmonic distortion.
21. Output frequency (Hertz).
22. Elapsed operating time (hours).
23. Diagnostic and service parameters.

O. Operator Interface: At controller or chiller control panel; with start-stop and auto-manual selector with manual-speed-control potentiometer.

P. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.

Q. Active Harmonic Distortion Filter: Factory mounted and wired to limit total voltage and current distortion to 5 percent.

R. Cooling: Air, refrigerant, or water cooled.

S. Accessories: Devices shall be factory installed in controller enclosure unless otherwise indicated.

1. Control Relays: Auxiliary and adjustable time-delay relays.

T. Chiller Capacity Control Interface: Equip chiller with adaptive control logic to automatically adjust the compressor motor speed and the compressor pre-rotation inlet vane position independently to achieve maximum part-load efficiency in response to sensor inputs that are integral to the chiller controls.

## 2.4 CONTROLS

A. Control: Standalone and microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

B. Enclosure: Unit mounted, NEMA 4X, hinged or lockable; factory wired with a single-point, field-power connection and a separate control circuit.

C. Operator Interface: Multiple-character digital or graphic display with dynamic update of information and with keypad or touch-sensitive display located on front of control enclosure. In either imperial or metric units selectable through the interface, display the following information:

1. Date and time.
2. Operating or alarm status.
3. Fault history with not less than last 10 faults displayed.
4. Set points of controllable parameters.
5. Trend data.
6. Operating hours.
7. Number of chiller starts.
8. Entering- and leaving-fluid temperatures of evaporator and condenser.
9. Difference in fluid temperatures of evaporator and condenser.
10. Fluid flow of evaporator and condenser.
11. Fluid pressure drop of evaporator and condenser.
12. Refrigerant pressures in evaporator and condenser.
13. Refrigerant saturation temperature in evaporator and condenser shell.
14. Compressor refrigerant suction and discharge temperature.
15. Compressor bearing temperature.
16. Motor bearing temperature.
17. Motor winding temperature.
18. Oil temperature.
19. Oil discharge pressure.
20. Phase current.
21. Percent of motor rated load amperage.
22. Phase voltage.
23. Demand power (kilowatts).
24. Energy use (kilowatt-hours).
25. Power factor.
26. For chillers equipped with variable frequency controllers and harmonic filters, include the following:

    a. Output voltage and frequency.
    b. Voltage total harmonic distortion for each phase.
    c. Supply current total demand distortion for each phase.
    d. Inlet vane position.
    e. Controller internal ambient temperature.
    f. Heatsink temperature.

27. Purge suction temperature if purge system is provided.
28. Purge elapsed time if purge system is provided.

D. Control Functions:

1. Manual or automatic startup and shutdown time schedule.
2. Entering and leaving chilled-water temperatures, control set points, and motor load limits.
3. Current limit and demand limit.
4. Condenser-fluid temperature.
5. External chiller emergency stop.
6. Variable evaporator flow.
7. Thermal storage.
8. Heat reclaim.

E. Manually Reset Safety Controls: The following conditions shall shut down chiller and require manual reset:

1. Low evaporator pressure or temperature; high condenser pressure.
2. Low evaporator fluid temperature.
3. Low oil differential pressure.
4. High or low oil pressure.
5. High oil temperature.
6. High compressor-discharge temperature.
7. Loss of condenser-fluid flow.
8. Loss of evaporator fluid flow.
9. Motor overcurrent.
10. Motor overvoltage.
11. Motor undervoltage.
12. Motor phase reversal.
13. Motor phase failure.
14. Sensor- or detection-circuit fault.
15. Processor communication loss.
16. Motor controller fault.
17. Extended compressor surge.
18. High motor temperature.

F. Trending: Capability to trend analog data of up to five parameters simultaneously over an adjustable period and frequency of polling.

G. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: view only; view and operate; and view, operate, and service.

H. Control Authority: At least four conditions: Off, local manual control at chiller, local automatic control at chiller, and automatic control through a remote source.

I. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

J. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display chiller status and alarms.

1. ASHRAE 135 (BACnet) communication interface with the BAS shall enable the BAS operator to remotely control and monitor the chiller from an operator workstation. Control features and monitoring points displayed locally at chiller control panel shall be available through the BAS.

## 2.5 FINISH

A. Paint chiller, using manufacturer's standard procedures, except comply with the following minimum requirements:

1. Provide at least one coat of primer with a total dry film thickness of at least 4 mils.

2. Provide baked phenolic coating finish with a total dry film thickness of at least 6 mils.
3. Paint surfaces that are to be insulated before applying the insulation.
4. Paint installed insulation to match adjacent uninsulated surfaces.
5. Color of finish coat to be manufacturer's standard.

## 2.6 ACCESSORIES

A. Flow Switches:

1. Chiller manufacturer shall furnish a switch for each evaporator and condenser and verify fieldmounting location before installation.
2. Pressure Differential Switches:

    a. Construction: Wetted parts of body and trim constructed of Type 316 stainless steel.
    b. Performance: Switch shall withstand, without damage, the full-pressure rating of the heat exchanger applied to either port and exhibit zero set-point shift due to variation in working pressure.
    c. Set Point: Screw type, field adjustable.
    d. Electrical Connections: Internally mounted screw-type terminal blocks.
    e. Switch Enclosure: NEMA 250, Type 4.
    f. Switch Action: Double-pole, double-throw switch with one pole field wired to the chiller control panel and the other pole field wired to the BAS.

B. Chillers shall be provided with BACNet Controls including BACNet interface communication card. The Control panel shall provide mapping out all points, and the Chiller manufacturer shall allow enough time to assist the Control Company to map all the chiller points.

C. Sound Barrier:

1. Furnish removable and reusable sound-barrier covers over the compressor housing, hermetic motor, compressor suction and discharge piping, and condenser shell.
2. Provide for repeated installation and removal without use of tape or calk.
3. Inner and outer cover shall consist of a PTFE-impregnated fiberglass cloth enclosing heavydensity, needled fiberglass insulation material with a mass-loaded vinyl acoustic barrier.
4. Covers shall be double sewn and lock stitched with edges folded and sewn so no raw cut edges are exposed.
5. Form covers around control devices, gages, conduit, piping, and supports without degrading sound-barrier performance.
6. Continuously lap all exposed seams at least 2 inches for better sound containment.
7. Permanently label each section of cover to indicate its location, description, size, and number sequence.
8. Randomly place stainless-steel quilting pins to prevent covers from shifting and

sagging.

D. Tool Kit: Chiller manufacturer shall assemble a tool kit specially designed for use in serving the chiller(s) furnished. Include special tools required to service chiller components not readily available to LAWA service personnel in performing routine maintenance. Place tools in a lockable case with hinged cover. Provide a list of each tool furnished and attach the list to underside of case cover.

E. Quick Start B with Uninterruptible Power Supply (UPS)

1. Quick Start shall enable the chiller to restart in 15 seconds the power is restored. Quick Start minimizes the time to restart and loads the chiller as quickly as possible, to rapidly achieve the leaving chiller water temperature setpoint. The main objective is to provide minimum down time and the fastest restart/loading as possible. Once the chiller is running and close to setpoint, it will return to standard chiller YK control

## 2.7 SOURCE QUALITY CONTROL

A. Perform functional tests of chillers before shipping.

B. Factory performance test chillers, before shipping, according to ARI 550/590.

1. Test the following conditions:

a. Design conditions indicated.
b. Reduction in capacity from design to minimum load in steps of 10 with condenser fluid at design conditions.

2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

C. For chillers using R-134a refrigerant, factory test and inspect evaporator and condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. For chillers located indoors, rate sound power level according to ARI 575.

# PART 3 - EXECUTION

## 3.1 GENERAL

A. The chillers will be delivered to the designated rigger's yard. Contractor shall coordinate shipment, receive, inspect and accept responsibility for equipment. Any damage or deficiency shall be resolved by Contractor directly with manufacturer and/or hauler, with no recourse to the LAWA.

B. Delivery and rigging of chillers will be staged based on the construction schedule. Contractor shall protect equipment, transport to the site, rig into place, install, pipe, wire and test equipment in accordance with drawings, specifications and manufacturer's

recommendations. Contractor shall coordinate any requirements directly with the manufacturer.

C. Consult equipment supplier regarding rigging requirements. If disassembly is required, both disassembly and reassembly shall be done by the Contractor in strict compliance with the manufacturer's instructions, under supervision of chiller manufacturer's representative, and shall not void any warranties.

## 3.2 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

1. Determine exact locations before roughing-in for piping and electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.3 CHILLER INSTALLATION

A. Equipment Mounting: Install chiller on concrete bases using restrained spring isolators if required.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Maintain manufacturer's recommended clearances for service and maintenance.

C. Charge chiller with refrigerant and fill with oil if not factory installed.

D. Install separate devices furnished by manufacturer and not factory installed.

E. Install piping adjacent to chiller to allow service and maintenance.

F. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a

mechanical coupling.

G. Condenser-Fluid Connections: Connect to condenser inlet with shutoff valve, thermometer, and plugged tee with pressure gage. Connect to condenser outlet with shutoff valve, balancing valve, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, and drain connection with valve. Make connections to chiller with a mechanical coupling.

H. Refrigerant Pressure Relief Device Connections: For chillers installed indoors, extend vent piping to the outdoors without valves or restrictions. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.

I. For chillers equipped with a purge system, extend purge vent piping to the outdoors.

J. Miscellaneous Unit Water Piping: Provide a water supply manifold piped to the compressor oil cooler and the unit-mounted refrigerant recovery unit condenser. The supply manifold shall be complete and include valves, sight glasses, thermometers and other devices to verify sufficient water flow.

K. Miscellaneous Unit Refrigerant Piping: Provide all interconnecting refrigerant piping between the chiller, refrigerant recovery unit, compressor and condenser, and remote refrigerant storage vessel, if required.

L. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.

## 3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and gages are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. Verify that refrigerant pressure relief device is vented outside.
8. Verify proper motor rotation.
9. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
10. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
11. Verify and record performance of chiller protection devices.
12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.

C. Prepare test and inspection startup reports.

## 3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train LAWA's maintenance personnel to adjust, operate, and maintain chillers. Video record the training sessions. Provide 40 hour training sessions on site with equipment fully operational, minimum 15 LAWA personnel, 16 hours shall be classroom training and 24 hours shall be hands-on training.

## 3.6 FACTORY PERFORMANCE TESTS

A. Manufacturer shall conduct factory performance test for each chiller in accordance with ARI 550/590-98, to verify design capacity and part load capacity points indicated on Bid form. LAWA and/or LAWA's representative (2 persons) may elect to witness tests. Notify LAWA and/or LAWAs representative of test date at least 2 weeks in advanced. There will be zero tolerance on capacity and NPLV, other parameters are per ARI 550/590 tolerance.

B. Before shipment of chillers, all records and certifications approving testing requirements shall be submitted to and approved by LAWA.

C. Defective work or material shall be replaced or repaired, as necessary, and inspection and test repeated. Repairs shall be made with new materials. Run new performance test in accordance with ARI standard.

D. If chiller assembly fails to meet design capacity and a minimum of 15% more capacity at lower condenser water temperature, LAWA may elect not to accept delivery until chiller is modified at manufacturer's expense to meet design capacity.

E. If chiller assembly fails to meet any of part load performance data supplied by manufacturer with his bid, LAWA may elect not to accept delivery until chiller is modified at manufacturer's expense to meet all of design and part load performance data or to assess penalty charge equal to 10 years operating cost differential. This differential is to be determined by using part load data included in bid form and data obtained from performance test, subtracting bid data annual operating cost from test data annual operating cost, and multiplying difference by ten. Penalty charge shall apply to all chillers.

F. All design conditions and part load performance data shall be evaluated with 480 volt, 3-phase, 60 hertz power supplied to chiller.

G. Conduct test at approved ARI certified test facility of the manufacturer.

H. Instrumentation used for testing must be calibrated within 6 months of test date and traceable to National Bureau of Standards. Documentation verifying NBS traceability shall be submitted to LAWA.

1. Performance test shall be two-point test for one chiller. Points will be selected at time of test. Points will be selected from submitted performance from 25 to 100% of capacity.

## 3.7 COMMISSIONING

A. The manufacturer shall be present during all commissioning events. The anticipated schedule is for commissioning to occur during the least six to eight weeks of construction just prior to the anticipated end of construction date of. Include 40 hours of field time to perform the commissioning requirements.

B. A factory-authorized representative shall perform the startup service.

1. Fill out startup checklists and attach copy with Contractor Startup Report.

C. Complete installation and startup checks according to manufacturer's written instructions and check for the following items:

1. No physical damage to unit.
2. Unit is level.
3. Chiller vibration isolation and flexible pipe connections are installed.
4. Clearances have been maintained and piping is installed for easy removal for service and tube cleaning.
5. Chilled and condenser water pipes have been connected to correct ports.
6. Labels and safety instructions are clearly visible.
7. Oil levels are as recommended by manufacturer.
8. Refrigerant charge is sufficient and chiller has been leak tested.
9. Shipping skids, blocks and straps are removed.
10. Refrigerant pressure relief is vented to outside.
11. Thermometers and pressure gauges are installed.
12. Controls and safety interlocks are installed and connected.
13. Pumps are installed, connected and operational.

D. Check and record performance of chiller protection devices.

E. Check and record performance of chilled and condenser water flow and low temperature interlocks.

F. Operate chiller for run-in period as recommended by manufacturer.

G. Check static deflection of vibration isolators, including deflection during chiller startup and shutdown.

1. Check refrigerant charge. Check oil level.

## 3.8 CLEANING

A. After completion of system installation, start-up, testing and prior to commissioning, completely and thoroughly clean up the chillers from any foreign material and construction dirt and dust.

END OF SECTION 23 64 16

# SECTION 23 65 00 - COOLING TOWERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Open-circuit, induced-draft, counterflow cooling towers.
2. Basin water level controls.
3. Closed circuit fluid coolers and/or condensers are also acceptable, subject to meeting the capacity requirements.

B. Cooling towers are specified herein for reference only and will be for temporary use.

C. Cooling tower shall operate in a manner that no visible plume is produced. If necessary provide gas fired heaters or HW coils for cooling tower discharge for plume abatement.

### 1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME).

1. Boiler and Pressure Vessel Code, Section VIII, Division 1, “Rules for Construction of Pressure Vessels”.
2. Performance Test Code PTC 23, “Atmospheric Water Cooling Equipment”.

B. Cooling Technology Institute (CTI).

C. Standard 201, “Standard for the Certification of Water-Cooling Tower Thermal Performance”.

D. Acceptance Test Code ATC 105, “Acceptance Test Code for Water Cooling Towers”.

1. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

E. Standard 90.1, “Energy Standard for Building Except Low-Rise Residential Buildings”.

1. National Fire Protection Association (NFPA).

F. Standard 70, “National Electrical Code”.

1. American National Standards Institute (ANSI).
2. American Society for Testing and Materials (ASTM).
3. Institute of Electrical and Electronics Engineers (IEEE).
4. National Electrical Manufacturers Association (NEMA).

G. Factory Mutual (FM).

H. Underwriters Laboratories (UL).

## 1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design:Design cooling tower support structure and seismic restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Cooling tower support structure shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.

1. Dead Loads: By Structural Engineer
2. Live Loads: By Structural Engineer
3. Roof Loads: By Structural Engineer
4. Snow Loads: By Structural Engineer
5. Seismic Loads: By Structural Engineer
6. Wind Loads: By Structural Engineer
7. Deflection Limits: By Structural Engineer

C. Seismic Performance: Cooling towers shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

D. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

## 1.4 SUBMITTALS

A. Product Data: Include rated capacities, pressure drop, fan performance data, rating curves with selected points indicated, materials of construction, furnished specialties, and accessories.

1. Maximum flow rate.
2. Minimum flow rate.
3. Drift loss as percent of design flow rate.
4. Volume of water in suspension for purposes of sizing a remote storage tank.
5. Sound power levels in eight octave bands for operation with fans off, fans at minimum, and design speed.
6. Performance curves for the following:

    a. Varying entering-water temperatures from design to minimum.
    b. Varying ambient wet-bulb temperatures from design to minimum.
    c. Varying water flow rates from design to minimum.
    d. Varying fan operation (off, minimum, and design speed).

7. Fan airflow, brake horsepower, and drive losses.
8. Pump flow rate, head, brake horsepower, and efficiency.
9. Motor amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
10. Electrical power requirements for each cooling tower component requiring power.

B. Shop Drawings: Complete set of manufacturer's prints of cooling tower assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Sizes and locations of piping and wiring connections.
5. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For cooling tower support structure indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of support structure.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

D. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

E. Certificates: Provide certificate from manufacturer.

F. Seismic Qualification Certificates: For cooling towers, accessories, and components, from manufacturers.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

G. Source quality-control reports.

H. Field quality-control reports.

I. Startup service reports.

J. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals. Include start-up instructions, maintenance data, parts lists, controls, accessories, and trouble-shooting guide.

## 1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:

1. Fan assembly including fan, drive, and motor.
2. All components of cooling tower.
3. Warranty Period: Five (5) years.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit start-up instructions, maintenance data, parts lists, controls, and accessories.

# PART 2 - PRODUCTS

## 2.1 OPEN-CIRCUIT, INDUCED-DRAFT, COUNTERFLOW COOLING TOWERS

A. Products: Subject to compliance with requirements, provide one of the following:

**1. Baltimore Aircoil Company.**
**2. Delta Cooling Towers.**
**3. Evapco.**

B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.

C. Cooling tower designed to resist wind load of 30 lbf/sq. ft.

D. Casing and Frame:

1. Casing and Frame Material: Stainless steel, Type 304.

E. Collection Basin:

1. Material: Stainless steel, Type 304.
2. Strainer: Removable stainless-steel strainer with openings smaller than nozzle orifices.
3. Overflow and drain connections.
4. Makeup water connection.
5. Outlet Connection: ASME B16.5, Class 150 flange.
6. Removable equalization flume plate between adjacent cells of multiple-cell towers.
7. Equalizer connection for field-installed equalizer piping.
8. Basin Sweeper Distribution Piping and Nozzles:

    a. Pipe Material: PVC.
    b. Nozzle Material: Plastic.
    c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.

F. Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve:

1. Enclosure: NEMA 250, Type 4.
2. Sensor: Solid-state controls with multiple electrode probes and relays factory wired to a terminal strip to provide control of water makeup valve, low- and high-level alarms, and output for shutoff of pump on low level.
3. Electrode Probes: Stainless steel.
4. Water Stilling Chamber: Corrosion-resistant material.
5. Solenoid Valve: Slow closing with stainless-steel body; controlled and powered through level controller in response to water-level set point.
6. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

G. Pressurized Water Distribution Piping: Main header and lateral branch piping designed for even distribution over heat-exchanger coil or fill throughout the flow range without the need for balancing valves and for connecting individual, removable, nonclogging spray nozzles.

1. Pipe Material: PVC.
2. Spray Nozzle Material: PVC.
3. Piping Supports: Corrosion-resistant hangers and supports to resist movement during operation and shipment.

H. Fill:

1. Materials: PVC, resistant to rot, decay, and biological attack; with maximum flame-spread index of 5 according to ASTM E 84.
2. Minimum Thickness: 15 mils before forming.
3. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
4. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 deg F.

I. Removable Drift Eliminator:

1. Material: Fiberglass reinforced plastic; resistant to rot, decay, and biological

attack; with maximum flame-spread index of 5 according to ASTM E 84.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.

J. Air-Intake Louvers:

1. Material: Matching casing.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.

K. Removable Air-Intake Screens: Stainless-steel wire mesh.

L. Axial Fan: Balanced at the factory after assembly.

1. Blade Material: Aluminum.
2. Hub Material: Aluminum.
3. Blade Pitch: Field adjustable.
4. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens, complying with OSHA regulations.
5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of 50,000 hours.
6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

M. Belt Drive:

1. Service Factor: 1.5 based on motor nameplate horsepower.
2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.

    a. Belt: Multiple V-belt design with a matched set of cogged belts.
    b. Belt: One-piece, multigrooved, solid-back belt.
    c. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
    d. Belt-Drive Guard: Comply with OSHA regulations.

N. Direct Drive: Fan hub directly connected, and properly secured, to motor shaft.

O. Fan Motor:

1. Motor Enclosure: Totally enclosed fan cooled (TEFC).
2. Service Factor: 1.15.
3. Insulation: Class F.
4. Variable-Speed Motors:

| GUARANTEED MINIMUM FULL LOAD EFFICIENCY OF MOTORS | | |
|---|---|---|
| Rated HP | Nominal 1200 RPM | Nominal 1800 RPM |
| 1 | 82.5 | 85.5 |
| 1.5 | 86.5 | 86.5 |
| 2 | 87.5 | 86.5 |
| 3 | 89.5 | 89.5 |
| 5 | 89.5 | 89.5 |
| 7.5 | 91.7 | 91.0 |
| 10 | 91.7 | 91.7 |
| 15 | 92.4 | 93.0 |
| 20 | 92.4 | 93.0 |
| 25 | 93.0 | 93.6 |
| 30 | 93.6 | 94.1 |
| 40 | 94.1 | 94.1 |
| 50 | 94.1 | 94.5 |
| 60 | 95.0 | 95.0 |
| 75 | 95.0 | 95.0 |
| 100 | 95.0 | 95.4 |
| 125 | 95.4 | 95.4 |
| 150 | 95.8 | 95.8 |
| 200 | 95.4 | 95.8 |

5. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
6. Severe-duty rating with the following features:

    a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
    b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F.
    c. Internal heater automatically energized when motor is de-energized.

7. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.

P. Fan Discharge Stack: Material shall match casing, manufacturer's standard design.

1. Stack Extension: Fabricated to extend above fan deck.
2. Stack Termination: Wire-mesh, stainless-steel screens.

Q. Gear-Drive, Oil-Level Switch: Low-oil-level warning switch for connection to a BMS.

1. Switch shall, on reaching a low-oil-level set point recommended by cooling tower manufacturer, signal an alarm through the BMS.

R. Controls: See Section "Building Automation System."

S. Control Package: Factory installed and wired, and functionally tested at factory before shipment.

1. NEMA 250, Type 4X enclosure with removable internally mount backplate.
2. Control-circuit transformer with primary and secondary side fuses.
3. Terminal blocks with numbered and color-coded wiring to match wiring

diagram. Spare wiring terminal block for connection to external controls or equipment.

4. Microprocessor-based controller for automatic control of fan based on cooling tower leaving water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
5. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
6. Collection basin level controller complying with requirements in "Electric/Electronic, Collection Basin Water-Level Controller with Solenoid Valve" Paragraph.
7. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
8. Oil-level switch for each fan with a gear drive, complying with requirement in "Gear-Drive, Oil Level Switch" Paragraph.
9. Single-point, field-power connection to a circuit breaker.

    a. Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker.
    b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

10. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor with liquidtight conduit.
11. Visual indication of status and alarm with momentary test push button for each motor.
12. Audible alarm and silence switch.
13. Visual indication of elapsed run time, graduated in hours for each motor.
14. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:

    a. Operational status of each motor.
    b. Position of dampers.
    c. Cooling tower leaving-fluid temperature.
    d. Fan vibration alarm.
    e. Oil-level alarm.
    f. Collection basin high- and low-water-level alarms.

T. Personnel Access Components:

1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
2. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
3. External Platforms with Handrails: Stainless-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.

4. Handrail: Stainless steel complete with kneerail and toeboard, around top of cooling tower. Comply with 29 CFR 1910.23.
5. Internal Platforms: Stainless-steel bar grating.

    a. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
    b. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

## 2.1 SOURCE QUALITY CONTROL

A. Verification of Performance: Test and certify cooling tower performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

B. Factory pressure test heat exchangers after fabrication and prove to be free of leaks.

C. Shop Inspection – 2 LAWA personnel.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Maintain manufacturer's recommended clearances for service and maintenance.

B. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

## 3.2 CONNECTIONS

A. Install piping adjacent to cooling towers to allow service and maintenance.

B. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.

C. Provide drain piping with valve at cooling tower drain connections and at low points in piping.

D. Connect cooling tower overflows and drains, and piping drains to sanitary sewage system.

E. Domestic Water Piping: Connect to water-level control with shutoff valve and union, flange, or mechanical coupling at each connection.

F. Supply and Return Piping: Connect to entering cooling tower connections with shutoff valve, balancing valve, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve. Connect to leaving cooling tower connection with shutoff valve. Make connections to cooling tower with a union, flange, or mechanical coupling.

G. Equalizer Piping: Piping requirements to match supply and return piping. Connect an equalizer pipe, full size of cooling tower connection, between tower cells. Connect to cooling tower with shutoff valve.

## 3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform field tests and inspections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections: Comply with ASME PTC 23, "ASME Performance Test Codes - Code on Atmospheric Water Cooling Equipment."

E. Cooling towers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

## 3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Obtain performance data from manufacturer.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

a. Clean entire unit including basins.
b. Verify that accessories are properly installed.
c. Verify clearances for airflow and for cooling tower servicing.
d. Check for vibration isolation and structural support.
e. Lubricate bearings.
f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
g. Adjust belts to proper alignment and tension.

h. Verify proper oil level in gear-drive housing. Fill with oil to proper level.
i. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
j. Check vibration switch setting. Verify operation.
k. Verify water level in tower basin. Fill to proper startup level. Check makeup water-level control and valve.
l. Verify operation of basin heater and control.
m. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
n. Replace defective and malfunctioning units.

D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.

E. Prepare a written startup report that records the results of tests and inspections.

## 3.5 ADJUSTING

A. Set and balance water flow to each tower inlet.

B. Adjust water-level control for proper operating level.

## 3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train LAWA's maintenance personnel to adjust, operate, and maintain cooling towers. Training to include minimum of 15 personnel for 40 hours training, 16 hours shall be classroom training and 24 hours shall be hands-on training.

END OF SECTION 23 65 00

# SECTION 23 74 13 - CENTRAL-STATION AIR-HANDLING UNITS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes modular factory fabricated air-handling units and accessories for indoor and outdoor installation.

**NOTE:** Provide structural calculations and supporting analysis that the additional roof /floor load does not increase the force in any adjacent structural element by more than 5%. If the increase is greater than 5% demonstrate that the structural elements and their lateral resistance are in compliance with the Los Angeles Building Code.

Provide the following details to LAWA:

- The operational weight of the new equipement.
- The location of the center of gravity.
- Points of anchorage to the existing structure.

In addition, provide details and calculations pertaining to any new roof openings such as access hatches or any other new openings that relate to the installation of the new air handling units.

### 1.2 REFERENCES

A. American Bearing Manufacturers Association:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.:

1. AMCA 99 - Standards Handbook.
2. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
3. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
4. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
5. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

C. Air-Conditioning and Refrigeration Institute:

1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
2. ARI 430 - Central-Station Air-Handling Units.
3. ARI Guideline D - Application and Installation of Central Station Air-Handling Units.

D. National Electrical Manufacturers Association:

1. NEMA MG 1 - Motors and Generators.

E. Sheet Metal and Air Conditioning Contractors:

1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

F. Underwriters Laboratories Inc.:

1. UL 900 - Air Filter Units.
2. UL - Fire Resistance Directory.

G. NRCA standards.

## 1.3 SUBMITTALS

A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

B. Product Data, Submit the following:

1. Published Literature: Indicate capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
3. Fans: Performance and fan curves with specified operating point plotted, power, RPM.
4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
5. Dampers: Include leakage, pressure drop, and sample calibration curves. Indicate materials, construction, dimensions, and installation details.
6. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring. Indicate factory installed and field installed wiring.
7. Clearly identify the type of Coating(s) being proposed for use.

C. Manufacturer's Installation Instructions

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

## 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

## 1.5 QUALITY ASSURANCE

A. All items shall be in accordance with the requirements dictated by the City of Los Angeles Department of Building and Safety, and LAWA standards.

## 1.6 WARRANTY

A. Furnish five year manufacturer warranty for air handling units and drives.

## PART 2 - PRODUCTS

## 2.1 AIR HANDLING UNITS

A. Manufacturers:

1. **Temtrol.**
2. **Energy Labs.**
3. **Pace.**

B. Performance Base: Sea level.

C. Roof Curb: Required.

> **NOTE:** All roof top equipment shall be curb mounted. A 6 inch high concrete curb is also required for interior installations.

1. Factory assembled galvanized steel mounting curb designed and manufactured by unit manufacturer.
2. Perimeter type with support of air handling sections.
3. Furnish supply and return opening duct frames as part of curb structure allowing duct connections to be made directly to curb.
4. Minimum of 12 inches high.
5. Furnish gaskets for field mounting.

## 2.2 CASING

A. Channel base of welded steel. Assemble sections with gaskets and bolts.

B. Outside Casing:

1. Galvanized Steel: 0.0635 inch (16 gage).
2. Seal fixed joints with flexible weather tight sealer. Seal removable joints with closed-cell foam gasket.
3. Furnish cap strips over roof flanges. Furnish rain caps and gaskets on access doors.

C. Outside Casing Finish:

> **NOTE:** Coating is required due to LAX marine environment and the nearby Hyperion plant.

1. Zinc chromate, iron oxide, shop coated with 4.0 mils epoxy primer and 6.0 mils topcoat phenolic baked coating for a total of 10.0 mils. Coating shall withstand 5,000 hour of salt spray test in accordance with ASTM B117.
2. Finish exceeds 5000 hour salt spray test in accordance with ASTM B117.
3. Color: As selected by LAWA.

D. Inside Casing:

1. Galvanized Steel: Perforated 0.336 inch thick (22 gage) at fan section.
2. Galvanized Steel: Solid, 0.032 inch thick (20 gage).
3. Stainless Steel: Solid, 0.0375 inch thick (20 gage) at CHW coil section.
4. Shop coated with 4.0 mils epoxy primer and 6.0 mils topcoat phenolic baked coating for a total of 10.0 mils. Coating shall withstand 5,000 hour of salt spray test in accordance with ASTM B117.

E. Floor Plate:

1. Galvanized Steel: 0.0635 inch thick (16 gage) at inner floor with phenolic coating.
2. Galvanized Steel: 0.0396 inch thick (20 gage) at bottom floor.
3. Shop coated with 4.0 mils epoxy primer and 6.0 mils topcoat phenolic baked coating for a total of 10.0 mils. Coating shall withstand 5,000 hour of salt spray test in accordance with ASTM B117.

F. Insulation: Neoprene coated, glass fiber, applied to internal surfaces with adhesive and weld pins with exposed edges of insulation coated with adhesive.

1. 'K' factor at 75 degrees F: Maximum 0.26 Btuh inch/ sq ft/ degrees F.
2. Density: 4 inch thick, 3lbs/cu ft.

G. Inspection Doors: 10 x 10 inch of galvanized steel for flush mounting, with gasket, latch, and handle assembly and 1/4 inch thick Plexiglas inspection window. Furnish welded channel frame to set door out from casing to permit external insulation.

H. Walk-in Access Doors: 24 x 60 inch Galvanized steel insulated sandwich construction, for flush mounting, with hinges, gasket, latch, and handle assemblies, and 12 x 12 inch inspection window of 1/4 inch thick Plexiglas. Furnish welded channel frame to set door out from casing to permit external insulation.

I. Lights: Located in accessible sections suitable for damp locations with wire guards, factory wired to weatherproof switch and pilot light and duplex outlet mounted on casing exterior.

J. Drain Pans: Double thickness stainless steel with insulation between layers with welded corners. Cross break and pitch to drain connection. Furnish drain pans under mixing section cooling coil section. For units with multiple coils, provide drain pans for each coil section.

K. Bottom Inlet Units: Furnish steel or aluminum walking grate on structural supports.

L. Strength: Furnish structure to brace casings for suction pressure of 5 inch wg, with maximum deflection of 1 in 200.

M. Louvers: Stationary, of galvanized steel, 4 inch deep with plenum, nylon bearings, 1/2 inch mesh, 0.04 inch galvanized wire bird screen in aluminum frame, and bearing AMCA Certified Ratings Seal in accordance with AMCA 500.

## 2.3 FANS

A. Type: Double inlet, centrifugal type fan.

B. Performance Ratings: Conform to AMCA 210 and label with AMCA Certified Rating Seal.

C. Sound Ratings: AMCA 301, tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.

D. Bearings: Self-aligning, grease lubricated, ball or roller bearings with lubrication fittings extended to exterior of casing with copper tube and grease fitting rigidly attached to casing.

E. Mounting: Locate fan and motor internally on welded steel base coated with corrosion resistant paint. Factory mount motor on slide rails. Furnish access to motor, drive, and bearings through removable casing panels or hinged access doors. Mount base on spring vibration isolators.

F. Fan Modulation: Variable Frequency Drive. See Section on VARIABLE FREQUENCY DRIVES.

G. Flexible Connection: Separate unit from connecting ductwork.

**NOTE:** Fan-Wall systems may be considered in lieu of centrifugal plug fans.

## 2.4 BEARINGS AND DRIVES

A. Bearings: Pillow block type, self-aligning, grease-lubricated ball bearings, with ABMA 9 L-50 life at 100,000 hours or roller bearings, or ABMA 11, L-50 life at 400,000 hours.

B. Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

C. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts, and keyed. Variable and adjustable pitch sheaves for motors 15 hp and under selected so required rpm is obtained with sheaves set at mid-position; fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.

D. Belt Guard: Fabricate to SMACNA Standard; 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

## 2.5 COILS

A. Casing with access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.

B. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high. All drain pans shall be stainless steel.

C. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with ARI 410.

D. Fabrication:

1. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
2. Fins: Copper.
3. Casing: Die formed channel frame of stainless steel.
4. All coils shall be coated with minimum 1.0 mil. aluminum impregnated polyurethane coating by Blygold PoluAl XT or approved equal. Coating shall withstand 4,000 hours in both salt spray test per ASTM B117 and acid salt spray test per ASTM D5339. Finned-tube coils applied coating shall have 5 year warranty.
5. Provide five (5) year warranty for all coils.

E. Water Heating Coils:

1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
2. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.

F. Water Cooling Coils:

1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

G. Refrigerant Coils:

1. Headers: Seamless copper tubes with silver brazed joints.
2. Liquid Distributors: Brass or copper venturi distributor with seamless copper distributor tubes.
3. Configuration: Down feed with bottom suction.

## 2.6 FILTERS

A. Various filter types are specified in HVAC AIR CLEANING DEVICES.

**NOTE:** Provide MERV 8 pre-filter, MERV 13 final filter, carbon filter and bipolar ionization unit.

## 2.7 DAMPERS

A. Mixing Boxes: Section with factory mounted outside and return air dampers of galvanized steel with vinyl bulb edging and edge seals in galvanized frame, with galvanized steel axles in self-lubricating nylon bearings, in opposed blade arrangement

B. Outside Air Damper Leakage: Maximum 3.0 cfm per square foot at 1.0 inches wg pressure differential.

C. Damper Leakage: Maximum 2 percent at 4 inch wg differential pressure when sized for 2000 fpm face velocity.

D. Damper Actuators: Furnish factory installed electric damper actuators for outside air, return air, and exhaust air dampers.

## 2.8 OUTSIDE AIR MEASURING AND MODULATION DEVICE

A. Factory mounted in outside air and return air openings.

B. Damper and airflow measurement assembly sized to accommodate economizer outside airflow.

C. Construction:

1. Frame: Extruded aluminum.
2. Blades:

    a. Modulating Air Control:

        1) Style: Airfoil-shaped, single-piece.
        2) Action: Parallel.
        3) Orientation: Horizontal.
        4) Material: Heavy gage 6063-T5 extruded aluminum.
        5) Width: Maximum 5 inches.

    b. Stationary Sensing:

        1) Style: Airfoil-shaped, single-piece.
        2) Orientation: Horizontal.
        3) Material: Heavy gage 6063-T5 extruded aluminum.
        4) Width: Maximum 5-1/4 inches.
        5) Finish: Anodized.

3. Bearings: Self-lubricating molded synthetic sleeve, turning in extruded hole in frame.
4. Seals:

    a. Blade: Extruded rubber. Mechanically attached to blade edge.
    b. Jamb: Stainless steel, flexible metal compression type.
    c. Linkage: Concealed in frame.

d. Axles: Minimum 1/2 inch diameter plated steel, hex-shaped, mechanically attached to blade.
e. Mounting: Vertical.
f. Electric Actuator: 24 V, 60 Hz, modulating, with position feedback.

5. Digital Controller: Application specific controller. Programming logic and calibration in nonvolatile EPROM. Controller uses generic 0 - 10 vdc inputs and outputs for interface to building automation system.
6. Air Straightener Section: 3 inches deep section contained in 5 inch long sleeve attached to damper-airflow monitor frame.
7. Finish: Mill aluminum.

D. Performance Data:

1. Temperature Rating: Withstand -40 to 140 degrees F.
2. Accuracy: Plus or minus 5 percent.
3. Leakage: Maximum of 2.0 cfm per square foot at 1.0 inches wg pressure differential.
4. Measures from 15 percent to 100 percent of unit nominal air flow.
5. Adjusts air flow for temperature variations.
6. Provides 2 to 10 volt DC signal corresponding to actual air flow.

GUARANTEED MINIMUM FULL LOAD EFFICIENCY OF MOTORS

| Rated HP | Nominal 1200 RPM | Nominal 1800 RPM |
|---|---|---|
| 1 | 82.5 | 85.5 |
| 1.5 | 86.5 | 86.5 |
| 2 | 87.5 | 86.5 |
| 3 | 89.5 | 89.5 |
| 5 | 89.5 | 89.5 |
| 7.5 | 91.7 | 91.0 |
| 10 | 91.7 | 91.7 |
| 15 | 92.4 | 93.0 |
| 20 | 92.4 | 93.0 |
| 25 | 93.0 | 93.6 |
| 30 | 93.6 | 94.1 |
| 40 | 94.1 | 94.1 |
| 50 | 94.1 | 94.5 |
| 60 | 95.0 | 95.0 |
| 75 | 95.0 | 95.0 |
| 100 | 95.0 | 95.4 |
| 125 | 95.4 | 95.4 |
| 150 | 95.8 | 95.8 |
| 200 | 95.4 | 95.8 |

## 2.9 CONTROLS

A. Coordinate with the Building Automation System for the Terminal.

## 2.10 ELECTRICAL

A. Motor:

1. Enclosure Type: Totally enclosed, fan cooled.
2. Inverter duty, NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
3. Motors must be “matched” with variable frequency drives.

B. Electrical Requirements

1. Where unit-mounted disconnects are provided, mount unit-mounted disconnect switches on exterior of unit.
2. Variable Frequency Controllers shall be factory mounted in a ventilated compartment which is part of the air handling unit and factory wired to motors and controls. Access shall be through a louvered access door. The access door shall be flush with the outside of unit.

## 2.11 FACTORY TESTING

A. The following testing shall be provided on a minimum of three units. LAWA shall select the three units to be tested. **Manufacturer shall include cost of travel to allow two LAWA's representatives to witness all factory tests.** Manufacturer shall provide a written report of all test results to the Contractor and LAWA as part of the shop drawing process. In the event that tested units do not meet performance requirements (Including but limited to leak, deflections, air volume, Sound), manufacturer shall provide enhancements, within the requirements of this specification, until unit meets testing requirements. In the event that two or more units do not meet performance requirements, LAWA shall select an additional three units for testing – and the above requirements shall be applicable to newly tested units.

B. Factory Leak Test

1. Factory test shall verify that unit casing leakage is less than 0.5% of design airflow at 1 ½ times design static pressure or a maximum of 10 in. w.g. Unit openings shall be sealed. A pressure blower shall be connected to the air-handling unit and adjusted to provide the test pressure. At the manufacturer's option, the unit shall be either positively or negatively pressurized. CFM shall be measured using a calibrated orifice. The measured CFM shall be considered casing leakage. Casing leakage must not exceed 0.5% of design CFM

C. Factory Cabinet Deflection Test:

1. Air handling unit manufacturer shall provide Panel Deflection Test on units in conjunction with the Casing Leakage Test. Panel deflection test shall verify casing deflection is less than 1/240 of longest plane being measured at design static pressure or a maximum of 10 in. w.g. The casing deflection shall be measured at mid point of panel and at panel seam.

D. Factory Air Performance Test:

1. Air handling unit manufacturer shall test at an AMCA Accredited Laboratory for air performance per AMCA Standard 210-99. For air handlers with air volumes below 65000 CFM, air volume shall be determined using a multiple nozzle chamber that meets the requirements of AMCA 210-99 (Laboratory Methods for Performance Testing) figure 12 or 15. Measured air volume, static pressure, and RPM shall be shall be within the tolerance limits of AMCA Standard 211 (Certified Ratings Program Air Performance).

E. Factory Sound & Air Performance Test:

1. Air handling unit manufacturer shall test a minimum of three units at an AMCA Accredited Laboratory for airflow testing in accordance with AMCA Standard 210-99 and sound testing in accordance with AMCA Standard 300-96. Specified air volume shall first be confirmed in accordance with AMCA standard 210-99 (Laboratory Methods of Testing Fans for Performance Rating). Air Volume, static pressure, and RPM shall be within the tolerance limits of AMCA Standard 211 (Certified Ratings Program Air Performance).
2. Once design operating point has been confirmed, the submitted sound power levels for both inlet and outlet shall be measured per AMCA Standard 300-96 (Reverberant Room

Method for Testing of Fans) and the relevant parts of ARI Standard 260-01 (Sound Rating of Ducted Air Moving and Conditioning Equipment). The total air handling unit volume shall not exceed 5% of the volume of the reverberant room. The reverberant room used for testing shall be qualified to perform narrow band measurements in accordance with AMCA Standard 300-96 Appendix B. All measurements shall be taken in 1/3 octave bands. If applicable, duct end correction and elbow corrections shall be calculated per ARI Standard 260-01. The test results will verify that inlet and outlet sound power levels are within the tolerance limits of AMCA-311 (Certified Sound Ratings Program) of the specified levels.

3. Sound power data shall be given at the supply connection(s) and return connection(s) in addition to radiated sound power from the cabinet. Raw fan sound power data shall be derived from tests done on the same sizes and types of fans scheduled. Data extrapolated from non-like fan sizes and types scheduled, is not acceptable. Attenuation assumed for cabinet configuration, type of insulation, opening locations, and sizes, etc., shall be verified through actual test measurements.
4. Alternate equivalent method of testing may be acceptable, subject to meeting the requirements and intent stated above.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install flexible connections between unit and inlet and discharge ductwork. Install metal bands of connectors parallel with minimum 1 inch flex between ductwork and fan while running.

B. Install assembled units with minimum 2” vibration isolators on minimum 4” high level platform. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining seismic snubbers as indicated. Adjust snubbers to prevent tension in flexible connectors when fan is operating.

C. Install condensate piping with trap and route from drain pan to nearest approved roof receptacle, direct connection to lavatory waste, or air gap to janitor sink.

D. Provide sheaves required for final air balance if required.

E. Insulate coil headers located outside airflow as specified for piping.

### 3.2 INSTALLATION CHILLED WATER COOLING COIL

A. Make connections to coils with unions or flanges.

B. Connect water supply to leaving airside of coil (counter flow arrangement).

C. Locate water supply at bottom of supply header and return water connection at top.

D. Install water coils to allow draining and install drain connection at low points.

E. Install the following piping accessories on chilled water piping connections.

1. On supply:

    a. Thermometer well and thermometer.
    b. Well for control system temperature sensor.
    c. Shutoff valve.
    d. Strainer.
    e. Control valve.
    f. Pressure gage.

2. On return:

    a. Thermometer well and thermometer.
    b. Well for control system temperature sensor.
    c. Pressure gage.
    d. Shutoff valve.
    e. Balancing valve or Flow control valve.

## 3.3 INSTALLATION HOT WATER HEATING COIL

A. Same as for chilled water coil.

## 3.4 MANUFACTURER'S FIELD SERVICES

A. Furnish services of factory trained representative for minimum of one day to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct LAWA on operation and maintenance. Training to include minimum of 8 LAWA personnel for 40 hours training, 16 hours shall be classroom training per person and 24 hours shall be hands-on training per person.

## 3.5 CLEANING

A. Vacuum clean coils and inside of unit cabinet.

B. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

## 3.6 PROTECTION OF FINISHED WORK

A. Do not operate units until units and ductwork are clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION 23 74 13

# SECTION 23 81 03-PACKAGED ROOFTOP AIR CONDITIONING UNITS – NON-CUSTOM

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Packaged rooftop air conditioning unit (5 tons and smaller).
2. Roof curb.

### 1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
3. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.

B. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
2. ASHRAE 62 - Ventilation for Acceptable Indoor Air Quality.
3. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

D. ASTM International:

1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

E. National Fire Protection Association:

1. NFPA 54 - National Fuel Gas Code.
2. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

### 1.3 SUBMITTALS

A. Product Data: Submit data indicating:

1. Cooling and heating capacities.
2. Dimensions.
3. Weights.

4. Rough-in connections and connection requirements.
5. Duct connections.
6. Electrical requirements with electrical characteristics and connection requirements.
7. Controls.
8. Accessories.

B. Test Reports: Submit results of factory test at time of unit shipment.

C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

E. Manufacturer’s Field Reports: Submit start-up report for each unit.

## 1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of controls installed remotely from units.

B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

## 1.5 WARRANTY

A. Furnish five year manufacturer’s warranty for compressors.

B. Furnish five year manufacturer’s warranty for heat exchangers.

C. Furnish five year manufacturer’s warranty for condenser coils.

## 1.6 MAINTENANCE SERVICE

A. Furnish service and maintenance of equipment for one year from Date of Substantial Completion. Include maintenance items as shown in manufacturer's operating and maintenance data, including filter replacements, fan belt replacement, and controls checkout and adjustments.

B. Furnish 24-hour emergency service on breakdowns and malfunctions for this maintenance period.

# PART 2 - PRODUCTS

## 2.1 ROOFTOP AIR CONDITIONING UNITS

A. Manufacturers:

1. **Carrier**
2. **Trane**
3. **York**

B. Product Description: Self-contained, packaged, factory assembled and wired, consisting of roof curb, cabinet, supply fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, gas-fired heating section, air filters, mixed air casing, controls, and accessories.

C. Roof Mounting Curb: 14 inch high, galvanized steel, channel frame with gaskets, nailer strips. Full perimeter type for mounting under entire unit.

D. Cabinet:

1. Designed for outdoor installation with weatherproof construction.
2. Panels: Constructed of galvanized steel with baked enamel finish meeting salt spray test in accordance with ASTM B117. Furnish access doors or removable access panels.
3. Insulation: Factory applied to exposed vertical and horizontal panels. Minimum one inch thick neoprene coated glass fiber with edges protected from erosion.

E. Supply Fan: Forward curved centrifugal type, resiliently mounted with direct drive or V-belt drive, adjustable variable pitch motor pulley high efficiency motor. Motor permanently lubricated with built-in thermal overload protection.

F. Evaporator Coil: Constructed of copper tubes expanded onto copper fins. Stainless steel drain pan with piping connection. Factory leak tested under water.

G. Compressor: Hermetically sealed, resiliently mounted with positive lubrication, and internal motor overload protection. Furnish internal vibration isolators, short cycle protection.

H. Refrigeration circuit: Furnish the following for each circuit thermal expansion valve, filter-drier, suction, discharge, and liquid line service valves with gauge ports, high and low pressure safety controls. Dehydrate and factory charge each circuit with oil and refrigerant.

I. Condenser:

1. Coil: Copper tube copper fin coil assembly and coil guard. Factory leak tested under water.
2. Condenser Fan: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Motor permanently lubricated with built-in thermal overload protection. Furnish high efficiency fan motors.

J. Gas-Fired Heating Section:

1. Fuel: Natural gas if so scheduled.
2. Heat Exchangers: Stainless steel, welded construction.
3. Gas Burner: Induced draft type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shut-off pilot. Require unit fan operation before allowing gas valve to open.

K. Air Filters: 2 inch thick glass fiber disposable media in metal frames. 25 to 30 percent efficiency based on ASHRAE 52.1.

L. Mixed Air Casing:

**NOTE:** Include additional filtration similar to custom package units.

1. Economizer: Factory installed fully modulating motorized outside air and return air dampers controlled by dry bulb controller with minimum position setting. Outside air damper normally closed and return air damper normally open. Furnish barometric relief damper capable of closing by gravity. Furnish rain hood with screen. Provide economizer components and controls.

M. Controls:

1. Furnish control to provide low ambient cooling to 0 degrees F.
2. Furnish low limit thermostat in supply air to close outside air damper and stop supply fan.
3. Furnish terminal strip on unit for connection of operating controls to remote panel.
4. Thermostat: 365 days programmable electronic space thermostat with 1 stage heating and 2 stage cooling with manual changeover and heating setback and cooling setup capability.
5. Furnish interface to Building Automation System.
6. Microprocessor Based Controls:

    a. Factory mounted with the following features:

        1) Monitor each mode of operation.
        2) Evaporator fan status.
        3) Filter status.
        4) Indoor air quality.
        5) Supply air temperature.
        6) Outdoor air temperature.

    b. Diagnostics for thermostat or temperature sensor commands for staged heating, staged cooling, fan operation, and economizer operation.
    c. Zone space temperature sensor to interface with microprocessor controls with Automatic programmable with night setback.

N. Accessories:

1. Convenience Outlet: Factory installed, 115 volt, 15 amp, GFCI type, internally mounted.
2. Roof Curb Adaptor Package: Furnish duct support hardware to adapt unit to existing roof curb.
3. Factory installed ultraviolet C light located downstream of cooling coil.

## 2.2 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Disconnect Switch: Factory mounted, non-fused type, interlocked with access door, accessible from outside unit, with power lockout capability.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Roof Curb:

1. Assemble roof curb.
2. Install roof curb level.
3. Coordinate curb installation and flashing with other trades.
4. Install units on roof curb providing watertight enclosure to protect ductwork and utility services.
5. Install gasket material between unit base and roof curb.

B. Connect units to supply and return ductwork with flexible connections.

C. Install condensate piping with trap and route from drain pan to condensate drainage system as shown on the drawings.

D. Install components furnished loose for field mounting.

E. Install electrical devices furnished loose for field mounting.

F. Install control wiring between unit and field installed accessories.

G. Install Work in accordance with City of Los Angeles codes and standards.

## 3.2 INSTALLATION - NATURAL GAS HEATING SECTION

A. Connect natural gas piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.

B. Install the following piping accessories on natural gas piping connections.

1. Strainer.
2. Pressure gage.
3. Shutoff valve.
4. Pressure reducing valve.

C. Install natural gas piping accessories above roof and readily accessible.

## 3.3 MANUFACTURER'S FIELD SERVICES

A. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

## 3.4 CLEANING

A. Vacuum clean coils and inside of unit cabinet.

B. Install new throwaway filters in units at Substantial Completion.

C. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

## 3.5 DEMONSTRATION

A. Demonstrate unit operation and maintenance.

END OF SECTION 23 81 03

# SECTION 23 81 06 - PACKAGED ROOFTOP AIR CONDITIONING UNITS - CUSTOM

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes equipment types that contain all the components of the refrigeration process within a single package.

1. Packaged rooftop air conditioning unit (larger than 5 tons).
2. Roof curb.

### 1.2 REFERENCES

A. AMCA Standard 99: Standards Handbook

B. AMCA /ANSI Standard 204: Balance Quality and Vibration Levels for Fans

C. AMCA Standard 210: Laboratory Methods of Testing Fans for Ratings

D. AMCA Standard 300: Reverberant Room Method for Sound Testing of Fans

E. AMCA Standard 500:Test Methods for Louvers, Dampers and Shutters

F. ARI Standards: 210/240, 270, 410, and 435

G. ASHRAE Standard 52: Gravimetric and Dust Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter

H. Unit shall be designed to conform to ANSI/ASHRAE 15, latest revision.

I. Unit shall be certified in accordance with ANSI Z21.47 Standards.

J. ASHRAE/ANSI Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems

K. UL Standard 1995: Heating and Cooling Equipment

L. ASTM A-525: Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

M. Equipment shall be UL or ETL listed.

N. Roof curb shall be designed to conform to NRCA Standards.

## 1.3 SUBMITTALS

A. Product Data: Submit data indicating:

1. Cooling and heating capacities.
2. Dimensions.
3. Weights.
4. Rough-in connections and connection requirements.
5. Duct connections.
6. Electrical requirements with electrical characteristics and connection requirements.
7. Controls.
8. Accessories.

B. Test Reports: Submit results of factory test at time of unit shipment.

C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

D. Manufacturer’s Certificate: Certify products meet or exceed specified requirements.

## 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

## 1.5 TESTING

A. Equipment shall be factory run tested for a minimum of eight hours to ensure proper operation.

B. Factory test shall be witnessed by the Owner’s representative (2 people) prior to shipping to the project site.

# PART 2 - PRODUCTS

## 2.1 MATERIALS

A. Packaged Rooftop Cooling Unit. Provide outdoor rooftop mounted electrically controlled cooling unit utilizing multiple compressors as specified herein for cooling.

B. Manufacturers

**1. Mammoth**
**2. Energy Labs**
**3. Pace**

## 2.2 EQUIPMENT

A. Cabinet and Frame

**NOTE:** Due to the corosive marine environment at the airport, a rust inhibiting high performance coating is mandatory for all exterior mechanical equipment including cabinets and frames. Most standard coatings will quickly deteriorate in this environment thereby exposing the underlying metal and accelerating the corrosion process.

1. The unit base frame shall be fabricated with 6-inch, 10.2 lb. per foot, structural steel C-channel. Structural cross members shall be placed at critical locations to support internal components. Vertical frame members shall be fabricated from formed 11-gauge channels. The unit base frame shall be furnished with lifting lugs capable of accepting cable or chain hooks for rigging. Prior to unit assembly, the entire frame shall be covered with a minimum one-mil coat of air-dried sandstone rust inhibiting coating for maximum corrosion protection.
2. Internal floor liners shall be fabricated from 14-gauge galvanized steel welded to the base frame and sealed to prevent air leakage. The entire unit length shall include an underliner constructed of 20-gauge galvanized steel to contain insulation and provide additional structural support. The air handler cabinet casing shall utilize double wall sandwich construction. The exterior surfaces of the wall shall form the air seal and shall be fabricated from 20-gauge galvanized steel. The interior shall be lined with 20-gauge galvanized steel. The exterior panels shall be galvanized steel, pre-coated with 6.0 mils of phenolic baked coating which will withstand 5,000 hours of salt spray per ASTM B-117 over 4.0 mils epoxy primer for a total of 10.0 mils for marine environments.
3. The unit base shall be insulated with 4-inch, 1-pound density of fiberglass insulation with a minimum R-value of 13. Wall and roof panels shall be insulated with 2-inch, 1-pound density fiberglass with a minimum R-value of 6.9. Compressing 2” insulation between 1” panels is not acceptable. A 4-inch space shall be provided between the air handler top liner and the roof panels to accommodate refrigerant piping and electrical runs. Electrical wiring shall be run in a full-length electrical raceway above the air handler top liner. Exterior roof panels shall be crowned for drainage and easily removable for service access.

B. Access Doors

1. A full-size hinged access door shall be provided for any section requiring service access. Removable casing panels shall not be allowed. Door frame shall be of rigid extruded aluminum. Adhesive-backed gasket applied to the frame shall not be allowed. Access doors shall be thermally broken and provided to the following components at a minimum: supply and return fan motors, supply and return fan inlets, filters, dampers, cooling/heating coils and any other serviceable component. Hinged access doors shall be complete with stainless steel hinges and multiple-point, single-handle compression-type latches to provide quick access and a positive air seal. Latch shall include integral keyed lock. Interior

latch allows door closure during inclement weather. Doors shall include locking type door retainers to protect doors against wind damage when open. Doors shall be nominal 18- or 24-inch or 36-inch width. Actual opening widths shall be 17.25 inches and 29.25 inches respectively.

2. Door safety restraints provide a 2-turn secondary latch which shall prevent unwanted rapid door opening against high interior pressures.
3. Each fan section access door shall include a secondary door. This door shall be constructed of expanded metal in a rigid frame which shall allow visual inspection of the fan, motor, and drive components. To gain access to the fan through this door requires the use of a tool.
4. Each door shall include a view port to allow visual inspection of interior components.

## 2.3 FANS

**NOTE:** Fan-Wall systems may be used in lieu of centrifugal plug fans.

A. Type: Double inlet, centrifugal type fan.

B. Performance Ratings: Conform to AMCA 210 and label with AMCA Certified Rating Seal.

C. Sound Ratings: AMCA 301, tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.

D. Bearings: Self-aligning, grease lubricated, ball or roller bearings with lubrication fittings extended to exterior of casing with copper tube and grease fitting rigidly attached to casing.

E. Mounting: Locate fan and motor internally on welded steel base coated with corrosion resistant paint. Factory mount motor on slide rails. Furnish access to motor, drive, and bearings through removable casing panels or hinged access doors. Mount base on spring vibration isolators.

F. Fan Modulation: Variable Frequency Drive. See Section on VARIBALE FREQUENCY DRIVES.

G. Flexible Connection: Separate unit from connecting ductwork.

## 2.4 VARIABLE FREQUENCY DRIVES

A. VFDs for supply fans and return fans and condenser fans shall be mounted and wired by the unit manufacturer inside of ventilated NEMA 3R enclosures. See Section on VARIABLE FREQUENCY DRIVES.

## 2.5 REFRIGERANT COILS

A. Air-Cooled Condensing Section: Condenser coils shall be constructed of seamless copper tubes, mechanically expanded into copper fins. Each coil shall include an integral 10 degree F sub-cooling circuit. The mechanical refrigerant system shall be capable of operating at ambient conditions down to 0 degree F and shall include ASME receivers on all circuits and ASME relief valve on all circuits. Condenser fans shall be direct drive, propeller type. Fans shall be VFD controlled to vary the speed to maintain a minimum head pressure. Condenser deck shall be insulated.

B. Compressors: The compressor shall be scroll or screw type. Compressors shall be high efficiency, suction-gas cooled, single speed, hermetic type, with three Teflon bearings and a cast iron motor frame. Compressors shall be mounted on rubber-in-shear isolators. The compressor circuit shall include high and low pressure taps, a discharge service valve, and a check valve at the discharge outlet to prevent reverse rotation. Compressors shall have internal motor protection for over-temperature and over-current conditions. Other safety devices include a crankcase heater, high-pressure cutout, and low pressure freeze protection. Capacity reduction shall be performed with compressor staging and hot gas bypass on tandem compressor models. Capacity reduction shall be performed with hot gas bypass on non-tandem compressor models.

C. Mechanical Pressure-Controlled Hot Gas Bypass: A pressure-controlled modulating hot gas bypass valve will trim the #1 compressor's effective capacity. The valve shall be controlled between each and every compressor control stage. The valve follows the cooling demand and must be commanded fully closed before a compressor stage is enabled and commanded to its maximum open position (adjustable) before a stage is disabled.

D. Refrigeration Circuit Specialties: Each independent refrigerant circuit shall be completely piped, tested, dehydrated, and fully charged with oil and refrigerant R410A or R407C. Each refrigerant circuit includes compressor, condenser with integral liquid sub-cooler, liquid line service and charging valve, filter drier, sight glass, fusible plug, and thermostatic expansion valve.

E. Evaporator Coil: Direct expansion coil shall be constructed of 2-inch seamless coated copper tubes expanded into copper fins and shall not be less than three rows in depth, nor have more than 12 fins per inch. Coil casing shall be constructed of type 201 stainless steel. Headers shall be copper. Evaporator coil shall be provided with adjustable superheat controls and external equalizers. Coils shall be tested to be leak-free with nitrogen at 500 PSIG under water. The entire refrigerant piping circuit shall be leak tested at 150 PSIG air pressure.

F. The evaporator coil shall be provided with a drain pan which shall be fabricated of 14-gauge 201 stainless steel and sloped for positive drainage of condensate. A 1-1/4-inch diameter condensate drain connection shall be provided on one side of the unit for slab coils and on both sides of the unit for V-bank coils and shall be field trapped by others.

G. All coils (evaporator and condenser) shall be coated with minimum 1.0 mil. aluminum impregnated polyurethane coating by Blygold PoluAl XT or approved equal. Coating shall withstand 4,000 hours in both salt spray test per ASTM B117 and acid salt spray test per ASTM D5339. Finned-tube coils applied coating shall have 5 year warranty.

## 2.6 DAMPERS, HOODS, AND LOUVERS

A. Low Leak Outside Air/Return Air (OA/RA) Dampers: Outside air and return air (economizer) dampers shall be constructed of heavy gauge, aluminum airfoil-shaped blades and 14-gauge galvanized steel frames. The damper blades shall be mounted to plated square shafts which rotate in permanently-lubricated nylon bearings to insure smooth operation. Vinyl blade seals shall be locked into extruded aluminum blade slots. Side seals shall be constructed of flexible metal compression-type stainless steel. Damper blades operate without clatter or binding and damper linkage will be located out of the air stream. Actuator shall be direct-mounting type.

B. Outside Air Louvers - Economizer: Outside air louvers shall be of a storm-proof design and provided with a 2-inch by 2-inch galvanized bird screen. A fully-insulated divider deck shall be provided to separate outside air from return air.

## 2.7 FILTERS

Provide MERV 8 pre-filter, carbon filter, bipolar ionization unit and MERV 13 final filter.

A. See Section on HVAC AIR CLEANING DEVICES.

## 2.8 ELECTRICAL

A. General: All electrical wiring conforms to UL 1995. Where required, wiring will be run in EMT. The unit shall be equipped for single source power connection.

B. Main Control Panel - Exterior: The main control panel will have access door(s) for direct access to the controls. The panel shall be equivalent to NEMA type 3R (rainproof) and contain a single externally-operated, molded case switch (non-automatic circuit breaker) suitable for copper wire up to and including 3-inch conduit. Low-voltage control panel wiring shall be enclosed in a wiring duct.

C. Service Outlet and Lights: GFI-type service outlet(s) shall be provided. Power is provided from the main unit. Circuit shall remain energized regardless of main unit disconnect position.

D. Lights not in the air stream shall be fluorescent with a wire guard. Lights in the air stream shall be vapor-proof screw-in type fluorescent with a cast alloy base with threaded hubs, gasketed glass cover, and wire guard. Lights are wired to a single switch. Power shall be on the same circuit as the Service Outlet. Light circuit shall remain energized regardless of main unit disconnect position.

| GUARANTEED MINIMUM FULL LOAD EFFICIENCY OF MOTORS | | |
|---|---|---|
| Rated HP | Nominal 1200 RPM | Nominal 1800 RPM |
| 1 | 82.5 | 85.5 |
| 1.5 | 86.5 | 86.5 |
| 2 | 87.5 | 86.5 |
| 3 | 89.5 | 89.5 |
| 5 | 89.5 | 89.5 |
| 7.5 | 91.7 | 91.0 |
| 10 | 91.7 | 91.7 |
| 15 | 92.4 | 93.0 |
| 20 | 92.4 | 93.0 |
| 25 | 93.0 | 93.6 |
| 30 | 93.6 | 94.1 |
| 40 | 94.1 | 94.1 |
| 50 | 94.1 | 94.5 |
| 60 | 95.0 | 95.0 |
| 75 | 95.0 | 95.0 |
| 100 | 95.0 | 95.4 |
| 125 | 95.4 | 95.4 |
| 150 | 95.8 | 95.8 |
| 200 | 95.4 | 95.8 |

## 2.9 CONTROLS

A. A microprocessor controller shall be mounted in the electrical panel. The unit will be provided with all necessary temperature, pressure sensors, filter switches and wiring for complete temperature controls and economizer operation as indicated on the control drawings.

B. Unit controller shall have capability as standard for remote access and monitoring over the internet.

C. Building BAS Interface. Provide an interface between the unit controls and the building automation system.

D. Connect unit to the Central Utility Plant via the LAWA intranet.

## 2.10 ROOF CURB

A. Factory assembled galvanized steel mounting curb designed and manufactured by unit manufacturer.

1. Perimeter type with support of air handling sections.
2. Furnish supply and return opening duct frames as part of curb structure allowing duct connections to be made directly to curb.
3. Minimum of 12 inches high.
4. Furnish gaskets for field mounting.

**NOTE:** All roof top equipment including packaged rooftop air conditioning units are to be curb mounted.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

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

## 3.2 TRAINING

A. Furnish services of factory trained representative for minimum of one day to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct LAWA on operation and maintenance. Training to include minimum of 8 LAWA personnel (minimum) for 40 hours training, 16 hours shall be classroom training per person and 24 hours shall be hands-on training per person.

B. Training shall occur after the system is fully operational.

## 3.3 WARRANTY

A. Provide 5 years parts and labor warranty for compressors, VFD, motors and Ultraviolet Disinfection System.

END OF SECTION 23 81 06

# SECTION 23 81 07 - VARIABLE FREQUENCY DRIVES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This section includes all variable frequency drives. All standard and optional features shall be included within the VFD panel

### 1.2 QUALITY REQUIREMENTS

A. Requirements of Regulatory Agencies:

1. All variable frequency drives shall be tested and rated in conformity with applicable codes and authorities having jurisdiction, for variable frequency drives (VFD's).
2. VFDs and options shall be UL listed as a complete assembly. VFDs that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. The base VFD shall be UL listed for 100 KAIC without the need for input fuses.

B. Manufacturer testing

1. To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.
2. All optional features shall be functionally tested at the factory for proper operation.

### 1.3 SUBMITTALS

A. Shop Drawings and Product Data.

B. Variable Frequency Drives

1. Submit complete wiring diagrams, dimensional drawings, transformer data and connection diagrams.
2. Outline dimensions, conduit entry locations and weight.
3. Complete technical product description include a complete list of options provided
4. Customer connection and power wiring diagrams.
5. Compliance to IEEE 519 B harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).

    a. The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFDs shall include a minimum of 5% impedance reactors, no exceptions.

## 1.4 WARRANTY

A. Warranty shall be 5 years from the date of certified start-up. The warranty shall include all parts, labor, travel time and expenses. There shall be support available via a toll free phone number.

## PART 2 - PRODUCTS

## 2.1 MATERIALS

A. Variable Frequency Drives:

1. Description:

a. Motors shall be provided with UL Listed variable frequency drive (VFD) control systems.
b. The VFD shall be UL Type 1 or UL Type 12 for indoor applications or UL NEMA-3R for outdoor applications as required on the schedule. The VFD shall have been evaluated by UL and found acceptable for mounting in a plenum or other air handling compartment. Manufacturer shall supply a copy of the UL plenum evaluation upon request.
c. The VFD shall be tested to UL 508C. The appropriate UL label shall be applied. When the VFDs are to be located in Canada, C-UL certifications shall apply. VFD shall be manufactured in ISO 9001, 2000 certified facilities.
d. The VFD and any optional panels, of any type (bypass, etc.) shall be UL listed for a short circuit current rating of 100,000 amps and labeled with this rating.
e. The VFD and any optional panels of any type (bypass, etc.), shall be shown to be in compliance with the seismic requirements of Section 1613 of the California Building Code (CBC) 2007 and ASCS 7-05. Compliance documentation shall be included as part of the equipment submittal.

2. Manufacturers.

**a. Danfoss.**
**b. GE.**
**c. ABB**

3. General

a. The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating. When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load

current during full load and full speed operation.

b. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.
c. The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable. VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.
d. The VFD=s full load output current rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.
e. The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway torque of 160% shall be available.
f. A programmable automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continuously monitor the motor=s speed and load to adjust the applied voltage to maximize energy savings.
g. The VFD must be able to produce full torque at low speed to operate direct drive fans.
h. Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.
i. An automatic motor adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.
j. Galvanic isolation shall be provided between the VFD=s power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.
k. VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.
l. All VFDs shall contain integral EMI filters to attenuate radio frequency interference conducted to the AC power line.

4. Protective Features

a. A minimum of Class 20 $I^2t$ electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.
b. Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not

acceptable.

c. Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.
d. Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.
e. Protect from over voltage. The VFD shall continue to operate without faulting with an input voltage as high as 130% of the nominal voltage.
f. The VFD shall incorporate a programmable motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.
g. VFD shall include a “signal loss detection” algorithm with adjustable time delay to sense the loss of an analog input signal. It shall also include a programmable time delay to eliminate nuisance signal loss indications. The functions after detection shall be programmable.
h. VFD shall function normally when the keypad is removed while the VFD is running. No warnings or alarms shall be issued as a result of removing the keypad.
i. VFD shall catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.
j. Selectable over-voltage control shall be provided to protect the drive from power regenerated by the motor while maintaining control of the driven load.
k. VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.
l. If the temperature of the VFD’s heat sink rises to 80 degree C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD’s temperature becomes too high.
m. In order to ensure operation during periods of overload, it must be possible to program the VFD to periodically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.
n. The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.
o. The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.
p. When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

5. Interface Features

a. Hand, Off and Auto keys shall be provided to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.
b. There shall be an "Info" key on the keypad. The Info key shall include "on-line" context sensitive assistance for programming and troubleshooting.
c. The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.
d. Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.
e. All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.
f. To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.
g. Display shall be programmable to communicate in multiple languages including English, Spanish and French.
h. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
i. A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.
j. A three-feedback PID controller to control the speed of the VFD shall be standard.

    1) This controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or the feedback signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.
    2) The VFD shall be able to apply individual scaling to each feedback signal.
    3) For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.
    4) The VFD's PID controller shall be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.

k. The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.
l. Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
m. Five simultaneous meter displays shall be available. They shall include at a

minimum, frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, among others.

n. Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into Sleep Mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.

o. A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.

p. VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F).

q. VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

r. Standard Control and Monitoring Inputs and Outputs

    1) Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
    2) Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.
    3) Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.

        a) Each relay shall have an adjustable on delay / off delay time.

    4) Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.

        a) Each shall be independently selectable to be used with either an analog voltage or current signal.
        b) The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.
        c) A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.
        d) The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,

    5) One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the

reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.

6) It shall be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.
7) It shall be possible to command all digital and analog output through the serial communication bus.

s. Optional Control and Monitoring Inputs and Outputs

1) It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.
2) These modules shall use rigid connectors to plug into the VFD's control card.
3) The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.
4) Modules may include such items as:

a) Additional digital outputs, including relay outputs
b) Additional digital inputs
c) Additional analog outputs
d) Additional analog inputs, including Ni or Pt temperature sensor inputs

5) It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.

t. Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter's override mode. Firemode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.

u. A real-time clock shall be an integral part of the VFD.

1) It shall be possible to use this to display the current date and time on the VFD's display.
2) Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. Is shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.
3) All VFD faults shall be time stamped to aid troubleshooting.
4) It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.
5) The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.

v. The VFD shall be able to store load profile data to assist in analyzing the system

demand and energy consumption over time.

w. The VFD shall include a smart logic controller to provide advanced control interface capabilities. This shall include:

1) Comparators for comparing VFD analog values to programmed trigger values
2) Logic operators to combine up to three logic expressions using Boolean algebra
3) Delay timers
4) A 20-step programmable structure
5) The Smart Logic controller will allow the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of 2 additional constant speed motor starters. (Cascade Control).

6. Serial Communications

a. The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:

1) Johnson Controls Metasys N2
2) Siemens Apogee FLN (P1)
3) Modbus RTU
4) LonWorks Free Topology (FTP) certified to LonMark standard 3.3
5) BACnet MS/TP

b. VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.

c. The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

7. Adjustments

a. The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 kHz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.

b. Four independent setups shall be provided.

c. Four preset speeds per setup shall be provided for a total of 16.

d. Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.

e. Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.

f. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.
g. The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
h. An automatic "start delay" may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.
i. Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Automated setting of lockout ranges shall simplify the set-up.

8. Optional Features

a. All optional features shall be built and mounted by VFD manufacturer. All optional features shall be UL listed by the VFD manufacturer as a complete assembly and carry a UL label.
b. All panels shall be marked for 100,000 AMP short circuit current rating in compliance with UL.
c. The enclosure rating of the VFD w/options shall be consistent with the VFD rating of either NEMA/UL type 1 or NEMA/UL type 12, as required for the installation location and/or as called for on the schedule. The package shall include ALL optional devices and shipped as a complete factory tested assembly.
d. Three-Contactor bypass shall be provided that allows operation of the motor via line power in the event of a failure of the VFD. Motor control selection shall be through either a VFD output contactor or a bypass contactor that are electrically interlocked to ensure that both contactors are not energized simultaneously. A third contactor, the drive input contactor, shall be supplied as standard. This allows the powering of the VFD with the motor off or operating in bypass mode for testing, programming and troubleshooting purposes.

e. The three-contactor bypass shall include the following interface and control features:

1) Mode selection via a four position DRIVE/OFF/BYPASS/TEST switch.

a) DRIVE Mode: Both the drive input and output contactors are closed and the motor is operated via VFD power
b) OFF Mode: DRIVE input, drive output and bypass contactors are all open.
c) BYPASS Mode: Bypass contactor is closed and motor is operating from line power. Both the drive input and drive output contactors are open for servicing of the VFD without power.
d) TEST Mode: Bypass contactor is closed and the motor is operated from line power. The drive input contactor is closed but the drive output contactor is open. This allows for the testing and programming of the VFD while the motor is operated via line power.

2) Contactors shall operate from a 24vdc power supply that shall function off of any two legs of the AC line and shall maintain power on the loss of any one of

the AC lines.

3) A bypass pilot light is supplied to indicate that the motor is operating from line power.
4) Common start/stop command when operating in either bypass or VFD mode.
5) Selectable Run Permissive logic shall operate in either VFD or bypass operation. When activated, any command to start the motor, in either hand bypass, remote bypass, hand VFD or remote VFD shall not start the motor, but instead close a relay contact that is used to initiate operation of another device, such as an outside air damper. A contact closure from this device shall confirm that it is appropriately actuated and the motor shall then start.
6) Bypass package shall include an external safety interlock that will disable motor operation in either bypass or VFD when open.
7) Firemode bypass operation shall be standard. When activated via a contact closure, the motor shall transfer to bypass (line power) regardless of the mode selected. All calls to stop the motor shall be ignored. These include the opening of the start command, an external safety trip or the tripping of the motor overload. Firemode operation will take precedence over all other commands.
8) The bypass must include a selectable time delay of 0 to 60 seconds before the initiation of bypass operation. When transferring from VFD to bypass modes, the time delay starts after the motor has decelerated to zero speed. This delay allows the BAS to prepare for bypass operation. Bypass packages that do not include a time delay, or do not include a selectable delay period, will not be acceptable.
9) Automatic bypass shall be selectable. When active, the motor shall be transferred to line power on a VFD fault condition. The bypass time delay shall be activated prior to this transfer to line power to allow the VFD time to attempt to recover from the fault condition prior to running in bypass.

f. Protective Features

1) Main input disconnect shall be provided that removes power from both the bypass and VFD.
2) Main input motor rated fuses that protect the entire package.
3) VFD only fast acting input fuses shall be provided. Packages that include only main input motor rated fusing or circuit breaker are not acceptable.
4) Overload protection shall be supplied in bypass mode.

    a) This overload shall supply minimum class 20 protection as well as wide adjustable current setting for complete motor protection when operating on line power. Those overloads that are not class 20 or current selectable will not be acceptable.
    b) Overload protection shall include phase loss and phase imbalance protection.

5) Low voltage contactor operation shall be maintained to 70% of the packages nominally rated voltage. This will ensure VFD operation on low voltage conditions that would otherwise be interrupted due to contactor dropout.
6) The VFD shall be able to operate the motor at a reduced load with the loss of any one of the three phases of power. Contactors shall remain closed

regardless of which phase is lost. This will ensure VFD operation on single phase conditions that would otherwise be interrupted due to contactor dropout.

g. Line/Load Conditioners

1) VFDs that do not include 5% DC link impedance shall include 5% AC line reactors in the operations enclosure. Lower levels of impedance will not be acceptable.
2) When the installation requires additional motor dV/dT protection, it shall be via a dV/dT filter mounted in the options enclosure. Packages that include only load reactors or filters supplied separately will not be accepted.

9. Service Conditions

a. Ambient temperature, continuous, full speed, full load operation:

1) -10 to 45°C (14 to 113°F) through 125 HP @ 460 and 600 volt, through 60 HP @ 208 volt

b. 0 to 95% relative humidity, non-condensing.
c. Elevation to 3,300 feet without derating.
d. AC line voltage variation, -10 to +10% of nominal with full output.
e. No side clearance shall be required for cooling.
f. All power and control wiring shall be done from the bottom.
g. All VFDs shall be plenum rated.

10. Quality Assurance

a. To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.
b. All optional features shall be functionally tested at the factory for proper operation.

## PART 3 - EXECUTION

### 3.1 START-UP SERVICE

A. The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system.

B. armonic filtering. The VFD supplier shall, with the aid of the buyer's detailed electrical power single line diagram showing all impedances in the power path to the VFDs, perform an analysis to initially demonstrate the supplied equipment will met the IEEE recommendations after installation. If, as a result of the analysis, it is determined that additional filter equipment

is required to meet the IEEE recommendations, then the cost of such equipment shall be included in the drive supplier quotation.

## 3.1 TRAINING

A. Factory representative shall provide on-site training (minimum of 24 hours) for LAWA operating personnel after the system is fully operational.

END OF SECTION 23 81 07

# SECTION 23 81 23-COMPUTER-ROOM AIR-CONDITIONERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes air conditioning units, controls and control panels.

### 1.2 REFERENCES

A. Air-Conditioning, Heating, and Refrigeration Institute

1. ARI 210/240 - Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment.
2. ARI 340/360 - Performance Rating of Commercial and Industrial Unitary Air-Conditioning & Air-Source Heat Pump Equipment.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

C. American Society of Mechanical Engineers:

1. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

### 1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s literature and data indicating water, drain, refrigeration, and electrical characteristics and connection requirements.

B. Manufacturer's Installation Instructions: Submit procedures for rigging and making service connections.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

D. Manufacturer's Field Reports: Indicate conditions at initial start-up including date, and initial set points.

## 1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

## 1.5 WARRANTY

A. Furnish five year manufacturer’s warranty.

## 1.6 MAINTENANCE SERVICE

A. Furnish service and maintenance of units for one year from Date of Substantial Completion.

B. Examine unit components monthly. Clean, adjust, and lubricate equipment.

C. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.

D. Perform work without removing units from service during building normal occupied hours.

E. Provide emergency call back service at all hours for this maintenance period.

F. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

G. Perform maintenance work using competent and qualified personnel under supervision of manufacturer or original installer.

H. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of LAWA.

## 1.7 EXTRA MATERIALS

A. Furnish one set of filters for each unit.

# PART 2 - PRODUCTS

## 2.1 FLOOR MOUNTED AIR CONDITIONING UNITS

A. Manufacturers:

1. **Liebert.**
2. **APC.**

**3. Stulz.**

B. Product Description: Packaged, water or air cooled, factory assembled, pre-wired and pre-piped unit, consisting of cabinet, fans filters, humidifier and controls, reheat and heating coils. Refrigerant shall be R407C or R410A.

C. Cabinet and Frame:

1. Structural Frame: 14 gage welded steel suitably braced for rigidity, capable of supporting compressors and other mechanical equipment and fittings with welded tubular steel floor stand with adjustable legs and vibration isolation pads.
2. Doors and Access Panels: 20 gage galvanized steel with polyurethane gaskets, hinges to allow removal of panels, and concealed fastening devices.
3. Insulation: Thermally and acoustically line cabinet interior with 1 inch thick acoustic duct liner.
4. Finish of Exterior Surfaces: Shop coated with 4.0 mils epoxy primer and 6.0 mils topcoat phenolic baked coating for a total of 10.0 mils. Coating shall withstand 5,000 hour of salt spray test in accordance with ASTM B117.

D. Evaporator Fans and Motors:

1. Fans: Double inlet, forward curved centrifugal fans, statically and dynamically balanced.
2. Motor: Drip proof, permanently lubricated ball bearing motor with built-in current and overload protection.
3. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, keyed, variable and adjustable pitch motor sheave, minimum of two matched belts, drive rated minimum 2.0 times nameplate rating of motor.

E. Compressors:

1. Type: Hermetic with resilient suspension system, oil strainer, crankcase sight glass, internal motor protection, low pressure switch, manual reset high pressure switch.
2. Compressors: Individually serviceable without dismantling other components or removing unit from service.
3. Refrigeration Circuits: Two, each with hot gas mufflers, thermal expansion valve with external equalizer, liquid line solenoid valve, liquid line filter-drier, refrigerant sight glass with moisture indicator, service shut-off valves and charging valves and accumulator sized for liquid seal under light load.

F. Evaporator Coils:

1. Direct expansion cooling coils of seamless copper tubes expanded into copper fins.
2. Mount coil assembly in stainless steel drain pan.

G. Condensers:

1. Water Cooled: Shell and tube type ASME Section VIII or Coaxial tube in tube type with liquid line stop valve and head pressure actuated water regulating valve. Terminate outside cabinet for easy external connections.

2. Air Cooled: Corrosion resistant cabinet, copper tube copper fin coils arranged for two circuits, multiple direct drive propeller fans with permanently lubricated ball bearing single phase motors with internal overload protection. Furnish capacity control by cycling fans.

H. Water Coil:

1. Seamless copper tubes expanded into copper fins with control valve and strainer.

I. Filters:

1. Media: Pleated, lofted, non-woven, reinforced cotton fabric; supported and bonded to welded wire grid; enclosed in cardboard frame; 2 inch nominal thickness.
2. Rating, ASHRAE 52.1:

a. Dust spot efficiency: 25-30 percent.
b. Weight arrestance: 90-92 percent.
c. Initial resistance at 500 fpm face velocity: 0.30 inch wg inch wg.
d. Recommended final resistance: 1.0 inch wg inch wg.

J. Refrigerant Reheat Coil:

1. Hot gas refrigerant coil of seamless copper tubes expanded into copper fins with three-way solenoid valve on first stage refrigerant circuit.

K. Reheat/heating Coils:

1. Heating Coils: Enclosed fin electrical elements arranged for minimum of two stages.
2. Circuit Protection: Primary and secondary thermal cutouts, differential air pressure switch, and manual reset overload protection and branch circuit overcurrent protection.
3. Hot water heating coil of seamless copper tubes expanded into copper fins.

L. Humidifier:

1. Infrared Type: High intensity quartz lamps mounted above stainless steel evaporator pan, serviceable without disconnecting water, drain, or electrical connections; pre-piped and utilizing condensate water from cooling coils with stainless steel or brass float valve mechanism; located in bypass air stream.

M. Control Cabinet: NEMA 250; Type 2 enclosure, UL listed, with piano hinged door, grounding lug, combination magnetic starters with overload relays, circuit breakers and cover interlock, and fusible control circuit transformer.

N. Disconnect Switch: Non-automatic molded case circuit breaker with handle accessible with panel closed and capable of preventing access until switched to "off" position.

O. Electronic Control System:

1. Solid state with start button, stop button, temporary loss of power indicator, manual reset circuit breakers, temperature control humidity control, and monitor panel.

2. Monitor Panel: Back lighted with no visible indicator lights until operating function is activated; indicators include cooling, humidification, loss of air flow, change filters, high temperature, low temperature, high humidity, low humidity, high head pressure (each compressor), and low suction pressure (each compressor).
3. Temperature and Humidity Control Modules: Solid state plug-in with adjustable set point, "push-to-test" calibration check button, and built-in visual indicators to indicate mode of operation.
4. Location: Through hinged door in front of unit; isolated from conditioned air stream to allow service while system is operating.

P. Outside Casing Coating

**NOTE:** A rust inhibiting coating is required due to the marine environment at LAX along with the corrosive atmosphere from the neighboring Hyperion plant .

1. Zinc chromate, iron oxide, shop coated with 4.0 mils epoxy primer and 6.0 mils topcoat phenolic baked coating for a total of 10.0 mils. Coating shall withstand 5,000 hour of salt spray test in accordance with ASTM B117.
2. Finish exceeds 5000 hour salt spray test in accordance with ASTM B117.

Q. Outside Coil Coating

1. All coils shall be coated with minimum 1.0 mil. aluminum impregnated polyurethane coating by Blygold PoluAl XT or approved equal. Coating shall withstand 4,000 hours in both salt spray test per ASTM B117 and acid salt spray test per ASTM D5339. Finned-tube coils applied coating shall have 5 year warranty.

## 2.2 CEILING MOUNTED AIR CONDITIONING UNITS

A. Manufacturers:

**1. Liebert.**
**2. APC.**
**3. Stulz.**

B. Product Description: Self-contained air cooled, factory assembled, pre-wired and pre-piped unit, consisting of cabinet, fan, filters, humidifier, controls.

C. Assembly: For horizontal ceiling mounting to fit 24 x 48 inches T-bar ceiling opening.

D. Cabinet: 14 gage welded steel with baked enamel finish, and lined with 1/2 inch thick acoustic duct liner.

E. Provide condensate pump integrated with unit.

F. Evaporator Fan: Forward curved centrifugal, directly driven by two-speed motor.

G. Compressor: Hermetic with resilient suspension system, oil strainer, internal motor overload protection, low pressure switch, manual reset high-pressure switch.

H. Evaporator Coil: Direct expansion cooling coil of seamless copper tubes expanded into aluminum fins, with thermal expansion valve with external equalizer, liquid line filter-drier, service shut-off valves and charging valves. Mount coil assembly in stainless steel drain pan.

I. Air Cooled Condenser: Integral copper tube aluminum fin coil sized for scheduled capacity.

J. Filter: 1 inch thick disposable glass fiber media.

K. Heating Coils: Nichrome wire electric elements with contactor, dehumidification relay, and high temperature limit switch.

L. Evaporative Pan Type: Stainless steel pan and cover, with stainless steel or brass float valve mechanism, electric heating coil with low water cut-off switch, flush cycle timer and solenoid drain valve.

M. Control System:

1. Unit Mounted: Main fan contactor, compressor and condenser fan contactor, compressor start capacitor, controls transformer with circuit breaker, solid state temperature and humidity control modules.
2. Solid state wall mounted with start/stop switch, adjustable humidity setpoint, adjustable temperature setpoint to interface with unit mounted controls.

**NOTE:** Provide leak detector kit for raised floor installation.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Coordinate installation of computer room air conditioning units with computer room raised floor. Floor mounted units shall be on level stand with 2” deflection spring isolators and seismic restraints. Units hung from above shall have 2” spring isolation hangers and seismic restraints.

B. Coordinate installation of air conditioning unit with computer room ceiling.

C. Install drainage piping connections for humidifier flushing system.

D. Install hot water heating piping connections to reheat coils. Install shut-off valves in hot water heating inlet and outlet piping.

E. Install refrigerant piping connections to air-cooled condensing units.

F. Install accessories furnished loose for field mounting.

G. Install electrical devices furnished loose for field mounting.

H. Install control wiring between control panel and field mounted control devices.

I. Provide connection to electrical service.

## 3.2 MANUFACTURER'S FIELD SERVICES

A. Furnish services of factory trained representative for minimum of one days to start-up, calibrate controls, and instruct a minimum of 8 LAWA personnel for 40 hours, 16 hours shall be classroom training and 24 hours shall be hands on training on operation and maintenance.

B. Set initial temperature and humidity set points.

## 3.3 DEMONSTRATION

A. Demonstrate system operations and verify specified performance.

B. Demonstrate alarm conditions.

END OF SECTION 23 81 23

**SECTION 23 81 23.13 HVAC for MPOE (Minimum Point of Entry) Rooms**

**PART 1 - GENERAL**

**1.01 SUMMARY**

A. These Specifications describe requirements for an environmental control system. The system shall be designed to control temperature and relative humidity conditions within the MPOE rooms (minimum point of entry).

B. The manufacturer shall design and furnish all equipment in the quantities and configurations shown on the project drawings.

C. System shall be supplied with CSA Certification to the harmonized U.S. and Canadian product safety standard CSA C22.2 No 236/UL 1995 for "Heating and Cooling Equipment and marked with the CSA c-us logo (60 Hz only).

D. This specification defines the mechanical and electrical characteristics and requirements for an environmental control system. All references to model numbers and other pertinent information herein are intended to establish standards of performance, quality and construction. These model numbers are based on equipment manufactured by Liebert. Equivalent products may be considered if adequate information is submitted to the specifying engineer for approval beforehand.

E. Related documents included in the specification requirements:

1. Section 01 11 00 – Summary of Work
2. Section 01 25 00 – Substitution Procedure
3. Section 01 31 00 – Administrative Requirements
4. Section 01 33 00 – Submittal
5. Section 01 40 00 – Quality Requirements
6. Section 01 43 00 – Quality Assurance
7. Section 01 64 00 – Owner Furnished Products
8. Section 01 77 13 – Preliminary Closeout Reviews
9. Section 01 77 16 – Final Closeout Review
10. Section 01 78 00 – Close Out Submittals
11. Section 27 05 00 – Basic Telecommunication Requirements

F. Products furnished (but not installed) under this section:

G. Products installed (but not furnished) under this section:

## 1.02 PRICE AND PAYMENT PROCEDURES

## 1.03 REFERENCES

A. Standards

1. The UPS shall be designed in accordance with the applicable sections of the current revision of the following documents. Where a conflict arises between these documents and statements made herein, the statements in this specification shall govern.

   (Designer to list applicable documents)

## 1.04 ADMINISTRATIVE REQUIREMENTS

## 1.05 SUBMITTALS

A. Submittals shall be provided with the proposal and shall include: (1) Single-Line Diagrams; Dimensional, Electrical and Capacity data; Piping and Electrical Connection Drawings.

B. Manufacturer's Field Reports: Indicate conditions at initial start-up including date, and initial set points.

## 1.06 QUALITY ASSURANCE

A. The specified system shall be factory-tested before shipment. Testing shall include, but shall not be limited to: Quality Control Checks, "Hi-Pot" Test (two times rated voltage plus 1000 volts, per NRTL agency requirements) and Metering Calibration Tests. The System shall be designed and manufactured according to world class quality standards. The manufacturer shall be ISO 9001 certified.

## 1.07 SUBSTITUTION OF EQUIPMENT

A. Approval of alternate or substitute equipment or material in no way voids Specification requirements.

B. Under no circumstances shall the LAWA be required to prove that an item proposed for substitution is not equal to the specified item. It shall be mandatory that the Contractor submits to Engineer all evidence to support the contention that the item proposed for substitution is equal to the specified item. The Owner's decision as to the equality of substitution shall be final and without further recourse.

C. In the event that the Design Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Design Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Design

Consultant's expenses in connection with such additional services shall be paid by the Contractor and may be deducted from any moneys owed to the Contractor.

## 1.08 DELIVERY, STORAGE AND HANDLING

A. Submit manufacturers' instructions for storage, handling, protection, examination, preparation, operation, and installation of all products. Include any application conditions or limitations of use stipulated by any product testing agency.

## 1.09 FIELD/SITE CONDITIONS

## 1.10 WARRANTY

## PART 2 - PRODUCTS

### 2.01 DESIGN REQUIREMENTS

A. The environmental control system shall be a Liebert Mini-Mate2 factory assembled unit. The evaporator section shall be designed for ceiling installation.

B. The System shall have a total cooling capacity of 88,400 BTU/hr. and a sensible cooling capacity of 83,700 BTU/hr. based on the entering air condition of 77°F dry bulb, and 62°F wet bulb.

C. The unit is to be supplied for operation on a 460 volt, 3 phase, 60 Hz power supply.

D. LAWA approved Manufacturer and Model for MPOE Rooms (final sizing TBD).

1. Mechanical – CHW Air Unit w/Reheat/Humidification

   a. Provide (1) 8 Ton ceiling-mounted (outside room) chilled water air unit, model Liebert Mini-mate2 MMD8TCDAHELA. Unit shall have reheat and humidification with sensible capacity of 83,700 BTUH at 77F. 42% RH. 460V, 3-PH, 21.0 FLA, 26.3 WSA, 30A MFCB. Insulated Chilled Water Piping with 2-Way Modulating Control Valve – 350 PSI, 18.4 GPM, 4.4 PSI Pressure Drop, 2.0 HP Motor, 3750 CFM @ 0.50 ESP.

2. Mechanical – CHW Air Unit (Cooling Only Option)

   a. Provide (1) 8 Ton ceiling-mounted (outside room) chilled water air unit, model Liebert Mini-mate2 MMD8TCDA00LA. Unit shall have sensible capacity of 83,700 BTUH at 77F. 42% RH. 460V, 3-PH, 3.1 FLA, 3.9 WSA, 15A MFCB. Insulated Chilled Water Piping with 2-Way Modulating Control Valve – 350 PSI, 18.4 GPM, 4.4 PSI Pressure Drop, 2.0 HP Motor, 3750 CFM @ 0.50 ESP.

### 2.02 STANDARD FEATURES / ALL SYSTEMS

A. Evaporator Cabinet Construction

1. The cabinet and chassis shall be constructed of heavy gauge galvanized steel and shall be serviceable from one side only. Mounting brackets shall be factory-attached to the cabinet.

2. Internal cabinet insulation shall meet ASHRAE 62.1 requirements for Mold Growth, Humidity and Erosion, tested per UL 181 and ASTM 1338 standards.

B. Air Distribution

1. The fan shall be the belt-drive, centrifugal type, double width, double inlet. The shaft shall be heavy-duty steel with self-aligning ball bearings with minimum life of 100,000

hours. The fan motor shall be 1750 rpm and mounted on an adjustable base. The drive package shall be equipped with an adjustable motor pulley. The fan/motor assembly shall be mounted on vibration isolators.

2. The evaporator system shall be capable of delivering 3750 CFM at 0.50 inches of external static pressure. The fan motor shall be 2.0 HP.

3. System shall be suitable for ducted air distribution.

C. Microprocessor Control

1. The control system shall be microprocessor-based, factory-wired into the System cabinet and tested prior to shipment.

2. The wall-mounted control enclosure shall include a 2-line by 16-character liquid crystal display (LCD) providing continuous display of operating status and alarm condition which is wired into the control board using 4-conductor field-supplied wire.

3. A 7-key membrane keypad for setpoint/program control and unit On/Off shall be located below the display. The control shall be capable of displaying values in °F or °C.

4. The microprocessor shall provide three stages of cooling for direct expansion units by cycling the 3-ton compressor, 5-ton compressor and then both compressors.

5. The microprocessor shall determine the optimal stage to run based on historical run data.

6. The microprocessor shall adjust the modulating chilled water valve on chilled water units.

7. Temperature and humidity sensors shall be located in the wall box, which shall be capable of being located up to 300 ft. from the evaporator unit.

D. Monitoring

1. The LCD shall provide an On/Off indication, operating mode indication (cooling, heating, humidifying, dehumidifying) and current day, time, temperature and humidity (if applicable) indication. The monitoring system shall be capable of relaying unit operating parameters and alarms to the Liebert SitScan® Monitoring System.

E. Control Setpoint Parameters

1. Temp. Setpoint 65-85°F (18-29°C)
2. Temp. Sensitivity 1-9.9°F (1-5°C)
3. Humidity Setpoint 20-80% RH
4. Humidity Sensitivity 1-30% RH

F. Unit Controls

1. Compressor Short-Cycle Control

   a. The control system shall prevent compressor short-cycling by a 3-minute timer from compressor stop to the next start.

2. Common Alarm and Remote On/Off

   a. A common alarm relay shall provide a contact closure to a remote alarm device. Two (2) terminals shall also be provided for remote On/Off control. Individual alarms shall be “enabled” or “disabled” from reporting to a common alarm.

3. Setback Control

   a. The control shall be user-configurable to use a manual setpoint or a programmable, time-based setback control. The setback control will be based on a 5 day/2day programmed weekly schedule with capability of accepting 2 events per program day.

4. Temperature Calibration

   a. The control shall include the capabilities to calibrate the temperature and humidity sensors and adjust the sensor response delay time from 10 to 90 seconds. The control shall be capable of displaying temperature values for °F or °C.

5. System Auto Reset

   a. For Startup after power failure, the system shall provide automatic restart with a programmable (up to 9.9 minutes in 6–second increments) time delay. Programming can be performed either at the wall-mounted controller or from the central site-monitoring System.

G. **A**larms

1. Unit Alarm

   a. The control system shall monitor unit operation and activate an audible and visual alarm in the event of the following factory preset alarm conditions:

      1) High Temperature
      2) Low Temperature
      3) High Humidity
      4) Low Humidity
      5) High Water Alarm – Lockout Unit Operation
      6) High Head Pressure #1 and #2
      7) Loss of Power
      8) Compressor Short Cycle #1 and #2
      9) Humidifier Problem
      10) Filter Clog

2. Custom Alarms (3x)

a. User-customized text can be entered for the three (3) custom alarms.

1) Smoke Detected
2) Standby Unit On
3) Water Flow Loss
4) Standby GC Pump
5) Custom #1
6) Custom #2
7) Custom #3

3. Alarm Controls

a. Each alarm (unit and custom) shall be individually enabled or disabled (except for high head pressure and high water in condensate pan) and can be programmed for a time delay of 0 to 255 seconds of continuous alarm condition to be recognized as an alarm. Each alarm can also be enabled or disabled to activate the common alarm (except high head pressure and high water in condensate pan).

4. Audible Alarm

a. The audible alarm shall annunciate at the LCD wall box any alarm that is enabled by the operator.

5. Common Alarm

a. A programmable common alarm shall be provided to interface user selected alarms with a remote alarm device. Alarms shall be enabled or disabled from reporting to the common alarm.

6. Remote Monitoring

a. All alarms shall be communicated to the Liebert site monitoring system with the following information: (1) date and time of occurrence, (2) unit number, and (3) present temperature and humidity.

H. Chilled Water System Components

1. Chilled Water Control Valve

a. A (2-way) (3-way) modulating, non-spring return valve shall be controlled by the microprocessor to position the valve in response to room conditions. Water-side design pressure shall be 400 psig static pressure.

2. Chilled Water Coil

b. The cooling coil shall have a minimum 7.6 sq.ft. face area, 4 rows deep, constructed of copper tubes and aluminum fins, and have a maximum face velocity of 491 ft. per

minute at 3750 CFM. The coil shall be supplied with 45°F entering water temperature. The coil shall be supplied with 18.4 GPM of chilled water and the pressure drop shall not exceed 4.8 PSI. The coil assembly shall be mounted in a stainless steel condensate drain pan with internally trapped drain line. The evaporator drain pan shall include a factory-installed float switch to shut down the evaporator upon high water condition.

## 2.03 FACTORY-INSTALLED OPTIONS

A. Steam Generating Humidifier (optional) **Design Engineer to Finalized These Options with LAWA Prior to Bid**

1. The environmental control system shall be equipped with a steam generating humidifier that is controlled by the microprocessor control system. It shall be complete with disposable canister, all supply and drain valves, 1" air gap on fill line, inlet strainer, steam distributor and electronic controls. The need to change canister shall be annunciated on the microprocessor wall box control panel. The humidifier shall have a capacity of 10.0 lb/hr. An LED light on the humidifier assembly shall indicate cylinder full, overcurrent detection; fill system fault and end of cylinder life conditions.

B. Electric Reheat (optional) **Design Engineer to Finalized These Options with LAWA Prior to Bid**

1. The electric reheat shall be low-watt density, 304/304 stainless steel, finned-tubular and shall be capable of maintaining room dry bulb conditions when the system is calling for dehumidification. The reheat section shall include an agency-approved safety switch to protect the system from overheating. The capacity of the reheat coils shall be 39,110 (11.5kW) BTU/HR, with unit input voltage of 460V, controlled in two stages.

C. Disconnect Switch – Non-Locking

1. The electric reheat shall be low-watt density, 304/304 stainless steel, finned-tubular and shall be capable of maintaining room dry bulb conditions when the system is calling for dehumidification. The reheat section shall include an agency-approved safety switch to protect the system from overheating. The capacity of the reheat coils shall be 39,110 (11.5kW) BTU/HR, with unit input voltage of 460V, controlled in two stages.

D. Smoke Sensor

1. The smoke sensor shall immediately shut down the environmental control system and activate the alarm system when activated. The sensing element shall be located in the return air compartment. This smoke sensor shall not function or replace any room smoke detection system that may be required by local or national codes.

E. Filter Clog Switch

1. The filter clog switch senses pressure drop across the filters and shall annunciate the wall-box display upon exceeding the adjustable setpoint.

F. Air Filter Box

1. The evaporator section shall be supplied with an air filter box for use with ducted installations. Two (2) filters shall be included 4" x 20" x 25" (102mm x 508mm x 635mm) each, deep-pleated type, with a MERV8 rating, based on ASHRAE 52.2.

G. Condensate Pump

1. The Condensate pump shall have the capacity of 25 GPH at 40 ft. head. It shall be complete with integral float switch, discharge check valve, pump, motor assembly, and reservoir. A secondary float switch shall be provided to permit field wiring to the unit control to shut down the evaporator upon a high water level condition.

H. Condensate Pump Bracket

1. A condensate pump bracket shall be provided to mount condensate pump to the end of the unit and allow easy alignment and installation of the condensate pump.

I. SiteScan Site Monitoring System (or equiv.)

1. A Liebert SiteScan Site Monitoring System Model Sitelink SSW-2E shall be provided for remote monitoring of the Liebert Mini-Mate2 unit and monitoring of other Liebert support equipment. The Liebert SiteScan shall have the capability to monitor and change (at the user direction) the temperature and humidity setpoints and sensitivities of each unit. It shall also be capable of being programmed to print out environmental conditions or operating modes at each unit.

## 2.04 SPECIFICATIONS, WIRING SPECIFICATION, ORDERING INFORMATION

A. Power: 24VAC ±10%, 50 to 60 HZ, 24VA – or – 26VDC ±10%, 10W, 48VDC

B. Dimensions: (W x D x H: inches)
1. Module: 11.3 x 0.56 x 7.5
2. Enclosure (brush aluminum): 14.25 x 2.85 x 12

C. Communication Ports:

1. Ethernet Port: 10/100 Base-T Fast Ethernet port.

2. ARC156 Port: ARCNET156 or EIA-485 communication. In ARCNET 156 mode, the port communicates via BACnet ARC156.

3. TPI Port SI: EIA-232/422/485 configurable port for interaction with 3rd –party building automation systems via software-selectable protocols. May also be configured for remote modem access.

4. EIA-422/485 Ports 1-12: For communication with equipment via software-selectable. Each port can be individually set for different protocols & baud rates. The number of ports varies by model:

   **SiteLink-2E (SSW-2E); SiteLink-4E (SSW-4E); SiteLink-12E (SSW-12E)**

   a. Ports 11-12: These two ports include an option for EIA-232 connection
   b. Ports 9-12: These four ports include an option for EIA-232 connection
   c. Ports 1-12: Four of these 12 ports (9-12) include an option for EIA-232 connection

D. Environmental Operating Range: 20°F to 140°F (-29°C to 60°C); 10-90% relative humidity, non-condensing. Note: Control modules should be installed within the building.

E. Memory: 16 MByte non-volatile battery-backed SDRAM and 8 MByte Flash.

F. Power Protection: Built-in surge and transient protection circuitry – internal solid polyswitches on incoming power and network communications connections.

G. Battery: 3V lithium battery; Part Number CR-123A; battery shelf like is 10 years with 720 hours of continuous operation.

H. Fault Detection: Hardware watchdog timer.

I. Agency Listings: UL cUL, CE, FCC.

J. Connection Supported**;** Wire Types**;** Maximum Wire Length**;** Rating:

1. Ethernet 10 BaseT**;** CAT 5**;** 328 ft (100m)**;** N/A
2. BACnet Port**;** MAGNUM Cable - Part Number A3-ARC-156-3**;** 3000 ft. (915m)**;** NA
3. Port S1 EIA-485**;** 18-22 AWG Stranded & Shielded - 18 AWG is recommended, Non-Plenum-Belden 9461 / Plenum Belden 88761**;** 1000 ft. (300m)**;** N/A
4. Port S1 EIA-232 18-22 AWG Stranded & Shielded; 18AWG (recommended) Non Plenum – Belden 9461 / Plenum Belden 88761**;** 50 ft. (15m)**;** N/A

K. Quantity – Part # Description: SSW-2E SiteLink-2E with enclosure – communicates with up to 2 Liebert unit controllers.

## PART 3 - EXECUTION

### 3.01 GENERAL

A. General: Install air conditioning unit in accordance with manufacturer's installation instructions. Install unit plumb and level, firmly anchored in locations indicated and maintain manufacturer's recommended clearances.

B. Electrical Wiring: Install and connect electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's electrical connection diagram submittal to electrical contractor. Install and wire per local and national codes.

C. Piping Connections: Install and connect devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's piping connection diagram submittal to piping contractor.

D. Supply and Drain Water Piping: Connect water supply and drains to air conditioning unit. Unit drain shall be trapped internally and shall not be trapped externally.

E. Field-Supplied Pan: A field-supplied pan with drains shall be installed beneath cooling units and water /glycol condensing units.

### 3.02 EXAMINATION

A. The Contractor shall perform a detailed inspection of the site prior to submitting any technical data for approval.

B. The Contractor shall verify that the proposed equipment and methods of installation are compatible with the existing conditions and prepare a corresponding written report of their findings.

C. LAWA shall be notified in writing if modifications of the existing building are required in order to accommodate the new equipment. These modifications shall be made only upon receiving written approval from LAWA.

D. Submit Installation drawing for LAWA review and approval prior to any construction.

### 3.03 PREPARATION

### 3.04 INSTALLATION

### 3.05 QUALITY CONTROL

A. Site Test and inspections – Startup air conditioning unit in accordance with manufacturer's startup instructions. Test controls and demonstrate compliance with requirements.

B. Non-Conforming Work

**3.06 STARTUP**

**3.07 CLEANING**

**3.08 CLOSEOUT ACTIVITIES**

**3.09 MAINTENANCE**

# SECTION 23 81 23.16 HVAC FOR TELECOM ROOMS

## PART 1 - GENERAL

### 1.01 SUMMARY

A. These Specifications describe requirements for an environmental control system. The system shall be designed to control temperature and relative humidity conditions within the MPOE rooms (minimum point of entry).

B. The manufacturer shall design and furnish all equipment in the quantities and configurations shown on the project drawings.

C. System shall be supplied with CSA Certification to the harmonized U.S. and Canadian product safety standard CSA C22.2 No 236/UL 1995 for "Heating and Cooling Equipment and marked with the CSA c-us logo (60 Hz only).

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9. Section 01 77 16 – Final Closeout Review
10. Section 01 78 00 – Close Out Submittals

11. Section 27 05 00 – Basic Telecommunication Requirements

F. Products furnished (but not installed) under this section:

G. Products installed (but not furnished) under this section:

**1.02 PRICE AND PAYMENT PROCEDURES**

**1.03 REFERENCES**

**1.04 ADMINISTRATIVE REQUIREMENTS**

**1.05 SUBMITTALS**

A. Submittals shall be provided with the proposal and shall include: Dimensional, Electrical and Capacity data; Piping and Electrical Connection Drawings.

B. Manufacturer's Field Reports: Indicate conditions at initial start-up including date, and initial set points.

**1.06 QUALITY ASSURANCE**

A. The specified system shall be factory-tested before shipment. Testing shall include, but shall not be limited to: Quality Control Checks, "Hi-Pot" Test (two times rated voltage plus 1000 volts, per NRTL agency requirements) and Metering Calibration Tests. The System shall be designed and manufactured according to world class quality standards. The manufacturer shall be ISO 9001 certified.

**1.07 SUBSTITUTION OF EQUIPMENT**

A. Approval of alternate or substitute equipment or material in no way voids Specification requirements.

B. Under no circumstances shall the LAWA be required to prove that an item proposed for substitution is not equal to the specified item. It shall be mandatory that the Contractor submits to Engineer all evidence to support the contention that the item proposed for substitution is equal to the specified item. The Owner's decision as to the equality of substitution shall be final and without further recourse.

C. In the event that the Design Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Design Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Design

Consultant's expenses in connection with such additional services shall be paid by the Contractor and may be deducted from any moneys owed to the Contractor.

## 1.08 DELIVERY, STORAGE AND HANDLING

A. Submit manufacturers' instructions for storage, handling, protection, examination, preparation, operation, and installation of all products. Include any application conditions or limitations of use stipulated by any product testing agency.

## 1.09 FIELD/SITE CONDITIONS

## 1.10 WARRANTY

## PART 2 - PRODUCTS

### 2.01 DESIGN REQUIREMENTS

A. The environmental control system shall be a Liebert Mini-Mate2 factory assembled unit. On direct expansion models, the refrigeration system shall be split, with the compressor located in a remote or close-coupled condensing unit.

B. The evaporator section shall be designed for above dropped-ceiling installation.

C. Condensing Units shall be designed for either outdoor or above-dropped-ceiling installation.

D. The System shall have a total cooling capacity of 61,000 BTU/hr. and a sensible cooling capacity of 56,900 BTU/hr. based on the entering air condition of 77°F dry bulb, and 62°F wet bulb.

E. The unit is to be supplied for operation on a 460 volt, 3 phase, 60 Hz power supply.

F. LAWA approved Manufacturer and Model for Telecom Rooms (final sizing TBD).

1. Mechanical – CHW Air Unit w/Reheat/Humidification

    a. Provide (1) 5 Ton ceiling-mounted (outside room) chilled water air unit, model Liebert Mini-mate2 MMD92CDAHELA. Unit shall have reheat and humidification with sensible capacity of 56,900 BTUH at 77F. 42% RH. 460V, 3-PH, 19.8 FLA, 24.8 WSA, 25A MFCB. Insulated Chilled Water Piping with 2-Way Modulating Control Valve – 350 PSI, 13.3 GPM, 6.8 PSI Pressure Drop, 1.5 HP Motor, 2500 CFM @ 0.50 ESP.

2. Mechanical – CHW Air Unit (Cooling Only Option)

    a. Provide (1) 5 Ton ceiling-mounted (outside room) chilled water air unit, model Liebert Mini-mate2 MMD92CDA00LA. Unit shall have sensible capacity of 56,900 BTUH at 77F. 42% RH. 460V, 3-PH, 2.8 FLA, 3.5 WSA, 15A MFCB. Insulated Chilled Water Piping with 2-Way Modulating Control Valve – 350 PSI, 13.3 GPM, 6.8 PSI Pressure Drop, 1.5 HP Motor, 2500 CFM @ 0.50 ESP.

### 2.02 STANDARD FEATURES / ALL SYSTEMS

A. Evaporator Cabinet Construction

1. The cabinet and chassis shall be constructed of heavy gauge galvanized steel and shall be serviceable from one side only. Mounting brackets shall be factory-attached to the cabinet.

2. Internal cabinet insulation shall meet ASHRAE 62.1 requirements for Mold Growth, Humidity and Erosion, tested per UL 181 and ASTM 1338 standards.

B. Air Distribution

1. The fan shall be the belt-drive, centrifugal type, double width, double inlet. The shaft shall be heavy-duty steel with self-aligning ball bearings with minimum life of 100,000 hours. The fan motor shall be 1750 rpm and mounted on an adjustable base. The drive package shall be equipped with an adjustable motor pulley. The fan/motor assembly shall be mounted on vibration isolators.

2. The evaporator system shall be capable of delivering 2500 CFM at 0.50 inches of external static pressure. The fan motor shall be 1.5 HP.

3. System shall be suitable for ducted air distribution.

C. Microprocessor Control

1. The control system shall be microprocessor-based, factory-wired into the System cabinet and tested prior to shipment.

2. The wall-mounted control enclosure shall include a 2-line by 16-character liquid crystal display (LCD) providing continuous display of operating status and alarm condition which is wired into the control board using 4-conductor field-supplied wire.

3. A 7-key membrane keypad for setpoint/program control and unit On/Off shall be located below the display. The control display shall be field-wired to the control board using 4-conductor field-supplied thermostat wire.

4. Temperature and humidity sensors shall be located in the wall box, which shall be capable of being located up to 300 ft. from the evaporator unit.

D. Monitoring

1. The LCD shall provide an On/Off indication, operating mode indication (cooling, heating, humidifying, dehumidifying) and current day, time, temperature and humidity (if

applicable) indication. The monitoring system shall be capable of relaying unit operating parameters and alarms to the Liebert SitScan® Monitoring System.

E. Control Setpoint Parameters

1. Temp. Setpoint 65-85°F (18-29°C)
2. Temp. Sensitivity 1-9.9°F (1-5°C)
3. Humidity Setpoint 20-80% RH
4. Humidity Sensitivity 1-30% RH

F. Unit Controls

1. Compressor Short-Cycle Control

a. The control system shall prevent compressor short-cycling by a 3-minute timer from compressor stop to the next start.

2. Common Alarm and Remote On/Off

a. A common alarm relay shall provide a contact closure to a remote alarm device. Two (2) terminals shall also be provided for remote On/Off control. Individual alarms shall be “enabled” or “disabled” from reporting to a common alarm.

3. Setback Control

a. The control shall be user-configurable to use a manual setpoint or a programmable, time-based setback control. The setback control will be based on a 5 day/2day programmed weekly schedule with capability of accepting 2 events per program day.

4. Temperature Calibration

a. The control shall include the capabilities to calibrate the temperature and humidity sensors and adjust the sensor response delay time from 10 to 90 seconds. The control shall be capable of displaying temperature values for °F or °C.

5. System Auto Reset

a. For Startup after power failure, the system shall provide automatic restart with a programmable (up to 9.9 minutes in 6–second increments) time delay. Programming can be performed either at the wall-mounted controller or from the central site-monitoring System.

G. Alarms

1. Unit Alarm

    a. The control system shall monitor unit operation and activate an audible and visual alarm in the event of the following factory preset alarm conditions:

        1) High Temperature
        2) Low Temperature
        3) High Humidity
        4) Low Humidity
        5) High Water Alarm – Lockout Unit Operation
        6) High Head Pressure #1 and #2
        7) Loss of Power
        8) Compressor Short Cycle

2. Custom Alarms (2x)

    a. User-customized text can be entered for the two (2) custom alarms.

        1) Humidifier Problem
        2) Filter Clog
        3) Water Detected
        4) Smoke Detected

3. Alarm Controls

    a. Each alarm (unit and custom) shall be separately enabled or disabled, selected to activate the common alarm (except high head pressure).

4. Audible Alarm

    a. The audible alarm shall annunciate any alarm that is enabled by the operator.

5. Common Alarm

    a. A programmable common alarm shall be provided to interface user selected alarms with a remote alarm device.

6. Remote Monitoring

a. All alarms shall be communicated to the Liebert site monitoring system with the following information: (1) date and time of occurrence, (2) unit number, and (3) present temperature and humidity.

H. Chilled Water System Components

1. Chilled Water Control Valve (Modulating)
   a. A (2-way) (3-way) modulating, non-spring return valve controlled by the microprocessor to position the valve in response to room conditions. Design pressure shall be 400 psig static pressure with a maximum close-off pressure of 72 psi.

2. Chilled Water Coil
   b. The cooling coil shall have a minimum 5.6 sq.ft. face area, 4 rows deep, constructed of copper tubes and aluminum fins, and have a maximum face velocity of 444 FPM (2.26 m/s) at 2500 CFM. The coil shall be supplied with 45°F entering water temperature. The coil shall be supplied with 13.3 GPM of chilled water and the pressure drop shall not exceed 6.8 PSI. The coil assembly shall be mounted in a stainless steel condensate drain pan with internally trapped drain line.

## 2.03 FACTORY-INSTALLED OPTIONS

A. Steam Generating Humidifier (optional) **Design Engineer to Finalized These Options with LAWA Prior to Bid**

1. The environmental control system shall be equipped with a steam generating humidifier that is controlled by the microprocessor control system. It shall be complete with disposable canister, all supply and drain valves, steam distributor and electronic controls. The need to change canister shall be annunciated on the microprocessor wall box control panel. The humidifier shall have a capacity of 8.0 lb/hr. An LED light on the humidifier assembly shall indicate cylinder full, overcurrent detection; fill system fault and end of cylinder life conditions.

*B.* Electric Reheat (optional) ***Design Engineer to Finalized These Options with LAWA Prior to Bid***

1. The electric reheat shall be low-watt density, 304/304 stainless steel, finned-tubular and shall be capable of maintaining room dry bulb conditions when the system is calling for dehumidification. The reheat section shall include an agency-approved safety switch to

protect the system from overheating. The capacity of the reheat coils shall be 39,110 (11.5kW) BTU/HR, with unit input voltage of 460V, controlled in two stages.

C. Disconnect Switch – Non-Locking

1. The electric reheat shall be low-watt density, 304/304 stainless steel, finned-tubular and shall be capable of maintaining room dry bulb conditions when the system is calling for dehumidification. The reheat section shall include a UL approved safety switch to protect the system from overheating. The capacity of the reheat coils shall be 39,110 BTU/HR (11.5kW), with unit input voltage of 460V, controlled in two stages.

D. Smoke Sensor

1. The smoke sensor shall immediately shut down the environmental control system and activate the alarm system when activated. The sensing element shall sense the return air conditions. This smoke sensor shall not function or replace any room smoke detection system that may be required by local or national codes.

E. Filter Clog Switch

1. The filter clog switch senses pressure drop across the filters and shall annunciate the wall-box display upon exceeding the adjustable setpoint.

**2.04 SHIP – LOOSE ACCESSORIES**

A. Filter Box / Duct Flange

1. The evaporator section shall be supplied with an air filter box for use with ducted installations. Two (2) filters shall be included 4” x 20” x 20” (102mm x 508mm x 508mm) each, deep-pleated type, with a MERV8 rating, based on ASHRAE 52.2. A duct flange shall be supplied for use on the supply air opening of the unit.

B. Condensate Pump

1. The Condensate pump shall have the capacity of 25 GPH at 40 ft. head. It shall be complete with integral float switch, pump, motor assembly, discharge check valve, duct/wall mountable bracket and reservoir. A secondary float switch shall be provided to permit field wiring to the unit control to shut down the evaporator upon a high water level condition.

C. Condensate Pump Bracket

1. A condensate pump bracket shall be provided to mount condensate pump to the end of the unit and allow easy alignment and installation of the condensate pump.

D. Refrigerant Line Sweat Adapter Kit

1. Provide a sweat adapter kit to permit field brazing of refrigerant line connections.

E. Single Point Power Kit

1. A single point power kit shall be provided for a close-coupled system to allow a single electrical power feed to supply power to both the evaporator and indoor close-coupled condensing unit.

F. SiteScan Site Monitoring System (or equiv.)

1. A Liebert SiteScan Site Monitoring System Model Sitelink SSW-2E shall be provided for remote monitoring of the Liebert Mini-Mate2 unit and monitoring of other Liebert support equipment. The Liebert SiteScan shall have the capability to monitor and change (at the user direction) the temperature and humidity setpoints and sensitivities of each unit. It shall also be capable of being programmed to print out environmental conditions or operating modes at each unit.

## 2.05 SPECIFICATIONS, WIRING SPECIFICATION, ORDERING INFORMATION

A. Power: 24VAC ±10%, 50 to 60 HZ, 24VA – or – 26VDC ±10%, 10W, 48VDC

B. Dimensions: (W x D x H: inches)
1. Module: 11.3 x 0.56 x 7.5
2. Enclosure (brush aluminum): 14.25 x 2.85 x 12

C. Communication Ports:

1. Ethernet Port: 10/100 Base-T Fast Ethernet port

2. ARC156 Port: ARCNET156 or EIA-485 communication. In ARCNET 156 mode, the port communicates via BACnet ARC156.

3. TPI Port SI: EIA-232/422/485 configurable port for interaction with 3rd –party building automation systems via software-selectable protocols. May also be configured for remote modem access.

4. EIA-422/485 Ports 1-12: For communication with equipment via software-selectable. Each port can be individually set for different protocols & baud rates. The number of ports varies by model:
   **SiteLink-2E (SSW-2E); SiteLink-4E (SSW-4E); SiteLink-12E (SSW-12E)**

   a. Ports 11-12: These two ports include an option for EIA-232 connection
   b. Ports 9-12: These four ports include an option for EIA-232 connection
   c. Ports 1-12: Four of these 12 ports (9-12) include an option for EIA-232 connection

D. Environmental Operating Range: 20°F to 140°F (-29°C to 60°C); 10-90% relative humidity, non-condensing. Note: Control modules should be installed within the building.

E. Memory: 16 MByte non-volatile battery-backed SDRAM and 8 MByte Flash.

F. Power Protection: Built-in surge and transient protection circuitry – internal solid polyswitches on incoming power and network communications connections.

G. Battery: 3V lithium battery; Part Number CR-123A; battery shelf like is 10 years with 720 hours of continuous operation.

H. Fault Detection: Hardware watchdog timer.

I. Agency Listings: UL cUL, CE, FCC.

J. Connection Supported**;** Wire Types**;** Maximum Wire Length**;** Rating:

1. Ethernet 10 BaseT**;** CAT 5**;** 328 ft (100m)**;** N/A
2. BACnet Port**;** MAGNUM Cable - Part Number A3-ARC-156-3**;** 3000 ft. (915m)**;** NA
3. Port S1 EIA-485**;** 18-22 AWG Stranded & Shielded - 18 AWG is recommended, Non-Plenum-Belden 9461 / Plenum Belden 88761**;** 1000 ft. (300m)**;** N/A
4. Port S1 EIA-232 18-22 AWG Stranded & Shielded; 18AWG (recommended) Non Plenum – Belden 9461 / Plenum Belden 88761**;** 50 ft. (15m)**;** N/A

K. Quantity – Part # Description: SSW-2E SiteLink-2E with enclosure – communicates with up to 2 Liebert unit controllers.

## PART 3 - EXECUTION

### 3.01 GENERAL

A. General: Install air conditioning unit in accordance with manufacturer's installation instructions. Install unit plumb and level, firmly anchored in locations indicated and maintain manufacturer's recommended clearances.

B. Electrical Wiring: Install and connect electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's electrical connection diagram submittal to electrical contractor. Install and wire per local and national codes.

C. Piping Connections: Install and connect devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's piping connection diagram submittal to piping contractor.

D. Supply and Drain Water Piping: Connect water supply and drains to air conditioning unit. Unit drain shall be trapped internally and shall not be trapped externally.

E. Field-Supplied Pan: A field-supplied pan with drains shall be installed beneath cooling units and water /glycol condensing units.

### 3.02 EXAMINATION

A. The Contractor shall perform a detailed inspection of the site prior to submitting any technical data for approval.

B. The Contractor shall verify that the proposed equipment and methods of installation are compatible with the existing conditions and prepare a corresponding written report of their findings.

C. LAWA shall be notified in writing if modifications of the existing building are required in order to accommodate the new equipment. These modifications shall be made only upon receiving written approval from LAWA.

D. Submit Installation drawing for LAWA review and approval prior to any construction.

### 3.03 PREPARATION

### 3.04 INSTALLATION

### 3.05 FIELD QUALITY CONTROL

A. Site Test and inspections – Startup air conditioning unit in accordance with manufacturer's startup instructions. Test controls and demonstrate compliance with requirements.

B. Non-Conforming Work

**3.06 STARTUP**

**3.07 CLEANING**

**3.08 CLOSEOUT ACTIVITIES**

**3.09 MAINTENANCE**

END OF SECTION

# SECTION 23 81 26-SPLIT-SYSTEM AIR-CONDITIONERS (DUCTED)

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Air handling unit.
2. Condensing unit.

B. This applies to units less than 5 tons.

### 1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
3. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
4. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. ASTM International:

1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

D. National Electrical Manufacturers Association:

1. NEMA MG 1 - Motors and Generators.

E. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

### 1.3 SUBMITTALS

A. Product Data: Submit data indicating:

1. Cooling and heating capacities.
2. Dimensions.

3. Weights.
4. Rough-in connections and connection requirements.
5. Duct connections.
6. Electrical requirements with electrical characteristics and connection requirements.
7. Controls.
8. Accessories.

B. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

## 1.4 QUALITY ASSURANCE

A. Performance Requirements: Energy Efficiency Rating (EER) and Coefficient of Performance (COP) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with ARI Standards.

## 1.5 WARRANTY

A. Minimum one-year warranty.

# PART 2 - PRODUCTS

## 2.1 SPLIT SYSTEM AIR CONDITIONING UNITS

A. Manufacturers:

**1. Carrier.**
**2. Trane.**
**3. York.**

B. Product Description: Split system consisting of air handling unit and condensing unit including cabinet, evaporator fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, air filters, controls, air handling unit accessories, condensing unit accessories, and refrigeration specialties.

C. Refrigerants R-410A and R-407C.

## 2.2 AIR HANDLING UNIT

A. Cabinet:

1. Panels: Constructed of galvanized steel with baked enamel finish. Access Panels: Located on both sides of unit. Furnish with duct collars on inlets and outlets.
2. Insulation: Factory applied to each surface to insulate entire cabinet. One inch thick neoprene coated aluminum foil faced glass fiber with edges protected from erosion.

B. Evaporator Fan: Forward curved centrifugal type, resiliently mounted with adjustable belt drive and high efficiency motor. Motor permanently lubricated with built-in thermal overload protection.

C. Evaporator Coil: Constructed of copper tubes expanded onto aluminum fins. Factory leak tested under water. Removable, PVC construction, double-sloped drain pan with piping connections on both sides.

D. Refrigeration System: Single or Dual refrigeration circuits controlled by factory installed thermal expansion valve.

E. Hot Water Heating Coil: Factory mounted Field installed with casing to match unit construction. Coil: Constructed of copper tubes expanded into aluminum fins. Factory leak tested under water.

F. Air Filters: 1 inch thick glass fiber disposable media in metal frames. 25 to 30 percent efficiency based on ASHRAE 52.1.

## 2.3 CONDENSING UNIT

A. General: Factory assembled and tested air cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.

B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, motors, and drives.

C. Compressor: Single refrigeration circuit or Two independent refrigeration circuits with rotary or hermetic semi-hermetic reciprocating type compressors, resiliently mounted, with positive lubrication, and internal motor overload protection.

D. Condenser Coil: Constructed of copper tubing mechanically bonded to copper fins, factory leak and pressure tested. Coil shall be coated with minimum 1.0 mil. aluminum impregnated polyurethane coating by Blygold PoluAl XT or approved equal. Coating shall withstand 4,000 hours in both salt spray test per ASTM B117 and acid salt spray test per ASTM D5339.

E. Controls: Furnish operating and safety controls including high and low pressure cutouts. Control transformer. Furnish magnetic contactors for compressor and condenser fan motors.

F. Condenser Fans and Drives: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Permanently lubricated ball bearing type motors with built-in thermal overload protection. Furnish high efficiency fan motors.

G. Condensing Unit Accessories: Furnish the following accessories:

1. Controls to provide low ambient cooling to 0 degrees F.
2. Time delay relay.
3. Anti-short cycle timer.

4. Disconnect switch.
5. Vibration isolators.
6. Hot gas bypass kit.
7. Coil with corrosion resistant coating capable of withstanding salt spray test of 1000 hours in accordance with ASTM B117.
8. Condenser Coil Guard: Condenser fan openings furnished with PVC coated steel wire safety guards.
9. Suction and discharge pressure gauges.

H. Refrigeration specialties: Furnish the following for each circuit:

1. Charge of compressor oil.
2. Holding charge of refrigerant.
3. Replaceable core type filter drier.
4. Liquid line sight glass and moisture indicator.
5. Shut-off valves on suction and liquid piping.
6. Liquid line solenoid valve.
7. Charging valve.
8. Oil level sight glass.
9. Crankcase heater.
10. Hot gas muffler.
11. Pressure relief device.

## 2.4 CONTROLS

A. Capability to interface with BAS (Building Automation System).

# PART 3 - EXECUTION

## 3.1 INSTALLATION - AIR HANDLING UNIT

A. Install per manufacturer’s recommendations.

B. Install condensate piping with trap and route from drain pan to approved receptor.

## 3.2 TRAINING

A. Training to include maximum of 15 LAWA personnel for 40 hour training, 16 hours shall be classroom training and 24 hours shall be hands-on training.

END OF SECTION 23 81 26

# SECTION 23 81 27-DUCTLESS SPLIT-SYSTEM AIR-CONDITIONERS

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Fan Coil Unit.
2. Condensing unit.
3. For units/systems up to three tons maximum.

B. This applies to units less than 5 tons.

### 1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:

1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
3. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
4. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. ASTM International:

1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

D. National Electrical Manufacturers Association:

1. NEMA MG 1 - Motors and Generators.

E. National Fire Protection Association:

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

### 1.3 SUBMITTALS

A. Product Data: Submit data indicating:

1. Cooling and heating capacities.

2. Dimensions.
3. Weights.
4. Rough-in connections and connection requirements.
5. Electrical requirements with electrical characteristics and connection requirements.
6. Controls.
7. Accessories.

B. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

## 1.4 QUALITY ASSURANCE

A. Performance Requirements: Energy Efficiency Rating (EER) and Coefficient of Performance (COP) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with ARI Standards.

# PART 2 - PRODUCTS

## 2.1 SPLIT SYSTEM AIR CONDITIONING UNITS

A. Product Description: Split system consisting of fan coil unit and condensing unit including cabinet, evaporator fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, air filters, controls, air handling unit accessories, condensing unit accessories, and refrigeration specialties.

B. Manufacturers:

**1. Mitsubishi.**
**2. Daikin.**
**3. Sanyo.**

C. Refrigerants R-410A and R-407C.

## 2.2 FAN COIL UNIT

A. Cabinet:

1. Panels: Constructed of galvanized steel with baked enamel finish. Access Panels: Located on both sides of unit. Furnish with duct collars on inlets and outlets.
2. Insulation: Factory applied to each surface to insulate entire cabinet. One inch thick neoprene coated aluminum foil faced glass fiber with edges protected from erosion.

B. Evaporator Fan: Forward curved centrifugal type, resiliently mounted with adjustable belt drive and high efficiency motor. Motor permanently lubricated with built-in thermal overload protection.

C. Evaporator Coil: Constructed of copper tubes expanded onto copper fins. Factory leak tested under water. Removable, PVC construction, double-sloped stainless steel drain pan with piping connections on both sides. Coil shall be coated with minimum 1.0 mil. aluminum impregnated polyurethane coating by Blygold PoluAl XT or approved equal. Coating shall withstand 4,000 hours in both salt spray test per ASTM B117 and acid salt spray test per ASTM D5339.

D. Refrigeration System: Single or Dual refrigeration circuits controlled by factory installed thermal expansion valve. Refrigerant shall be R407C or R410A.

E. Air Filters: 1 inch thick glass fiber disposable media in metal frames. 25 to 30 percent efficiency based on ASHRAE 52.1.

F. Unit shall be wall mounted, ceiling mounted, or ceiling cassette type (integral with grid).

## 2.3 CONDENSING UNIT

A. General: Factory assembled and tested air cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.

B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, motors, and drives.

C. Compressor: Single refrigeration circuit or two independent refrigeration circuits with rotary or hermetic semi-hermetic reciprocating type compressors, resiliently mounted, with positive lubrication, and internal motor overload protection. Compressor shall five (5) year warranty.

D. Condenser Coil: Constructed of copper tubing mechanically bonded to copper fins, factory leak and pressure tested. Coil shall be coated with minimum 1.0 mil. aluminum impregnated polyurethane coating by Blygold PoluAl XT or approved equal. Coating shall withstand 4,000 hours in both salt spray test per ASTM B117 and acid salt spray test per ASTM D5339.

E. Controls: Furnish operating and safety controls including high and low pressure cutouts. Control transformer. Furnish magnetic contactors for compressor and condenser fan motors.

F. Condenser Fans and Drives: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Permanently lubricated ball bearing type motors with built-in thermal overload protection. Furnish high efficiency fan motors.

G. Condensing Unit Accessories: Furnish the following accessories:

1. Controls to provide low ambient cooling to 0 degrees F.
2. Time delay relay.
3. Anti-short cycle timer.
4. Disconnect switch.
5. Vibration isolators.
6. Hot gas bypass kit.

7. Coil with corrosion resistant coating capable of withstanding salt spray test of 1000 hours in accordance with ASTM B117.
8. Condenser Coil Guard: Condenser fan openings furnished with PVC coated steel wire safety guards.
9. Suction and discharge pressure gauges.

H. Refrigeration specialties: Furnish the following for each circuit:

1. Charge of compressor oil.
2. Holding charge of refrigerant.
3. Replaceable core type filter drier.
4. Liquid line sight glass and moisture indicator.
5. Shut-off valves on suction and liquid piping.
6. Liquid line solenoid valve.
7. Charging valve.
8. Oil level sight glass.
9. Crankcase heater.
10. Hot gas muffler.
11. Pressure relief device.

## 2.4 CONTROLS

A. Capability to interface with BAS (Building Automation System).

# PART 3 - EXECUTION

## 3.1 INSTALLATION – FAN COIL UNIT

A. Install per manufacturer's recommendations. Where appropriate, provide 2" deflection spring vibration isolators and seismic restraints.

B. Install condensate piping with trap and route from drain pan to approved receptor.

C. Training include minimum of 15 LAWA personnel for 40 hours training, 16 hours shall be classroom training and 24 hours shall be hands on training.

END OF SECTION 23 81 27

## HVAC Equipment Standards

| Equipment Type | Specified Manufacturers | Remarks | Specifications Section |
|---|---|---|---|
| Air Handling Units | Energy Labs,<br>Temtrol<br>Pace | Custom air handler unit;<br>4-stage filtration (65% pre-filter, bipolar ionization, carbon, MERV 13 final);<br>UV lights;<br>100% economizer | 23 74 13 – Packaged Outdoor Air Handling Units |
| Chilled Water Fan Coil Units | Trane<br>Carrier<br>York | Stainless steel drain pan w/leak detection;<br>Belt drive fans;<br>2" pleated MERV 11 filters;<br>Condensate pump | 23 82 19 – Fan Coil Units |
| VAV Boxes | Price<br>Titus<br>Krueger | Digital controller;<br>Hydronic heating coil - 2 row;<br>Lined discharge attenuator section (minimum 36" long) | 23 36 00 – Air Terminal Units |
| DX Self-Contained Air Conditioning Units | Liebert<br>Stulz-ATS<br>APC | Ceiling mounted or floor type;<br>Self-contained units type up to 3-tons;<br>Close-coupled units type over 3-tons;<br>Condensate pump;<br>Stainless steel drain pan w/leak detection | 23 81 23 – Computer Room Air Conditioners |
| Fans | Greenheck<br>Loren Cook<br>Barry Blower Co. | Belt drive w/motor cover and belt guard;<br>Upblast configuration for roof mounted fans ;<br>Stainless steel construction for grease applications;<br>Speed controller | 23 34 00 – HVAC Fans |
| Diffusers | Anemostat Products<br>Price<br>Titus | | 23 37 00 – Air Outlets and Inlets |
| Chillers | Carrier<br>Trane<br>York | | 23 64 11 – Package Water Chillers<br>23 64 16 – Centrifugal Water Chillers |
| Heat Exchangers | Armstrong Pumps<br>Bell & Gossett<br>Taco | | 23 57 00 – Heat Exchangers for HVAC |
| Boilers | Ajax<br>Lochinvar<br>Raypak | Temporary system | 23 52 00 – Heating Boilers |
| Valves | Milwaukee Valve Co.<br>Nibco<br>Crane | | 22 05 23 – General Duty Valves for Plumbing Piping<br>23 05 23 – General Duty Valves for HVAC Piping |

| Equipment Type | Specified Manufacturers | Remarks | Specifications Section |
|---|---|---|---|
| Dampers | Pottorff<br>Ruskin<br>Air Balance Inc | | 23 33 00 – Air Duct Accessories |
| Actuators | Belimo<br>Honeywell<br>Johnson Controls | | 23 09 00 – Instrumentation and Control for HVAC |
| Cooling Towers | Baltimore Aircoil Company<br>Delta Cooling Towers<br>Evapco Inc | Temporary system | 23 65 00 – Cooling Towers |
| Pumps | Armstrong Pumps<br>Bell & Gossett<br>Taco | | 23 21 13 – Hydronic Pumps |
| Vibration Isolators | The VMC Group<br>Mason Industries<br>M.W. Sausse and Co., Inc. | | 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment<br>23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment |
| Hangers and Supports | B-line Systems, Inc.<br>PHD Manufacturing, Inc.<br>Tolco, Inc. | | 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment<br>23 05 29 – Hangers and Supports for HVAC Piping and Equipment |
| BAS | Alerton<br>JCI<br>Siemens | | 25 20 00 – Building Automation System |
| FMCS | Vykon/ Niagara Framework (Tridium)<br>Or Approved Equal | | 25 09 00 – Facility Monitoring and Control System |

## Fire Protection Equipment Standards

| Equipment Type | Specified Manufacturers | Specification Section |
|---|---|---|
| Valves | Nibco<br>Viking<br>Clow | 21 12 00 – Fire Suppression Standpipes |
| Sprinklers | Viking<br>Grinnell<br>Reliable Sprinkler | 21 13 13 – Wet-Pipe Sprinkler Systems |
| Spray Heads | Viking<br>Grinnell<br>Reliable Sprinkler | 21 13 26 – Deluge Fire-Suppression Sprinkler Systems |

| Equipment Type | Specified Manufacturers | Specification Section |
|---|---|---|
| Fire Pumps | Peerless<br>A-C Fire Pumps<br>Patterson Pump Co. | 21 30 00 – Fire Pumps |
| Pressure Booster (Jockey) Pump | A-C Fire Pumps<br>Patterson Pump Co.<br>MTH Pumps | 21 30 00 – Fire Pumps |

Los Angeles World Airports

# LAWA Commissioning Forms

PROJECT:_____

Equipment Name/Tag:_____ Location:_____

System /Area Served: _____ Related Equipment: _____

## Air Handling Unit

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial Number | N/A | | |
| 4 | Cooling Capacity (MBH/gpm) | / | / | |
| 5 | Heating Capacity (MBH/gpm) | / | / | |
| 6 | Supply Air Flow, Design / Minimum (cfm) | / | / | |
| 7 | Supply Fan Motor Power / Speed (hp/rpm) | / | / | |
| 8 | Return Air flow, Design / Minimum (cfm) | | | |
| 9 | Return Fan Motor Power / Speed (hp/rpm) | | | |
| 10 | Voltage / Phase / Frequency (V / - / Hz) | / / | / / | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | Coil surface areas are free of damage | Yes | No | |
| 3 | The air openings are sealed with plastic | Yes | No | |
| 4 | The water openings are sealed with plastic plugs | Yes | No | |
| 5 | All components present and in proper order | Yes | No | |
| 6 | All access doors are operable | Yes | No | |
| 7 | Installation and startup manual provided | Yes | No | |
| 8 | Unit tags affixed | Yes | No | |
| **2** | **Construction Checklist** | | | |
| **A** | **Installation of AHU** | | | |
| 1 | Unit secured as required by manufacturing and specifications | Yes | No | |
| 2 | Adequate clearance around unit for service | Yes | No | |
| 3 | All components accessible for maintenance | Yes | No | |
| 4 | Unit can be removed from the building | Yes | No | |
| 5 | Cooling coil drain pan slopes correctly | Yes | No | |
| 6 | Internal vibration isolators in good condition and shipping bolts are removed | Yes | No | |
| 7 | Belts are tight | Yes | No | |
| 8 | Unit labeled and is easy to see | Yes | No | |
| | | | | |

**Contactor:** **LAWA Representative:**

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# LAWA Commissioning Forms

## Air Handling Unit (Continued)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **B** | **Chilled Water Piping** | | | |
| 1 | All piping components have been installed (in the correct order) as required by detail drawing | Yes | No | |
| 2 | Piping arranged for ease of unit /coil removal | Yes | No | |
| 3 | Piping supported as required by specification | Yes | No | |
| 4 | Piping is clean | Yes | No | |
| 5 | Piping insulation is complete and installed as per specifications | Yes | No | |
| 6 | All valves and test ports are easily accessible | Yes | No | |
| 7 | Valve tags attached | Yes | No | |
| **C** | **Hot Water Piping** | | | |
| 1 | All piping components have been installed (in the correct order) as required by detail drawing | Yes | No | |
| 2 | Piping arranged for ease of unit/coil removal | Yes | No | |
| 3 | Piping supported as required by specifications | Yes | No | |
| 4 | Piping is clean | Yes | No | |
| 5 | Piping insulation is complete and installed per specifications | Yes | No | |
| 6 | All valves and test ports are easily accessible | Yes | No | |
| 7 | Valve tags attached | Yes | No | |
| **D** | **Ductwork** | | | |
| 1 | Adequate locations available for testing and balancing of unit | Yes | No | |
| 2 | All dampers and sensors are accessible (access panels) | Yes | No | |
| 3 | Outdoor and return air arrangement will not freeze coils, i.e. outdoor air and return air is adequately mixed before reaching coils | Yes | No | |
| 4 | Vibration isolators installed | Yes | No | |
| 5 | All dampers close tightly and stroke fully and easily | Yes | No | |
| 6 | Ductwork is clean and free of debris | Yes | No | |
| **E** | **Electrical** | | | |
| 1 | Local disconnect installed in accessible location | Yes | No | |
| 2 | Motor rotation in the proper direction | Yes | No | |
| 3 | All electrical connections are tight | Yes | No | |
| 4 | All electrical components are grounded | Yes | No | |
| 5 | VFD installed (if applicable) | Yes | No | |
| **F** | **Controls – installation** | | | |
| 1 | Control panel accessible and labeled properly | Yes | No | |
| 2 | Temperature, humidity, pressure, and $CO_2$ sensors(as applicable) are installed and calibrated | Yes | No | |
| 3 | Dampers actuators installed and calibration verified | Yes | No | |
| 4 | Hot and chilled water actuators installed and calibration verified | Yes | No | |
| 5 | Safety items installed and verified (freezestat, high pressure, motor overland, etc.) | Yes | No | |

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# LAWA Commissioning Forms

## Air Handling Unit (Continued)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **G** | **Mechanical – startup** | | | |
| 1 | Unit is clean | Yes | No | |
| 2 | Internal isolators free to move | Yes | No | |
| 3 | Fans and motors lubricated and aligned | Yes | No | |
| 4 | Fan belts have proper tension and in good condition | | | |
| 5 | Protective shrouds for fans and belts in place and secure | Yes | No | |
| 6 | Terminal unit dampers manually opened or are controllable and open | Yes | No | |
| 7 | Filters installed properly (no bypass air) and are clean | Yes | No | |
| 8 | System starts and runs without any unusual noise or vibration | Yes | No | |
| 9 | Manufacturer's startup checklist completed and attached | Yes | No | |
| **H** | **Controls – startup** | | | |
| 1 | Cooling sequence of control verified | Yes | No | |
| 2 | Heating sequence of control verified | Yes | No | |
| 3 | Warm-up sequence of control verified | Yes | No | |
| 4 | Cool-down sequence of control verified | Yes | No | |
| 5 | Economizer sequence of control verified | Yes | No | |
| 6 | Unoccupied sequence of control verified | Yes | No | |
| **I** | **TAB** | | | |
| 1 | Filters and coils are clean | Yes | No | |
| 2 | Motor rotation verified – each motor | Yes | No | |
| 3 | Motor voltage and amps verified – each phase of each motor | Yes | No | |
| 4 | Fan RPM verified – each fan | Yes | No | |
| 5 | Entering and leaving cooling coil air temperature (°F) | Yes | No | |
| 6 | Entering and leaving heating coil temperature (°F) | Yes | No | |
| 7 | Entering and leaving chilled water temperature (°F) | Yes | No | |
| 8 | Entering and leaving hot water temperature (°F) | Yes | No | |
| 9 | Coil flow and air/water pressure drops verified – each coil | Yes | No | |
| | | | | |

**"NO" Responses**

| Item | Date | Reason for "NO" response |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

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# LAWA Commissioning Forms

## Boiler, Hot Water

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial number | N/A | | |
| 4 | Total Heating Capacity (MBH) | | | |
| 5 | Voltage / Phase / Frequency ( V/ -/ Hz) | / / | / / | |
| 6 | Entering / Leaving Hot Water Temperature (°F) | / | / | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | The water openings are sealed with plastic plugs | Yes | No | |
| 3 | All components present | Yes | No | |
| 4 | Installation and startup manual provided | Yes | No | |
| 5 | Unit tags affixed | Yes | No | |
| **2** | **Construction checklist** | | | |
| **A** | **Installation of Boiler** | | | |
| 1 | Unit secured as required by manufacturer and specifications | Yes | No | |
| 2 | Adequate clearance around unit for service | Yes | No | |
| 3 | All components accessible for maintenance | Yes | No | |
| 4 | Unit can be removed from building | Yes | No | |
| 5 | Flue completely installed and properly sloped | Yes | No | |
| 6 | Unit labeled and is easy to see | Yes | No | |
| **B** | **Piping** | | | |
| 1 | All piping components have been installed (in the correct order) as required by detail drawing | Yes | No | |
| 2 | Piping arranged for ease of unit removal | Yes | No | |
| 3 | Piping supported as required by specifications | Yes | No | |
| 4 | Piping is clean | Yes | No | |
| 5 | Piping insulation is complete and installed as per specifications | Yes | No | |
| 6 | Thermometers and pressure gauges on supply and return lines | Yes | No | |
| 7 | All valves and test ports are easily accessible | Yes | No | |
| 8 | Valve tags attached | Yes | No | |
| **C** | **Electrical** | | | |
| 1 | Local disconnect installed in accessible location | Yes | No | |
| 2 | All electrical connections are tight | Yes | No | |
| 3 | All electrical components are grounded | Yes | No | |
| | | | | |
| | | | | |

**Contactor:** **LAWA Representative:**

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# LAWA Commissioning Forms

## Boiler, Hot Water (Continued)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **D** | **Controls - Installation** | | | |
| 1 | Control panel accessible and labeled properly | Yes | No | |
| 2 | Remote start and stop verified | Yes | No | |
| 3 | Hot water temperature reset signal verified ( if applicable) | Yes | No | |
| 4 | Test ports installed near all control sensors | Yes | No | |
| 5 | Actuators installed and calibration verified | Yes | No | |
| **E** | **Mechanical - Startup** | | | |
| 1 | System flushed, filled, and air purged | Yes | No | |
| 2 | Burner adjusted to proper settings | Yes | No | |
| 3 | System starts and runs without any unusual noise or vibration | Yes | No | |
| 4 | Manufacturer's startup checklist completed and attached | Yes | No | |
| 5 | $CO_2$ and CO values from burner adjustment (ppm/ppm) | Yes | No | |
| **F** | **Controls –Startup** | | | |
| 1 | Low water switch operational | Yes | No | |
| 2 | Temperature sensors operational and calibrated | Yes | No | |
| 3 | Flow switch operational | Yes | No | |
| 4 | High pressure/ temperature cut out operational | Yes | No | |
| 5 | Unit operation sequence verified and correct | Yes | No | |
| | | | | |

**"NO" Responses:**

| Item | Date | Reason for "NO" responses |
|---|---|---|
| | | |
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# LAWA Commissioning Forms

## Centrifugal Chiller

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial number | N/A | | |
| 4 | Capacity (tons) | | | |
| 5 | Condenser Fluid Type | | | |
| 6 | Condenser Fluid Flow rate (gpm) | | | |
| 7 | Chilled Fluid Type | | | |
| 8 | Chilled Fluid Flow rate (gpm) | | | |
| 9 | Refrigerant Type | | | |
| 10 | Compressor Motor Power (kW) | | | |
| 11 | Compressor Motor Voltage / Phase / Frequency (V / - / Hz) | / / | / / | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | Openings are sealed with plastic | Yes | No | |
| 3 | All components present (cooler, condenser, compressor, motor, etc) | Yes | No | |
| 4 | Motor bearings are double sealed and permanently lubricated | Yes | No | |
| 5 | Electrical disconnect is provided | Yes | No | |
| 6 | Installation and startup manual provided | Yes | No | |
| 7 | Unit tags affixed | Yes | No | |
| **2** | **Construction checklist** | | | |
| **A** | **Installation of Chiller** | | | |
| 1 | Unit secured as required by manufacturer and specifications | Yes | No | |
| 2 | There is a minimum of 36 inches of clearance around entire unit | Yes | No | |
| 3 | There is a minimum of 48 inches of clearance in front of starter or VFD | Yes | No | |
| 4 | There is a minimum clearance of one unit length for tube pull space | Yes | No | |
| 5 | All components are accessible for maintenance | Yes | No | |
| 6 | Unit labeled and is easy to see | Yes | No | |
| **B** | **Refrigerant** | | | |
| 1 | Full tightened by chiller startup technician | Yes | No | |
| 2 | Unit factory leak tested and report is attached | Yes | No | |
| 3 | Relief piped to outdoors | Yes | No | |
| 4 | Refrigerant monitor installed and operational before refrigerant loaded | Yes | No | |
| 5 | Drip leg and flex connector at unit connection to relief piping | Yes | No | |
| | | | | |

**Contactor:** **LAWA Representative:**

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# LAWA Commissioning Forms

## Centrifugal Chiller (Continued)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **C** | **Electrical** | | | |
| 1 | Lugs tightened by chiller startup technician | Yes | No | |
| 2 | Safety disconnect switch installed in an accessible location | Yes | No | |
| 3 | Lug sizing matches wire size requirement | Yes | No | |
| 4 | Primary and secondary fused control power transformer provided | Yes | No | |
| 5 | Star-delta starter provided | Yes | No | |
| 6 | AIC and withstand ratings exceed available fault shown on electrical drawing s | Yes | No | |
| 7 | VFD installed (if applicable) | Yes | No | |
| **D** | **Controls - Installation** | | | |
| 1 | Control panel accessible and labeled properly | Yes | No | |
| 2 | All sensors are installed and calibrated | Yes | No | |
| 3 | Safety items installed and verified | Yes | No | |
| **E** | **Controls - Startup** | | | |
| 1 | Unit voltage and amps verified | Yes | No | |
| 2 | Remote start and stop signal verified | Yes | No | |
| 3 | Chilled water reset signal verified | Yes | No | |
| 4 | Demand limiting signal verified | Yes | No | |
| 5 | Unit "run" sequences verified | Yes | No | |
| 6 | Unit "alarm" sequences verified | Yes | No | |
| **F** | **Mechanical - Startup** | | | |
| 1 | Manufacturer's startup checklist completed and attached | Yes | No | |
| 2 | The following safety controls are operational and have been verified | Yes | No | |
| 3 | Low chilled water temperature | Yes | No | |
| 4 | High refrigerant pressure | Yes | No | |
| 5 | Low oil flow protection | Yes | No | |
| 6 | Loss of chilled water flow | Yes | No | |
| 7 | Loss of condenser flow | Yes | No | |
| 8 | Loss of refrigerant protection | Yes | No | |
| 9 | Motor current overload | Yes | No | |
| 10 | Phase reversal / unbalance/single phasing | Yes | No | |
| 11 | Over/ under voltage | Yes | No | |
| 12 | Failure of water temperature sensor used by controller | Yes | No | |
| 13 | Full load test to verify load limiting | Yes | No | |
| 14 | System starts and runs without any unusual noise or vibration | Yes | No | |
| | | | | |
| | | | | |

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# LAWA Commissioning Forms

## Centrifugal Chiller (Continued)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **G** | **TAB** | | | |
| 1 | Chilled water strainer is clean | Yes | No | |
| 2 | Evaporator pressure drop (ft) | Yes | No | |
| 3 | Chilled water flow rate (gpm) | Yes | No | |
| 4 | Condenser water strainer is clean | Yes | No | |
| 5 | Condenser water pressure drop (ft) | Yes | No | |
| 6 | Condenser water flow rate (gpm) | Yes | No | |
| | | | | |

**"NO" Responses:**

| Item | Date | Reason for "NO" responses |
|---|---|---|
| | | |
| | | |
| | | |
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| | | |
| | | |

**Contactor:** **LAWA Representative:**

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# LAWA Commissioning Forms

## Cooling Tower

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial number | N/A | | |
| 4 | Cooling Capacity (MBH/gpm) | | | |
| 5 | Fan speed / power (rpm / hp) | | | |
| 6 | Motor Power and Speed (hp / rpm) | | | |
| 7 | Motor Voltage / Phase / Frequency (V / - / Hz) | | | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | The air openings are sealed with plastic | Yes | No | |
| 3 | The water openings are sealed with plastic plugs | Yes | No | |
| 4 | All components present (fans, pumps, fill, etc) | Yes | No | |
| 5 | All access doors are operable | Yes | No | |
| 6 | Installation and startup manual provided | Yes | No | |
| 7 | Unit tags affixed | Yes | No | |
| **2** | **Construction checklist** | | | |
| **A** | **Installation of Cooling Tower** | | | |
| 1 | Unit secured as required by manufacturer and specifications | Yes | No | |
| 2 | Adequate clearance around unit for service | Yes | No | |
| 3 | All components accessible for maintenance | Yes | No | |
| 4 | Unit location is clear of trees, rubbish, dust, etc. to prevent fouling | Yes | No | |
| 5 | Vibration isolators installed and in good condition | Yes | No | |
| 6 | Ladder reached grade level | Yes | No | |
| 7 | Unit labeled and is easy to see | Yes | No | |
| **B** | **Piping** | | | |
| 1 | All piping components have been installed (in the correct order) as required by detail drawings | Yes | No | |
| 2 | Piping arranged for ease of unit removal | Yes | No | |
| 3 | Piping supported as required by specifications | Yes | No | |
| 4 | Piping is clean | Yes | No | |
| 5 | Makeup water supply provided | Yes | No | |
| 6 | All valves and test ports are easily accessible | Yes | No | |
| 7 | Valve tags attached | Yes | No | |
| 8 | Piping insulation complete and installed as per specifications | Yes | No | |
| | | | | |
| | | | | |

**Contactor:** **LAWA Representative:**

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# LAWA Commissioning Forms

## Cooling Tower (Continued)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **C** | **Electrical** | | | |
| 1 | Local disconnect installed in an accessible location | Yes | No | |
| 2 | Fan motor rotation in the proper direction | Yes | No | |
| 3 | All electrical connections are tight | Yes | No | |
| 4 | All electrical components grounded | Yes | No | |
| 5 | VFD installed (if applicable) | Yes | No | |
| **D** | **Controls - Installation** | | | |
| 1 | Control panel accessible and labeled properly | Yes | No | |
| 2 | All sensors (temperature, pressure, etc) are installed and calibrated verified | Yes | No | |
| 3 | Valve actuators installed and calibration verified | Yes | No | |
| 4 | Safety items installed and verified (low water, high water, etc) | Yes | No | |
| **E** | **Controls - Startup** | | | |
| 1 | Sequence of control verified | Yes | No | |
| 2 | High / low water alarms operational | Yes | No | |
| 3 | VFD operational | Yes | No | |
| 4 | Float switch, motorized valves, makeup water are operational | Yes | No | |
| **F** | **Mechanical - Startup** | | | |
| 1 | Tower basin filled | Yes | No | |
| 2 | Sump strainers and nozzles are clean | Yes | No | |
| 3 | Motors and gear box lubricated | Yes | No | |
| 4 | Fan pitch adjusted | Yes | No | |
| 5 | Critical frequencies identified, recorded, and programmed out of VFD | Yes | No | |
| 6 | System start and runs without any unusual noise or vibration | Yes | No | |
| 7 | Manufacturer's startup checklist completed and attached | Yes | No | |
| **G** | **Water treatment - Startup** | | | |
| 1 | Galvanized surfaces passivated ( if applicable) | Yes | No | |
| 2 | Conductivity and pH controls operational | Yes | No | |
| 3 | Makeup flow meter signal operational | Yes | No | |
| 4 | Blow – down control operational | Yes | No | |
| 5 | No – flow injection interlock operational | Yes | No | |
| | | | | |
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**Contactor:** **LAWA Representative:**

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Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Cooling Tower (Continued)

| Instructions: Step 1: Circle Yes or No and fill in with requested information<br>Step 2: Explain all "No" responses at the bottom of the checklist | | | | |
|---|---|---|---|---|
| **Item** | **Task Description** | **Response** | | **Comment:** |
| **H** | **TAB** | | | |
| 1 | Unit is free of unusual noise or vibration | Yes | No | |
| 2 | Motor overloads verified | Yes | No | |
| 3 | Motor rotation verified – each motor | Yes | No | |
| 4 | Motor voltage and amps verified - each phase of each motor | Yes | No | |
| 5 | Flow rate through tower verified | Yes | No | |
| 6 | Water distributed evenly in hot water basin with flow at 50% - no dumping | Yes | No | |
| 7 | Water distributed evenly in hot water with flow at 100% | Yes | No | |
| | | | | |

**"NO" Responses:**

| **Item** | **Date** | **Reason for "NO" responses** | | |
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| **Contactor:** | | | **LAWA Representative:** | | |
|---|---|---|---|---|---|
| Checks by: _____ | _____ | Date: _____; | Checks by:_____ | _____ | Date: _____ |
| **Commissioning Agency:** | | | | | |
| Checks by: _____ | _____ | Date: _____; | Checks by:_____ | _____ | Date: _____ |
| Print name | Signature | | Print name | Signature | |

Los Angeles World Airports

# LAWA Commissioning Forms

## Coil, HW Heat

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial number | N/A | | |
| 4 | Equipment or Area Served | | | |
| 5 | Heating Capacity (MBH/gpm) | / | / | |
| 6 | Piping Inlet / Outlet Diameter (in.) | / | / | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | The water openings are sealed | Yes | No | |
| 3 | Installation and startup manual provided | Yes | No | |
| 4 | Unit tags affixed | Yes | No | |
| 5 | Manufacturer's rating readable/accurate | Yes | No | |
| **2** | **Construction checklist** | | | |
| **A** | **Installation of Reheat Coil** | | | |
| 1 | Unit secured as required by specifications | Yes | No | |
| 2 | Adequate clearance around unit for service | Yes | No | |
| 3 | All components accessible for maintenance | Yes | No | |
| 4 | Unit can be removed from building | Yes | No | |
| 5 | Unit labeled and is easy to see | Yes | No | |
| **B** | **Piping** | | | |
| 1 | All piping components have been installed (in the correct order) as required by detail drawings | Yes | No | |
| 2 | Piping arranged for ease of unit removal | Yes | No | |
| 3 | Piping supported as required by specifications | Yes | No | |
| 4 | Piping is clean | Yes | No | |
| 5 | Piping insulation complete and installed as per specifications | Yes | No | |
| 6 | All valves and test ports are easily accessible | Yes | No | |
| 7 | Valve tags attached | Yes | No | |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Coil, HW Heat (Continued)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **C** | **Controls** | | | |
| 1 | Temperature sensor calibration verified | Yes | No | |
| 2 | Hot water actuator calibration verified | Yes | No | |
| 3 | Point-to-point connections of control wiring verified | Yes | No | |
| 4 | Central system accurately represents conditions of unit | Yes | No | |
| 5 | Heating sequence of control verified | Yes | No | |
| **D** | **TAB** | | | |
| 1 | Entering and leaving coil air temperature () | / | / | |
| 2 | Entering and leaving coil water temperature | / | / | |
| 3 | Coil flow and air /water pressure drops verified | Yes | No | |
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**"NO" Responses:**

| Item | Date | Reason for "NO" Response |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Ductwork: Installation

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist
Step 3: Samples of installed ductwork will be periodically reviewed to verify compliance

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **System Checks** | | | |
| **A** | **Sheet Metal Ductwork Installation Checks** | Submitted | Delivered | |
| 1 | Ductwork is clean and free of damage prior to installation. | Yes | No | |
| 2 | Ductwork is installed in accordance with SMACNA HVAC Duct Construction Standards, 2005 | Yes | No | |
| 3 | All hat sections and standoff brackets are at the same height as the duct lining. | Yes | No | |
| 4 | Access doors are installed in all casting, plenums, ductwork adjacent to fire dampers, automatic dampers, smoke dampers, and reheat coils, and as indicated on drawing. | Yes | No | |
| 5 | The access doors on casings or housings open to the inside on the discharge side and to the outside on the suction side. | Yes | No | |
| 6 | All galvanized sheet metal is separated from aluminum and copper with lead or felt gaskets. | Yes | No | |
| 7 | Ductwork is structurally sound to prevent drumming and sagging. | Yes | No | |
| 8 | All transverse and longitudinal joints are sealed | Yes | No | |
| 9 | All branch the tee connections are 45 degree. | Yes | No | |
| 10 | All medium pressure branch and tee connections are expanded 30 degrees on at least three sides. | Yes | No | |
| 11 | Ductwork meets static pressure requirements specified below and leakage class A for these pressures as defined by SMACNA HVAC Duct Construction Standards, 1985 | Yes | No | |
| 12 | All ductwork except as noted in the specification is leak tested. | Yes | No | |
| 13 | Elbows have an inside radius equal to a minimum of ¾ of the width if the duct | Yes | No | |
| 14 | All square elbows and radius elbows larger than 18 inches have turning vanes | Yes | No | |
| 15 | All wall and floor penetrations are sealed | Yes | No | |
| 16 | Volume dampers are at minimum provided for each horizontal branch from vertical risers serving two or more floors and branches serving two or more outlets | Yes | No | |
| 17 | All equipment requiring maintenance is accessible (valves, junction boxes, etc.) | Yes | No | |
| 18 | All duct openings temporary sealed to maintain duct system cleanliness. | Yes | No | |
| 19 | Record drawings have been updated to reflect any changes made. | Yes | No | |
| | | Yes | No | |

**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Ductwork: Installation (Continued)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist
Step 3: Samples of installed ductwork will be periodically reviewed to verify compliance

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **System Checks** | | | |
| **B** | **Flexile Ductwork Installation Checks** | Submitted | Delivered | |
| 1 | Flexible ductwork is clean and free from damage prior to installation | Yes | No | |
| 2 | Flexible ductwork is free of sags and kinks. | Yes | No | |
| 3 | Flexible ductwork is installed using extra heavy flexible duct straps | Yes | No | |
| 4 | The maximum length of flexible ductwork is 5 feet | Yes | No | |
| 5 | Flexible ductwork does not penetrate walls | Yes | No | |
| 6 | Flexible ductwork does not have 90 degree bends. | Yes | No | |
| **C** | **Ductwork Type Static Pressure Classification Installation Checks** | | | |
| 1 | From fan discharge to and including vertical risers, +6 in. static pressure | Yes | No | |
| 2 | Branch supply ductwork, +4 in. static pressure. | Yes | No | |
| 3 | Branch supply ductwork from terminal to room outlet, +1 in. static pressure. | Yes | No | |
| 4 | Exhaust/return ductwork, ± 1 in. static pressure | Yes | No | |
| 5 | All other ductwork, ± 2 in. static pressure | Yes | No | |
| | | | | |

**"NO" Responses:**

| Item | Date | Reason for "NO" Response |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Ductwork: Installation- Daily Checklist

**Checklist for Daily Progress**

Instructions: Step 1: This form is completed daily by each work crew at the end of their shift, indicate crew/shift designation.
Step 2: Date and describe work completed in the appropriate section (1 for pre-installation and 2 for installation.
Step 3: verify achievement of quality requirements by circling "Yes" or "No". For negative responses, complete Section 3

**1. Pre-insulation inspection by installer**

| Date | Description of Work Performed (relate to drawings and number) | Checklist Items | | | Percent Complete | Initial |
|---|---|---|---|---|---|---|
| | | A. Clean | B. Flex | C. Less 5' | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |

A. Ductwork is clean and free of damage prior to installation.
B. Flexible ductwork is clean and free of damage prior to installation.
C. The maximum length of flexible ductwork is 5'.

**2. Installation of Insulation Checklist by installer**

| Date | Description of Work Performed (relate to drawings and drawing number) | Checklist Items | | | Percent Complete | Initial |
|---|---|---|---|---|---|---|
| | | A. SMACNA | B. Drumming | C. Assess Doors | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |

A. Ductwork is installed in accordance with SMACNA HVAC Duct Construction Standards, 2005.
B. Ductwork is structurally sound to prevent drumming and sagging.
C. All required access doors installed.

**3. Conflicts (Attach sketches or other documentation, including resolutions support; all items in section 1 and 2 to be noted in this section. In addition, any conflicts or non-compliance of any items on the general checklist (Checklist Number 7A) or items not on the checklist should be noted in this section. If Cx Team determines it is significant issues, items will be added to the daily checklist**

| Date | Description of Conflict | Resolution or Suggested Resolution | Resolved |
|---|---|---|---|
| | | | Yes/No |
| | | | Yes/No |
| | | | Yes/No |
| | | | Yes/No |

**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Ductwork: Insulation

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist
Step 3: Samples of installed ductwork will be periodically reviewed to verify compliance

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **System Checks** | | | |
| **A** | **Installation Checks** | Submitted | Delivered | |
| 1 | Ductwork is clean, dry and free of damage prior to insulation installation. | Yes | No | |
| 2 | Insulation is clean and dry during installation and application of any finish | Yes | No | |
| 3 | Pressure and leakage tests performed and reports have been submitted prior to insulation installation. | Yes | No | |
| 4 | All equipment requiring maintenance is accessible (valve, junction boxes, etc.) | Yes | No | |
| 5 | Insulation is continuous through openings and sleeves in mom-rated construction, and is butted tightly against the fire stop with butt joints taped in rated construction. | Yes | No | |
| 6 | All insulation edges temporary sealed to maintain duct insulation cleanliness | Yes | No | |
| 7 | Insulation is removable at access panels with metal corner beads. | Yes | No | |
| 8 | Insulation omitted at all equipment name plates and/or data plates | Yes | No | |
| 9 | All outdoor intakes, housing, plenums from point of entry into the building to the fan or supply discharge and to exhaust duct from damper to outside and elsewhere be indicated on drawings are insulated with 1 ½ inch rigid insulation board w/ vapor barrier | Yes | No | |
| 10 | All exposed conditioned supply ductwork within the building is insulated with 1 inch thick rigid insulation board with vapor barrier | Yes | No | |
| 11 | All non flexible ductwork insulation is fastened by applying Foster No. 85-20 adhesive in 4-inch wide continuous bands on 120inch centers and further secured by welded mechanical pins applied on 12-inch centers as specified. | Yes | No | |
| 12 | All concealed flexible and round ductwork is insulated with 1 ½ inch thick insulation and secured by the means of metal staples using the stitching methods of application an das detailed in the specifications. | Yes | No | |
| 13 | All exterior corners are sealed with a 5-inch wide tape | Yes | No | |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Ductwork: Insulation (Continued)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist
Step 3: Samples of installed ductwork will be periodically reviewed to verify compliance

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **System Checks** | | | |
| **B** | **Installation checks – Flexible Ductwork** | Submitted | Delivered | |
| 1 | Flexible ductwork is clean and free from damage prior to installation | Yes | No | |
| 2 | Flexible ductwork is free of sags and kinks. | Yes | No | |
| 3 | Flexible ductwork is installed using extra heavy flexible duct straps | Yes | No | |
| 4 | The maximum length of flexible ductwork is 5 feet | Yes | No | |
| 5 | Flexible ductwork does not penetrate walls | Yes | No | |
| 6 | Flexible ductwork does not have 90 degree bends. | Yes | No | |
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**"NO" Responses:**

| Item | Date | Reason for "NO" Response |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Ductwork: Insulation- Daily Checklist

**Checklist for Daily Progress**

Instructions: Step 1: This form is completed daily by each work crew at the end of their shift, indicate crew/shift designation.
Step 2: Date and describe work completed in the appropriate section (1 for pre-installation and 2 for installation.
Step 3: verify achievement of quality requirements by circling "Yes" or "No". For negative responses, complete Section 3

**1. Pre-insulation inspection by installer**

| Date | Description of Work Performed (relate to drawings and number) | Checklist Items | | | Percent Complete | Initial |
|---|---|---|---|---|---|---|
| | | A. Clean | B. Leak Tested | C. Material | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |

A. Ductwork is clean or cleaned before insulation installed.
B. All sections leak tested prior to applying insulation.
C. Insulation material inspected to assure it had not been damaged.

**2. Installation of Insulation Checklist by installer**

| Date | Description of Work Performed (relate to drawings and drawing number) | Checklist Items | | | Percent Complete | Initial |
|---|---|---|---|---|---|---|
| | | A. Thickness | B. Sealed | C. Vapor Barrier | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |

A. Insulation thickness checked against project manual and is correct.
B. All flex duct installed per drawing and no runs more than five feet.
C. All vapor barriers installed.

**3. Conflicts (Attach sketches or other documentation, including resolutions support; all items in section 1 and 2 to be noted in this section. In addition, any conflicts or non-compliance of any items on the general checklist (Checklist Number 8A) or items not on the checklist should be noted in this section. If Cx Team determines it is significant issues, items will be added to the daily checklist**

| Date | Description of Conflict | Resolution or Suggested Resolution | Resolved |
|---|---|---|---|
| | | | Yes/No |
| | | | Yes/No |
| | | | Yes/No |

**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Operations and Maintenance: Energy Efficiency Checklist

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | | Response | | Comment: |
|---|---|---|---|---|---|
| **1** | **Owner's Project Requirements** | | | | |
| **A** | **Energy Efficiency Goal: Less than 20,000 kWh/ month, 35 kW, and 120 therms** | **Record Actual Usage** | **Was OPR Achieved?** | | |
| 1 | Actual kWh | | Yes | No | |
| 2 | Actual kW | | Yes | No | |
| 3 | Actual therms | | Yes | No | |
| **B** | **System Manual and Building Documentation** | **Provide appropriate document** | **Do the system operations meet OPR?** | | |
| 1 | Have changes been made to the energy control hardware this month? | | Yes | No | |
| 2 | Have software change been made, such as schedule or sequences? | | Yes | No | |
| 3 | Has the Systems Manual been updated? | | Yes | No | |
| 4 | Have changes been made to the drawings and schedules? | | Yes | No | |
| 5 | Has the commissioning team or commissioning authority been involved? | | Yes | No | |
| 6 | Has the optimization in section 24 of the System Manual implemented this month? | | Yes | No | |
| **C** | **General Owner's Needs** | | | | |
| 1 | Are there any unresolved punchlist items related to energy efficiency open? If so, list the number | | Yes | No | |
| 2 | Was Elementary Control Services required to resolve any energy efficiency related issues this month? | | Yes | No | |
| 3 | Where the seasonal control checks in Section 88 of the System Manual implemented? | | Yes | No | |
| 4 | Are there any conflicts with user' needs and energy efficiency? | | Yes | No | |
| 5 | Was a commissioning optimization workshop held this month? | | Yes | No | |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Operations and Maintenance: Energy Efficiency Checklist

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

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**"YES" or "NO" Responses:**

| Item | Item | Explain all "YES" Responses and Provide Reason for "NO" Responses |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Energy Recovery Wheel

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial number | N/A | | |
| 4 | Exhaust air flow (cfm) | | | |
| 5 | Supply air flow (cfm) | / | / | |
| 6 | Voltage / Phase / Frequency (V/ _/Hz) | / | / | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | The air openings are sealed with plastic | Yes | No | |
| 3 | All components present and in proper order | Yes | No | |
| 4 | All access doors are operable | Yes | No | |
| 5 | Installation and startup manual provided | Yes | No | |
| 6 | Unit identification attached and visible | Yes | No | |
| **2** | **Construction checklist** | | | |
| **A** | **Installation of Energy Recovery Wheel** | | | |
| 1 | Unit secured as required by manufacturer and specifications | Yes | No | |
| 2 | Purge section in correct direction | Yes | No | |
| 3 | Adequate clearance around unit for service | Yes | No | |
| 4 | All components accessible for maintenance | Yes | No | |
| 5 | Unit can be removed from building | Yes | No | |
| 6 | Unit identification attached and visible | Yes | No | |
| **B** | **Electrical** | | | |
| 1 | Local disconnect installed in an accessible location | Yes | No | |
| 2 | Wheel rotation in the proper direction | Yes | No | |
| 3 | All electrical connections are tight | Yes | No | |
| 4 | All electrical components are grounded | Yes | No | |
| 5 | VFD installed (if applicable) | Yes | No | |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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# LAWA Commissioning Forms

## Energy Recovery Wheel (Continued)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **C** | **Ductwork** | | | |
| 1 | Duct work is attached according to manufacturer recommendations | Yes | No | |
| 2 | Inlets and outlets of energy recovery wheel are free of ductwork blockage. | Yes | No | |
| 3 | Structural support for ductwork is independent of wheel unit | Yes | No | |
| 4 | Ductwork placement allows unrestricted airflow and clear view of rotation labeling | Yes | No | |
| 5 | Access doors have been supplied in each duct near the unit | Yes | No | |
| 6 | Adequate locations for testing and balancing of unit | Yes | No | |
| 7 | All dampers and sensors are accessible (access doors) | Yes | No | |
| 8 | Ductwork is clean and free of debris | Yes | No | |
| **D** | **Controls – installation** | | | |
| 1 | Control panel accessible and labeled properly | Yes | No | |
| 2 | Temperature, pressure, and $CO_2$ sensors (as applicable) are installed and calibrated | Yes | No | |
| 3 | Safety items installed and verified (freezestat, high pressure, motor overload, etc) | Yes | No | |
| **E** | **Mechanical – startup** | | | |
| 1 | System clean | Yes | No | |
| 2 | Wheel lubricated and aligned | Yes | No | |
| 3 | Wheel belts have proper tension and are in good condition | Yes | No | |
| 4 | Seals have been adjusted according to manufacturer specifications | Yes | No | |
| 5 | Duct installation conforms to airflow labeling | Yes | No | |
| 6 | System starts and runs without any unusual noise or vibration | Yes | No | |
| 7 | Manufacturer's startup checklist completed and attached | Yes | No | |
| **F** | **Control – Startup** | | | |
| 1 | Warm-up sequence of control verified | Yes | No | |
| 2 | Cool-down sequence of control verified | Yes | No | |
| 3 | Economizer sequence of control verified | Yes | No | |
| 4 | Unoccupied sequence of control verified | Yes | No | |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Energy Recovery Wheel (Continued)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **G** | **TAB** | | | |
| 1 | Motor voltage and amps verified | Yes | No | |
| 2 | Wheel speed, design/ actual (rpm) | Yes | No | |
| 3 | Pressure drop between outside air and return air is large enough | Yes | No | |
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**"NO" Responses:**

| Item | Date | Reason for "NO" Response |
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**Contactor:** **LAWA Representative:**

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# LAWA Commissioning Forms

## Exhaust Fan

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial number | N/A | | |
| 4 | Fan type | | | |
| 5 | Capacity / Static Pressure (cfm / in.wg) | / | / | |
| 6 | Motor Power / Speed (hp/rpm) | / | / | |
| 7 | Motor Voltage / Phase / Frequency ( V/ - / Hz) | / | / | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | The air openings are sealed with plastic | Yes | No | |
| 3 | All components present (belt guard, motor, damper, spring isolators, etc.) | Yes | No | |
| 4 | Installation and startup manual provided | Yes | No | |
| 5 | Unit tags affixed | Yes | No | |
| **2** | **Construction checklist** | | | |
| **A** | **Installation of Exhaust Fan** | | | |
| 1 | Unit secured as required by manufacturer and specifications | Yes | No | |
| 2 | Adequate clearance around unit for service | Yes | No | |
| 3 | All components accessible for maintenance | Yes | No | |
| 4 | Unit can be removed from building | Yes | No | |
| 5 | Shipping bots have been removed (if applicable) | Yes | No | |
| 6 | Belts are tight (if applicable) | Yes | No | |
| 7 | Back draft damper installed and moves freely | Yes | No | |
| 8 | Protective shrouds for fan and belts in place and secure | Yes | No | |
| 9 | Unit labeled and is easy to see | Yes | No | |
| **B** | **Ductwork** | | | |
| 1 | Adequate locations available for testing and balancing unit | Yes | No | |
| 2 | All dampers and sensors are accessible (access panels) | Yes | No | |
| 3 | Vibration isolators installed | Yes | No | |
| 4 | All dampers close tightly and stroke fully and easily | Yes | No | |
| 5 | Ductwork is clean and free of debris | Yes | No | |
| **C** | **Electrical** | | | |
| 1 | Safety disconnect installed in an accessible location | Yes | No | |
| 2 | Motor rotation is in correct direction | Yes | No | |
| 3 | All electrical connections are tight | Yes | No | |
| 4 | All electrical components are grounded | Yes | No | |

**Contactor:** **LAWA Representative:**

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Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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# LAWA Commissioning Forms

## Exhaust Fan (Continued)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **D** | **Controls – installation** | | | |
| 1 | Control panel accessible and labeled properly | Yes | No | |
| 2 | Dampers actuators installed and calibration verified | Yes | No | |
| 3 | Safety items installed and verified (high pressure, motor overload, etc) | Yes | No | |
| **E** | **Mechanical – startup** | | | |
| 1 | Unit is clean | Yes | No | |
| 2 | Internal isolators free to move | Yes | No | |
| 3 | Fan and motor lubricated and aligned | Yes | No | |
| 4 | Fan belts have proper tension and are in good condition (if applicable) | Yes | No | |
| 5 | System starts and runs without any unusual noise or vibration | Yes | No | |
| 6 | Manufacturer's startup checklist completed and attached | Yes | No | |
| **F** | **Control – Startup** | | | |
| 1 | Remote start/stop from central system verified | Yes | No | |
| 2 | Sequence of control is correct | Yes | No | |
| **G** | **TAB** | | | |
| 1 | Air flow, design / actual (cfm) | Yes | No | |
| 2 | Pressure drop, design / actual (in. wg) | Yes | No | |
| 3 | Fan rotation is in proper direction | Yes | No | |
| 4 | Motor overloads verified | Yes | No | |
| 5 | Motor voltage and amps verified – each phase | Yes | No | |
| | | | | |

**"NO" Responses:**

| Item | Date | Reason for "NO" Response |
|---|---|---|
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**Contactor:** **LAWA Representative:**

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# LAWA Commissioning Forms

## Fan Coil Unit, CW & HW

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial number | N/A | | |
| 4 | Capacity / Static Pressure (cfm / in. wg) | | | |
| 5 | Fan Motor Power (hp) | / | / | |
| 6 | Fan Motor Voltage / Phase / Frequency (V/ _ / Hz) | / | / | |
| 7 | Total / Sensible Cooling Capacity (MBH) | / | / | |
| 8 | Cooling Fluid Flow / Pressure Drop (gpm / ft.wg) | | | |
| 9 | Total Heating Capacity (MBH) | | | |
| 10 | Heating Fluid Flow / Pressure Drop (gpm / ft. wg) | / | / | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | Coil surface areas are free of damage | Yes | No | |
| 3 | The water openings are sealed with plastic plugs | Yes | No | |
| 4 | All components present | Yes | No | |
| 5 | Installation and startup manual provided | Yes | No | |
| 6 | Unit tags affixed | Yes | No | |
| **2** | **Construction checklist** | | | |
| **A** | **Installation of Fan Coil Unit** | | | |
| 1 | Unit supported using adequately sized mounting anchors | Yes | No | |
| 2 | Metal-to-metal connections eliminated to prevent noise problems | Yes | No | |
| 3 | Adequate clearance around unit for service | Yes | No | |
| 4 | All components are accessible for maintenance | Yes | No | |
| 5 | Unit can be removed from building | Yes | No | |
| 6 | Unit labeled and is easy to see | Yes | No | |
| **B** | **Chilled Water Piping** | | | |
| 1 | Condensate piping properly installed (trapped and run to a drain) | Yes | No | |
| 2 | P/T ports installed across the cooling coil | Yes | No | |
| 3 | All piping components have been installed (in the correct order) as required by detail drawing | Yes | No | |
| 4 | Piping arranged for ease of unit/coil removal | Yes | No | |
| 5 | Piping supported as required by specifications | Yes | No | |
| 6 | Piping is clean | Yes | No | |
| 7 | Piping insulation complete and installed as per specifications | Yes | No | |
| 8 | All valves and test ports are easily accessible | Yes | No | |
| 9 | Valve tags attached | Yes | No | |

**Contactor:** **LAWA Representative:**

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Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Fan Coil Unit, CW & HW (Continued)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **C** | **Hot Water Piping** | | | |
| 1 | All piping components have been installed (in the correct order) as required by detail drawing | Yes | No | |
| 2 | Piping arranged for ease of unit/coil removal | Yes | No | |
| 3 | Piping is supported as required by specifications | Yes | No | |
| 4 | Piping is clean | Yes | No | |
| 5 | Piping insulation complete and installed as per specifications | Yes | No | |
| 6 | All valves and test ports are easily accessible | Yes | No | |
| 7 | Valve tags attached | Yes | No | |
| **D** | **Ductwork** | | | |
| 1 | Adequate location available for testing and balancing of unit | Yes | No | |
| 2 | All dampers and sensors are accessible (access doors) | Yes | No | |
| 3 | All dampers close tightly and stroke fully and easily | Yes | No | |
| 4 | Filter is clean | Yes | No | |
| 5 | Filter is properly installed (air bypassing the filter is prevented) | Yes | No | |
| 6 | Ductwork is clean and free of debris | Yes | No | |
| **E** | **Electrical** | | | |
| 1 | Local disconnect installed in an accessible location | Yes | No | |
| 2 | Motor rotation in the proper direction | Yes | No | |
| 3 | All electrical connections are tight | Yes | No | |
| 4 | All electrical components are grounded | Yes | No | |
| **F** | **Controls – Installation** | | | |
| 1 | Control panel accessible and labeled properly | Yes | No | |
| 2 | Room thermostat installed and calibration verified | Yes | No | |
| 3 | Chilled and hot water actuators installed and calibration verified | Yes | No | |
| **G** | **Control – Startup** | | | |
| 1 | Unit operation accurately represented on main system | Yes | No | |
| 2 | Cooling sequence of control verified | Yes | No | |
| 3 | Heating sequence of control verified | Yes | No | |
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**Contactor:** **LAWA Representative:**

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Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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# LAWA Commissioning Forms

## Fan Coil Unit, CW & HW (Continued)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **H** | **TAB** | | | |
| 1 | Filters and coils are clean | Yes | No | |
| 2 | Motor rotation verified | Yes | No | |
| 3 | Motor overloads verified | Yes | No | |
| 4 | Motor voltage and amps verified – each phase | Yes | No | |
| 5 | Entering and leaving cooling coil air temperature() | Yes | No | |
| 6 | Entering and leaving heating coil air temperature() | Yes | No | |
| 7 | Entering and leaving chilled water temperature () | Yes | No | |
| 8 | Entering and leaving hot water temperature () | Yes | No | |
| 9 | Coil flow and air/water pressure drops verified – each coil | Yes | No | |
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**"NO" Responses:**

| Item | Item | Reason for "NO" Response |
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**Contactor:** **LAWA Representative:**

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# LAWA Commissioning Forms

## Fire Damper

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Style | N/A | | |
| 4 | Width (in.) | | | |
| 5 | Height (in.) | / | / | |
| 6 | Orientation | / | / | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | All components/accessories present | Yes | No | |
| 3 | Installation manual provided | Yes | No | |
| **2** | **Construction checklist** | | | |
| **A** | **Installation of Fire Damper** | | | |
| 1 | Unit secured as required by manufacturer and specification | Yes | No | |
| 2 | Adequate clearance around unit for maintenance | Yes | No | |
| 3 | Unit mounted in correct orientation | Yes | No | |
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**"NO" Responses:**

| Item | Item | Reason for "NO" Response |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Grilles, Registers & Diffusers

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Frame | | | |
| 4 | Color | | | |
| 5 | Neck Width (in.) | / | / | |
| 6 | Neck Height (in.) | / | / | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | All components/accessories present | Yes | No | |
| 3 | Installation manual provided | Yes | No | |
| **2** | **Construction checklist** | | | |
| **A** | **Installation of Grilles / Register** | | | |
| 1 | Unit secured as required by manufacturer and specification | Yes | No | |
| 2 | Any surface blemishes have been touched up | Yes | No | |
| 3 | Design CFM confirmed | Yes | No | |
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**"NO" Responses:**

| Item | Item | Reason for "NO" Response |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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# LAWA Commissioning Forms

## Humidifier, Steam

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial number | N/A | | |
| 4 | Steam Output Capacity (lb/hr) | | | |
| 5 | Steam Input Capacity (lb/hr) | / | / | |
| 6 | Inlet Steam Maximum Pressure (psig) | / | / | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | All components present | Yes | No | |
| 3 | Installation and startup manual provided | Yes | No | |
| 4 | Unit tags affixed | Yes | No | |
| **2** | **Construction checklist** | | | |
| **A** | **Installation of Humidifier** | | | |
| 1 | Unit secured as required by manufacturer and specifications | Yes | No | |
| 2 | Adequate clearance around unit for service | Yes | No | |
| 3 | All components are accessible for maintenance | Yes | No | |
| 4 | Unit can be removed from building | Yes | No | |
| 5 | Unit located below duct level for good drainage | Yes | No | |
| 6 | Dispersion tube located as per manufacturer's recommendations | Yes | No | |
| 7 | Unit labeled and is easy to see | Yes | No | |
| **B** | **Piping** | | | |
| 1 | All piping components have been installed (in the correct order) as required by detail drawing. | Yes | No | |
| 2 | Piping arranged for ease of unit removal | Yes | No | |
| 3 | Piping sloped for complete drainage | Yes | No | |
| 4 | Piping supported as required by specifications | Yes | No | |
| 5 | Piping is clean and free from leaks | Yes | No | |
| 6 | All valves and test ports are easily accessible | Yes | No | |
| 7 | Valve tags attached | Yes | No | |
| **C** | **Controls - Installation** | | | |
| 1 | Air flow sensor installed and calibration verified | Yes | No | |
| 2 | Duct high limit humidistat in stalled and calibration verified | Yes | No | |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Humidifier, Steam

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **D** | **Controls – Startup** | | | |
| 1 | Sequence of control verified | Yes | No | |
| 2 | Unit operation accurately represented on main system | Yes | No | |
| 3 | Airflow sensor operation verified | Yes | No | |
| 4 | Duct high limit humidistat operation verified | Yes | No | |
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**"NO" Responses:**

| Item | Item | Reason for "NO" Response |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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# LAWA Commissioning Forms

## HVAC Piping: Installation

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist
Step 3: Samples of installed ductwork will be periodically reviewed to verify compliance

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **System Checks** | | | |
| **A** | **Installation Checks** | Submitted | Delivered | |
| 1 | Piping is clean and free of damage prior to installation | Yes | No | |
| 2 | Piping is free to expand and contract without noise or damage to hangers, joints, or the building. | Yes | No | |
| 3 | Piping is installed with sufficient pitch and arranged in a manner to ensure drainage and venting of the entire system | Yes | No | |
| 4 | Manual air vents are provided at high points in close water systems | Yes | No | |
| 5 | Changes in pipe sizes are made with the proper size reducing fittings, reducing fittings, reducing elbow or reducing tees. Bushings are not allows | Yes | No | |
| 6 | All piping supports and hangers meet criteria set in Section 15140 of the specification | Yes | No | |
| 7 | All fittings meet specification requirements. | Yes | No | |
| 8 | All equipment requiring maintenance is accessible (valves, junction boxed, etc) | Yes | No | |
| 9 | Piping does not block access to equipment that is part of this system or another system (e.g., air terminal units) | Yes | No | |
| 10 | Piping is installed in a manner to ensure that insulation will not contact adjacent surfaces | Yes | No | |
| 11 | All pipe openings are temporarily sealed to maintain piping system cleanliness | Yes | No | |
| 12 | Record drawings have been updated to reflect any changes made. | Yes | No | |
| 13 | Nipples are made of the same material as the pipe | Yes | No | |
| 14 | Connections between copper and steel pipes are made with dielectric fittings | Yes | No | |
| 15 | A union is provided ahead of each screwed valve, trap, or strainer, and on each side of each piece of equipment and whatever needed to dismantle piping. | Yes | No | |
| 16 | Mechanical coupling if used is only used for piping and location as described in the specification section 15060 | Yes | No | |
| 17 | The chilled water system is installed with high pressure fittings, flanges and unions | Yes | No | |
| 18 | Auxiliary drain valves are provided at all low points in hose bib piping to facilitate seasonal draining. | Yes | No | |
| | | | | |

**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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# LAWA Commissioning Forms

## HVAC Piping: Installation

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist
Step 3: Samples of installed ductwork will be periodically reviewed to verify compliance

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**"NO" Responses:**

| Item | Date | Reason for "NO" Response |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## HVAC Piping: Insulation

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist
Step 3: Samples of installed ductwork will be periodically reviewed to verify compliance

**General Overall (Total Job) HVAC Piping Insulation Requirement**

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **System Checks** | | | |
| **A** | **Installation Checks** | Submitted | Delivered | |
| 1 | Piping is clean, dry and free of damage prior to installation. | Yes | No | |
| 2 | Pressure and leakage tests performed and reports have been submitted prior to insulation installation. | Yes | No | |
| 3 | All chilled water piping is insulated with 1 ½ inch thick fiberglass pipe insulation with vapor barrier except runouts to radiant cooling panels located beyond 1' – 0" within room being served. | Yes | No | |
| 4 | Secondary chilled water, low temperature chilled water ( 2 ½ inched thick), fan coil drain piping ( 2 ½ inched thick), and piping with electric trace freeze protection is insulated in the same manner as the chilled water pipes | Yes | No | |
| 5 | All chilled water pumps are insulated with 1 ½ inch thick rectangular box made of Manville 817 rigid fiberglass board having a density of 6 $lb/ft^3$ with rated vinyl coated and embossed laminate vapor seal (ASJ) jacket. | Yes | No | |
| 6 | The insulation box for the pump is open at top and bottom with a removable top to effect a complete insulation for each base mounted pump. | Yes | No | |
| 7 | The pipe insulation sections are firmly butted together and the longitudinal seam of the vapor barrier is cemented with Foster No. 85-75. | Yes | No | |
| 8 | End joints are sealed with a minimum of 3 inch wide factory furnished vapor barrier strips cemented with Foster No. 85-75 | Yes | No | |
| 9 | All fittings, valves, strainers etc. is insulated as described in the specifications. | Yes | No | |
| 10 | Exterior piping has a 0.016 inch aluminum jacket with moisture barrier lock seam and Gasco of equal factory applied fittings in lieu of glass cloth jackets, A sample is submitted | Yes | No | |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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# LAWA Commissioning Forms

## HVAC Piping: Insulation (Continued)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

**"NO" Responses:**

| Item | Date | Reason for "NO" Response |
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## HVAC Piping: Insulation- Daily Checklist

**Checklist for Daily Progress**

Instructions: Step 1: This form is completed daily by each work crew at the end of their shift, indicate crew/shift designation.
Step 2: Date and describe work completed in the appropriate section (1 for pre-installation and 2 for installation.
Step 3: verify achievement of quality requirements by circling "Yes" or "No". For negative responses, complete Section 3

**1. Pre-insulation inspection by installer**

| Date | Description of Work Performed (relate to drawings and number) | Checklist Items | | | Percent Complete | Initial |
|---|---|---|---|---|---|---|
| | | A. Clean | B. Valves | C. Material | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |

A. Piping clean or cleaned before insulation installed.
B. Valves and other accessory surfaces were clean.
C. Insulation material inspected to assure it had not been damaged.

**2. Installation of Insulation Checklist by installer**

| Date | Description of Work Performed (relate to drawings and drawing number) | Checklist Items | | | Percent Complete | Initial |
|---|---|---|---|---|---|---|
| | | A. Thick-ness | B. Sealed | C. Vapor barrier | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |
| | | Yes/No | Yes/No | Yes/No | | |

A. Insulation thickness checked against project manual and is correct.
B. The pipe insulation sections are firmly butted together and the longitudinal seam of the vapor barrier is cemented with foster No. 87-75.
C. All vapor barriers installed.

**3. Conflicts (Attach sketches or other documentation, including resolutions support; all items in section 1 and 2 to be noted in this section. In addition, any conflicts or non-compliance of any items on the general checklist (Checklist Number 8A) or items not on the checklist should be noted in this section. If Cx Team determines it is significant issues, items will be added to the daily checklist**

| Date | Description of Conflict | Resolution or Suggested Resolution | Resolved |
|---|---|---|---|
| | | | Yes/No |
| | | | Yes/No |
| | | | Yes/No |
| | | | Yes/No |

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# LAWA Commissioning Forms

## Pump, HVAC

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial Number | | | |
| 4 | Pump Type | | | |
| 5 | Impeller diameter (in.) | | | |
| 6 | Inlet / Outlet Sizes (in.) | | | |
| 7 | Capacity / Heat (gpm / ft wg) | | | |
| 8 | Motor Speed / Power (rmp/hp) | | | |
| 9 | Motor Voltage / Phase / Frequency (V/ _ / Hz) | | | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | All components present | Yes | No | |
| 3 | The water openings are sealed with plastic plugs | Yes | No | |
| 4 | Unit tags affixed | Yes | No | |
| 5 | Installation and startup manual provided | Yes | No | |
| 6 | Manufacturer's ratings readable / accurate | Yes | No | |
| **2** | **Construction Checklist** | | | |
| **A** | **Installation of Pump** | | | |
| 1 | Unit is supported as required by manufacturer and specifications | Yes | No | |
| 2 | Adequate clearance around unit for service | Yes | No | |
| 3 | All components accessible for maintenance | Yes | No | |
| 4 | Unit can be removed from building | Yes | No | |
| 5 | Unit labeled and is easy to see | Yes | No | |
| **B** | **Piping** | | | |
| 1 | All piping components have been installed (in the correct order) as required by detail drawing | Yes | No | |
| 2 | Piping arranged for ease of unit removal | Yes | No | |
| 3 | Shut-off valves and unions installed on inlet and outlet of pump | Yes | No | |
| 4 | Pressure gauges installed on inlet and outlet of pump | Yes | No | |
| 5 | Piping supported as required by specifications | Yes | No | |
| 6 | Piping is clean | Yes | No | |
| 7 | Piping insulation complete and installed as per specifications | Yes | No | |
| 8 | All valves and test ports are easily accessible | Yes | No | |
| 9 | Valve tags attached | Yes | No | |
| | | | | |

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**Commissioning Agency:**

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Los Angeles World Airports

# LAWA Commissioning Forms

## Pump, HVAC

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| | | | | |
|---|---|---|---|---|
| **C** | **Electrical** | | | |
| 1 | Safety disconnect installed in an accessible location | Yes | No | |
| 2 | Motor rotation in the proper direction | Yes | No | |
| 3 | All electrical connections are tight | Yes | No | |
| 4 | All electrical components are grounded | Yes | No | |
| **D** | **Mechanical – Startup** | | | |
| 1 | Unit checked, aligned, and certified prior to startup and report submitted | Yes | No | |
| 2 | Unit and motor lubricated before startup | Yes | No | |
| 3 | Pump shaft rotates easily with power turned off | Yes | No | |
| 4 | System starts and runs without any unusual noise or vibration | Yes | No | |
| 5 | Manufacturer's startup checklist completed and attached | Yes | No | |
| **E** | **TAB** | | | |
| 1 | Flow Rate, gpm | Yes | No | |
| 2 | Inlet pressure (ft) / Outlet pressure (ft) | Yes | No | |
| 3 | Motor rotation in the proper direction | Yes | No | |
| 4 | Motor overload verified | Yes | No | |
| 5 | Motor voltage and amps verified – each phase | Yes | No | |
| 6 | Start-up strainer removed (after 24 hours) | Yes | No | |
| | | | | |
| | | | | |

**"NO" Responses:**

| Item | Item | Reason for "NO" Responses |
|---|---|---|
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Split System A/C Unit (Coil portion)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial Number | | | |
| 4 | Airflow (cfm) | | | |
| 5 | Fan Motor Power (hp) | | | |
| 6 | Fan Motor Voltage / Phase / Frequency (V/ _ / Hz) | | | |
| 7 | Total Cooling Capacity (MBH) | | | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | All components present | Yes | No | |
| 3 | The refrigerant line openings are sealed | Yes | No | |
| 4 | Unit tags affixed | Yes | No | |
| 5 | Installation and startup manual provided | Yes | No | |
| **2** | **Construction Checklist** | | | |
| **A** | **Installation of Split System Coil** | | | |
| 1 | Unit supported using adequately sized mounting anchors | Yes | No | |
| 2 | Adequate clearance around unit for service | Yes | No | |
| 3 | All components accessible for maintenance | Yes | No | |
| 4 | Unit can be removed from building | Yes | No | |
| 5 | Condensate drain piping un-trapped and runs to open sight drain | Yes | No | |
| 6 | Unit labeled and is easy to see | Yes | No | |
| **B** | **Piping** | | | |
| 1 | All piping components have been installed (in the correct order) as required by detail drawing | Yes | No | |
| 2 | Piping arranged for ease of unit removal | Yes | No | |
| 3 | Piping supported as required by specifications | Yes | No | |
| 4 | Refrigerant lines connected to indoor and outdoor units | Yes | No | |
| 5 | Piping is clean and free from leaks | Yes | No | |
| 6 | Piping insulation complete and installed as per specifications | Yes | No | |
| 7 | Unit filled with correct refrigerant | Yes | No | |
| 8 | All valves and test ports are easily accessible | Yes | No | |
| 9 | Valve tags attached | Yes | No | |
| | | | | |
| | | | | |

**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Split System A/C Unit (Coil portion)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| | | | | |
|---|---|---|---|---|
| **C** | **Electrical** | | | |
| 1 | Local disconnect installed in an accessible location | Yes | No | |
| 2 | Fan motor rotation in the proper direction | Yes | No | |
| 3 | All electrical connections are tight | Yes | No | |
| 4 | All electrical components are grounded | Yes | No | |
| **D** | **Control – installation** | | | |
| 1 | Room thermostat installed and calibration verified | Yes | No | |
| 2 | Control wiring provided to outdoor (compressor) unit | Yes | No | |
| 3 | Communication with outdoor unit verified | Yes | No | |
| **E** | **Control – startup** | | | |
| 1 | Cooling sequence of control verified | Yes | No | |
| 2 | System starts and runs with no unusual noise or vibration | Yes | No | |
| 3 | Manufacturer's startup checklist completed and attached | Yes | No | |
| **F** | **TAB** | | | |
| 1 | Filters installed and are clean | Yes | No | |
| 2 | Entering and leaving air temperature (°F) | Yes | No | |
| 3 | Airflow (cfm) | Yes | No | |
| | | | | |
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**"NO" Responses:**

| Item | Item | Reason for "NO" Responses |
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Los Angeles World Airports

# LAWA Commissioning Forms

## Split System A/C Unit (Compressor portion)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial Number | | | |
| 4 | Airflow (cfm) | | | |
| 5 | Fan Motor Power (hp) | | | |
| 6 | Fan Motor Voltage / Phase / Frequency (V/ _ / Hz) | | | |
| 7 | Ambient Temperature (°F) | | | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | All components present | Yes | No | |
| 3 | The refrigerant line openings are sealed | Yes | No | |
| 4 | Unit tags affixed | Yes | No | |
| 5 | Installation and startup manual provided | Yes | No | |
| **2** | **Construction Checklist** | | | |
| **A** | **Installation of Split System Compressor** | | | |
| 1 | Unit secured as required by manufacturer and specifications | Yes | No | |
| 2 | Adequate clearance around unit for service | Yes | No | |
| 3 | All components accessible for maintenance | Yes | No | |
| 4 | Unit labeled and is easy to see | Yes | No | |
| **B** | **Piping** | | | |
| 1 | All piping components have been installed (in the correct order) as required by detail drawing | Yes | No | |
| 2 | Piping arranged for ease of unit removal | Yes | No | |
| 3 | Piping supported as required by specifications | Yes | No | |
| 4 | Refrigerant lines connected to indoor and outdoor units | Yes | No | |
| 5 | Piping is clean and free from leaks | Yes | No | |
| 6 | Piping insulation complete and installed as per specifications | Yes | No | |
| 7 | Unit filled with correct refrigerant | Yes | No | |
| 8 | All valves and test ports are easily accessible | Yes | No | |
| 9 | Valve tags attached | Yes | No | |
| | | | | |
| | | | | |

**Contactor:** **LAWA Representative:**

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# LAWA Commissioning Forms

## Split System A/C Unit (Compressor portion)

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| | | | | |
|---|---|---|---|---|
| **C** | **Electrical** | | | |
| 1 | Local disconnect installed in an accessible location | Yes | No | |
| 2 | Fan motor rotation in the proper direction | Yes | No | |
| 3 | All electrical connections are tight | Yes | No | |
| 4 | All electrical components are grounded | Yes | No | |
| **D** | **Control – installation** | | | |
| 1 | Control wiring provided to outdoor (compressor) unit | Yes | No | |
| 2 | Communication with outdoor unit verified | Yes | No | |
| **E** | **Control – startup** | | | |
| 1 | Safety items operational (high pres., low pres., discharge temp. switch). | Yes | No | |
| 2 | System starts and runs with no unusual noise or vibration | Yes | No | |
| 3 | Manufacturer's startup checklist completed and attached | Yes | No | |
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**"NO" Responses:**

| Item | Item | Reason for "NO" Responses |
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# LAWA Commissioning Forms

## Unit Heater

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial Number | | | |
| 4 | Total Heating Capacity (MBH) | | | |
| 5 | Fan Motor Power (hp) | | | |
| 6 | Fan Motor Voltage / Phase / Frequency (V/ _ / Hz) | | | |
| 7 | Heating Fluid Flow /Pressure Drop (gpm / ft wg) | | | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | All components present | Yes | No | |
| 3 | The water openings are sealed with plastic plugs | Yes | No | |
| 4 | Manufacturer's data readable/ accurate | Yes | No | |
| 5 | Unit identification attached and visible | Yes | No | |
| **2** | **Construction Checklist** | | | |
| **A** | **Installation of Unit Heater** | | | |
| 1 | Unit supported using adequately sized mounting anchors | Yes | No | |
| 2 | Adequate clearance around unit for service | Yes | No | |
| 3 | All components accessible for maintenance | Yes | No | |
| 4 | Unit can be removed from building | Yes | No | |
| 5 | Unit identification attached and visible | Yes | No | |
| **B** | **Piping** | | | |
| 1 | All piping components have been installed (in the correct order) as required by detail drawing | Yes | No | |
| 2 | Piping arranged for ease of unit removal | Yes | No | |
| 3 | Piping supported as required by specifications | Yes | No | |
| 4 | Piping is clean | Yes | No | |
| 5 | Piping insulation complete and installed as per specifications | Yes | No | |
| 6 | All valves and test ports are easily accessible | Yes | No | |
| **C** | **Electrical** | | | |
| 1 | Local disconnect installed in an accessible location | Yes | No | |
| 2 | Motor rotation in the proper direction | Yes | No | |
| 3 | All electrical connections are tight | Yes | No | |
| 4 | All electrical components are grounded | Yes | No | |
| | | | | |

**Contactor:** **LAWA Representative:**

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# LAWA Commissioning Forms

## Unit Heater

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| D | Control | | | |
|---|---|---|---|---|
| 1 | Room thermostat installed and calibration verified | Yes | No | |
| 2 | Hot water actuator calibration verified | Yes | No | |
| 3 | Heating sequence of control verified | Yes | No | |
| 4 | Valve tags are attached | Yes | No | |
| **E** | **TAB** | | | |
| 1 | Motor rotation in the proper direction | Yes | No | |
| 2 | Motor overloads verified | Yes | No | |
| 3 | Motor voltage and amps verified – each phase | Yes | No | |
| 4 | Entering and leaving air temperatures (°F) | Yes | No | |
| 5 | Flow and air/water pressure drops verified | Yes | No | |
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**"NO" Responses:**

| Item | Item | Reason for "NO" Responses |
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**Contactor:** **LAWA Representative:**

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# LAWA Commissioning Forms

## Variable Speed Drive

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial Number | | | |
| 4 | Service Area | | | |
| 5 | Maximum Capacity (amps) | | | |
| 6 | Voltage / Phase / Frequency (V/ _ / Hz) | | | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | All components present | Yes | No | |
| 3 | Installation and startup manual provided | Yes | No | |
| 4 | Wiring schematics (electrical & controls) for this application attached | Yes | No | |
| 5 | Unit tags affixed | Yes | No | |
| 6 | Manufacturer's ratings readable/accurate | Yes | No | |
| **2** | **Construction Checklist** | | | |
| **A** | **Installation of VSD** | | | |
| 1 | Unit secured as required by manufacturer and specifications | Yes | No | |
| 2 | Adequate clearance around unit for service | Yes | No | |
| 3 | All components accessible for maintenance | Yes | No | |
| 4 | Unit can be removed from building | Yes | No | |
| 5 | Unit labeled and is easy to see | Yes | No | |
| 6 | Wiring schematic inside enclosure and includes bypass section | Yes | No | |
| **B** | **Electrical** | | | |
| 1 | Drive to motor leads are in grounded metal conduit | Yes | No | |
| 2 | All electrical connections are tight | Yes | No | |
| 3 | All electrical components are grounded | Yes | No | |
| **C** | **Control – Installation** | | | |
| 1 | Control panel accessible and labeled properly | Yes | No | |
| 2 | Low voltage control signals are shielded and in own conduit | Yes | No | |
| 3 | Auxiliary safeties (F/A shutdown, etc) are installed and operational | Yes | No | |
| 4 | Analog output to control unit is isolated type | Yes | No | |
| | | | | |
| | | | | |
| | | | | |

**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## Variable Speed Drive

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| D | **Electrical – Pre-startup Checks** | | | |
|---|---|---|---|---|
| 1 | Motor full load amps less than max rating, design / actual | Yes | No | |
| 2 | Input voltage, design / actual (within 10% of rating) | Yes | No | |
| 3 | All grounds verified | Yes | No | |
| 4 | All fuses verified | Yes | No | |
| **E** | **Electrical – Startup** | | | |
| 1 | VSD properly powers up | Yes | No | |
| 2 | Stop button works | Yes | No | |
| 3 | Motor rotation is in the proper direction | Yes | No | |
| 4 | Minimum and maximum speeds reached using remote command | Yes | No | |
| 5 | "Accel" and "Decel" adjustments are made within the drive and do not depend on ramping signal from the DDC controls | Yes | No | |
| 6 | VSD restarts automatically | Yes | No | |
| 7 | No disconnect on load side of VSD | Yes | No | |
| 8 | Critical frequencies have been programmed out of VSD (if applicable) | Yes | No | |
| 9 | Motor runs in bypass mode while servicing or removing unit | Yes | No | |
| 10 | Motor overload protection and phase loss protection provided during bypass mode | Yes | No | |
| 11 | System starts and runs without any unusual noise or vibration | Yes | No | |
| 12 | Manufacturer's startup checklist completed and attached | Yes | No | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**"NO" Responses:**

| Item | Item | Reason for "NO" Responses |
|---|---|---|
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**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## VAV Box, Fan Power w/ Elect heat

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial Number | | | |
| 4 | Size (in) | | | |
| 5 | Max / Min Airflow (cfm) | | | |
| 6 | Heating Capacity (MBH/kW) | | | |
| 7 | Total Static Pressure (in. w.g.) | | | |
| 8 | Fan Power / Speed (hp/rpm) | | | |
| 6 | Voltage / Phase / Frequency (V/ _ / Hz) | | | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | The air openings are sealed with plastic | Yes | No | |
| 3 | The airflow sensing tubing is plugged | Yes | No | |
| 4 | The grommets for the airflow sensing tubing are secure | Yes | No | |
| 5 | The enclosure for the DDC control panel is in the proper location | Yes | No | |
| 6 | Installation and startup manual provided | Yes | No | |
| 7 | Unit tags affixed | Yes | No | |
| 8 | Manufacturer's ratings readable/accurate | Yes | No | |
| **2** | **Construction Checklist** | | | |
| **A** | **Hanging** | | | |
| 1 | Unit is supported as required by manufacturer and specifications | Yes | No | |
| 2 | Metal to metal connections eliminated to prevent noise problems | Yes | No | |
| 3 | Adequate clearance around control panel for maintenance | Yes | No | |
| 4 | Clear access below unit for easy maintenance | Yes | No | |
| 5 | Unit labeled and is easy to see | Yes | No | |
| 6 | Box openings temporarily sealed to maintain system cleanliness | Yes | No | |
| **B** | **Ductwork** | | | |
| 1 | Balancing damper present on inlet duct | Yes | No | |
| 2 | Sufficient length of straight ductwork installed upstream of unit | Yes | No | |
| 3 | Downstream ductwork free of transitions for sufficient length | Yes | No | |
| 4 | All components are accessible for maintenance | | | |
| 5 | Flexible connector (vibration isolator) installed on inlet duct to avoid noise problems from metal to metal contact | | | |
| 6 | Flex duct (if used) is installed in a way that avoids forming kinks on both inlet and outlet ductwork | | | |
| | | | | |

**Contactor:** **LAWA Representative:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

**Commissioning Agency:**

Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

Print name Signature Print name Signature

Los Angeles World Airports

# LAWA Commissioning Forms

## VAV Box, Fan Power w/ Elect heat

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| | | | | |
|---|---|---|---|---|
| **C** | **Electrical Heating Coil** | | | |
| 1 | Heating coil inspected for damage prior to applying power | Yes | No | |
| 2 | Wiring is properly sized | Yes | No | |
| 3 | All electrical connections are properly grounded | Yes | No | |
| 4 | All electrical connections are tight | Yes | No | |
| **D** | **Electrical** | | | |
| 1 | Local disconnect switch installed in an accessible location | Yes | No | |
| 2 | Motor rotation is in the proper direction | Yes | No | |
| 3 | All electrical connections are tight | Yes | No | |
| 4 | All electrical components are grounded | Yes | No | |
| 5 | Variable speed selector is operational | Yes | No | |
| 6 | P.E. switch is operational | Yes | No | |
| **E** | **Controls – Installation** | | | |
| 1 | Temperature sensor calibration verified | Yes | No | |
| 2 | Airflow sensor calibration verified | Yes | No | |
| 3 | Point-to-point connections of control wiring verified | Yes | No | |
| 4 | Central system accurately represents condition of unit | Yes | No | |
| **F** | **Control – Startup** | | | |
| 1 | Cooling/heating sequence of control verified | Yes | No | |
| 2 | Warm-up/cool-down sequence of control verified | Yes | No | |
| 3 | Unoccupied sequence of control verified | Yes | No | |
| **G** | **TAB** | | | |
| 1 | Motor rotation is in the proper direction | Yes | No | |
| 2 | Motor overloads verified | Yes | No | |
| 3 | Motor voltage and amps verified – each phase | Yes | No | |
| 4 | Minimum airflow (cfm) (design/measured) | Yes | No | |
| 5 | Maximum airflow (cfm) (design/measured) | Yes | No | |
| 6 | Entering and leaving coil air temperatures (°F) | Yes | No | |
| | | | | |

**"NO" Responses:**

| Item | Item | Reason for "NO" Responses |
|---|---|---|
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**Contactor:** **LAWA Representative:**

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Checks by: _____ _____ Date: _____; Checks by:_____ _____ Date: _____

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Los Angeles World Airports

# LAWA Commissioning Forms

## VAV Box, Non Fan Powered w/HW Heat

Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| Item | Task Description | Response | | Comment: |
|---|---|---|---|---|
| **1** | **Delivery Book** | | | |
| **A** | **Model Verification** | Submitted | Delivered | |
| 1 | Manufacturer | | | |
| 2 | Model | | | |
| 3 | Serial Number | | | |
| 4 | Size (in.) | | | |
| 5 | Max/Min Airflow (cfm) | | | |
| 6 | Heating Capacity (MBH/gpm) | | | |
| **B** | **Physical Checks** | | | |
| 1 | Unit is free from physical damage | Yes | No | |
| 2 | The air openings are sealed with plastic | Yes | No | |
| 3 | The water openings are sealed with plastic plugs | Yes | No | |
| 4 | The airflow sensing tubing is plugged | Yes | No | |
| 5 | The grommets for the airflow sensing tubing are secure | Yes | No | |
| 6 | The enclosure for the DDC control panel is in the proper location | Yes | No | |
| 7 | Installation and startup manual provided | Yes | No | |
| 8 | Unit tags affixed | Yes | No | |
| 9 | Manufacturer's ratings readable/accurate | Yes | No | |
| **2** | **Construction Checklist** | | | |
| **A** | **Hanging** | | | |
| 1 | Unit is supported as required by manufacturer and specifications | Yes | No | |
| 2 | Metal to metal connections eliminated to prevent noise problems | Yes | No | |
| 3 | Adequate clearance around control panel for maintenance | Yes | No | |
| 4 | Clear access below unit for easy maintenance | Yes | No | |
| 5 | Unit labeled and is easy to see | Yes | No | |
| 6 | Box openings temporarily sealed to maintain system cleanliness | Yes | No | |
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| | | | | |
|---|---|---|---|---|
| **B** | **Ductwork** | | | |
| 1 | Balancing damper present on inlet duct | Yes | No | |
| 2 | Sufficient length of straight ductwork installed upstream of unit | Yes | No | |
| 3 | Downstream ductwork free of transitions for sufficient length | Yes | No | |
| 4 | All components are accessible for maintenance | Yes | No | |
| 5 | Flexible connector (vibration isolator) installed on inlet duct to avoid noise problems from metal-to-metal contact | Yes | No | |
| 6 | Flex duct ( if used) is installed in a way that avoids forming kinks on both inlet and outlet ductwork | Yes | No | |
| **C** | **Piping** | | | |
| 1 | All piping components have been installed (in the correct order) as required by detail drawing | Yes | No | |
| 2 | Piping is arranged for ease of unit/coil removal | Yes | No | |
| 3 | Piping supported as required by specifications | Yes | No | |
| 4 | Piping is clean | Yes | No | |
| 5 | Piping insulation is complete and installed as per specifications | Yes | No | |
| 6 | All valves and test ports are easily accessible | Yes | No | |
| 7 | Valve tags attached | Yes | No | |
| **D** | **Controls - Installation** | | | |
| 1 | Temperature sensor calibration verified | Yes | No | |
| 2 | Airflow sensor calibration verified | Yes | No | |
| 3 | Point-to- Point connections of control wiring verified | Yes | No | |
| 4 | Central system accurately represents condition of unit | Yes | No | |
| **E** | **Controls – Startup** | | | |
| 1 | Cooling/heating sequence of control verified | Yes | No | |
| 2 | Warm-up/cool-down sequence of control verified | Yes | No | |
| 3 | Unoccupied sequence of control verified | Yes | No | |
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Instructions: Step 1: Circle Yes or No and fill in with requested information
Step 2: Explain all "No" responses at the bottom of the checklist

| F | TAB | | | |
|---|---|---|---|---|
| 1 | Minimum airflow (cfm) (design / measured) | Yes | No | |
| 2 | Maximum airflow (cfm) (design / measured) | Yes | No | |
| 3 | Entering and leaving coil air temperature (°F) | Yes | No | |
| 4 | Entering and leaving coil water temperature (°F) | Yes | No | |
| 5 | Coil flow and air/water pressure drops verified | Yes | No | |
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**"NO" Responses:**

| Item | Date | Reason for "NO" Response |
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