# **PROJECT MANUAL**

September 23, 2016 QTA 30% Submittal **VOLUME 3** OF 4



LAX Los Angeles World Airports

Capital Programming, Planning and Engineering Group 1 World Way Los Angeles, CA 90045 Prepared by:



**EXPERIENCE** Transportation

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Project Number P501140023

Contract Number DA-4881

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# **SPECIFICATIONS**

# **TABLE OF CONTENTS**

# VOLUME 1

Number	Section	Pages	Date Issued
Division 01	General Requirements		
00 01 10	Table of Contents	1-8	09/23/16
01 10 00	Summary	1-6	09/23/16
01 23 00	Alternates	1-2	09/23/16
01 31 00	Project Management and Coordination	1-12	09/23/16
01 32 00	Construction Progress Documentation	1-10	09/23/16
01 32 33	Photographic Documentation	1-4	09/23/16
01 33 00	Submittal Procedures	1-12	09/23/16
01 40 00	Quality Requirements	1-12	09/23/16
01 42 00	References	1-16	09/23/16
01 60 00	Product Requirements	1-6	09/23/16
01 74 19	Construction Waste Management and Disposal	1-8	09/23/16
01 77 00	Closeout Procedures	1-8	09/23/16
01 78 23	Operation and Maintenance Data	1-10	09/23/16
01 78 39	Project Record Documents	1-6	09/23/16
01 79 00	Demonstration and Training	1-8	09/23/16
01 91 13	General Commissioning Requirements	1-4	09/23/16
Division 02	Existing Conditions		
02 41 16	Structure Demolition	1-8	09/23/16
Division 03	Concrete		
03 30 00	Cast-In-Place Concrete	1-32	09/23/16
03 30 53	Miscellaneous Cast-In-Place Concrete	1-9	09/23/16
03 33 00	Architectural Concrete	1-15	09/23/16
03 41 00	Precast Structural Concrete	1-25	09/23/16
03 45 00	Precast Architectural Concrete	1-25	09/23/16
03 48 26.13	Precast Concrete Bollards, Barriers and Seats	1-6	09/23/16

TABLE OF CONTENTS	QTA 30% SUBMITTAL
	2016-09-23
00 01 10	Page 1 of 8

Number	Section	Pages	Date Issued
D::: 04	М		
Division 04	Masonry		
04 22 00	Concrete Unit Masonry	1-24	09/23/16
04 26 13	Masonry Veneer	1-27	09/23/16
Division 05	Metals		
05 12 00	Structural Steel Framing	1-14	09/23/16
05 12 13	Architecturally Exposed Structural Steel Framing	1-9	09/23/16
05 21 00	Steel Joist Framing	1-8	09/23/16
05 31 00	Steel Decking	1-11	09/23/16
05 40 00	Cold-Formed Metal Framing	1-12	09/23/16
05 50 00	Metal Fabrications	1-22	09/23/16
05 51 00	Metal Stairs	1-10	09/23/16
05 52 13	Pipe and Tube Railings	1-14	09/23/16
05 73 00	Decorative Metal Railings	1-22	09/23/16
05 73 16	Wire Rope Mesh Infill Guardrail	1-7	09/23/16
05 75 00	Decorative Formed Metal	1-6	09/23/16
05 75 30.13	Metal Column Covers	1-8	09/23/16
Division 06	Wood, Plastics and Composites		
06 10 00	Rough Carpentry	1-6	09/23/16
06 60 00	Plastic Fabrications	1-2	09/23/16
06 61 16	Solid Surface Material Fabrications	1-4	09/23/16
06 64 00	FRP Plastic Paneling	1-4	09/23/16
Division 07	Thermal and Moisture Protection		
07 11 13	Bituminous Dampproofing	1-6	09/23/16
07 14 16	Cold Fluid-Applied Waterproofing	1-6	09/23/16
07 18 00	Traffic Coatings	1-10	09/23/16
07 19 00	Water Repellants	1-6	09/23/16
07 21 00	Thermal Insulation	1-6	09/23/16
07 27 13	Modified Bituminous Sheet Air Barriers	1-10	09/23/16
07 27 26	Fluid-Applied Membrane Air Barriers	1-10	09/23/16
07 27 29	Air Barrier Coatings	1-10	09/23/16
07 42 13	Metal Wall Panels	1-14	09/23/16
07 54 19	PVC Roofing	1-12	09/23/16
07 62 00	Sheet Metal Flashing and Trim	1-14	09/23/16
07 71 00	Roof Specialties	1-12	09/23/16
07 72 00	Roof Accessories	1-10	09/23/16
07 81 00	Applied Fireproofing	1-8	09/23/16
07 84 13	Penetration Firestopping	1-8	09/23/16
07 84 46	Fire-Resistive Joint Systems	1-8	09/23/16
07 92 00	Joint Sealants	1-10	09/23/16

Number	Section	Pages	Date Issued
07 95 00	Expansion Control	1-8	09/23/16

# VOLUME 2

Division 08     Openings       08 11 13     Hollow Metal Doors and Frames     1-10     09/23       08 14 16     Flush Wood Doors     1-16     09/23       08 31 13     Access Doors and Frames     1-4     09/23       08 33 23     Overhead Coiling Doors     1-12     09/23       08 33 26     Overhead Coiling Grilles     1-10     09/23       08 51 13     Aluminum Windows     1-8     09/23       08 51 23     Steel Windows     1-8     09/23       08 80 00     Glazing     1-14     09/23       08 81 3     Fire-Resistant Glazing     1-8     09/23       08 91 10     Glazed Aluminum Curtain Walls     1-19     09/23	sued
08 11 13   Hollow Metal Doors and Frames   1-10   09/23     08 14 16   Flush Wood Doors   1-16   09/23     08 31 13   Access Doors and Frames   1-4   09/23     08 33 23   Overhead Coiling Doors   1-12   09/23     08 33 26   Overhead Coiling Grilles   1-10   09/23     08 51 13   Aluminum Windows   1-8   09/23     08 51 23   Steel Windows   1-8   09/23     08 71 00   Door Hardware   1-14   09/23     08 80 00   Glazing   1-14   09/23     08 81 3   Fire-Resistant Glazing   1-8   09/23     08 91 10   Glazed Aluminum Curtain Walls   1-19   09/23	
08 14 16   Flush Wood Doors   1-16   09/23     08 31 13   Access Doors and Frames   1-4   09/23     08 33 23   Overhead Coiling Doors   1-12   09/23     08 33 26   Overhead Coiling Grilles   1-10   09/23     08 51 13   Aluminum Windows   1-8   09/23     08 51 23   Steel Windows   1-8   09/23     08 71 00   Door Hardware   1-14   09/23     08 80 00   Glazing   1-14   09/23     08 81 3   Fire-Resistant Glazing   1-8   09/23     08 91 10   Glazed Aluminum Curtain Walls   1-19   09/23	.3/16
08 31 13   Access Doors and Frames   1-4   09/23     08 33 23   Overhead Coiling Doors   1-12   09/23     08 33 26   Overhead Coiling Grilles   1-10   09/23     08 51 13   Aluminum Windows   1-8   09/23     08 51 23   Steel Windows   1-8   09/23     08 71 00   Door Hardware   1-14   09/23     08 80 00   Glazing   1-14   09/23     08 88 13   Fire-Resistant Glazing   1-8   09/23     08 91 10   Glazed Aluminum Curtain Walls   1-19   09/23	3/16
08 33 23   Overhead Coiling Doors   1-12   09/23     08 33 26   Overhead Coiling Grilles   1-10   09/23     08 51 13   Aluminum Windows   1-8   09/23     08 51 23   Steel Windows   1-8   09/23     08 71 00   Door Hardware   1-14   09/23     08 80 00   Glazing   1-14   09/23     08 81 3   Fire-Resistant Glazing   1-8   09/23     08 91 10   Glazed Aluminum Curtain Walls   1-19   09/23	3/16
08 33 26   Overhead Coiling Grilles   1-10   09/23     08 51 13   Aluminum Windows   1-8   09/23     08 51 23   Steel Windows   1-8   09/23     08 71 00   Door Hardware   1-14   09/23     08 80 00   Glazing   1-14   09/23     08 88 13   Fire-Resistant Glazing   1-8   09/23     08 91 10   Glazed Aluminum Curtain Walls   1-19   09/23	3/16
08 51 13   Aluminum Windows   1-8   09/23     08 51 23   Steel Windows   1-8   09/23     08 71 00   Door Hardware   1-14   09/23     08 80 00   Glazing   1-14   09/23     08 88 13   Fire-Resistant Glazing   1-8   09/23     08 91 10   Glazed Aluminum Curtain Walls   1-19   09/23	3/16
08 51 23   Steel Windows   1-8   09/23     08 71 00   Door Hardware   1-14   09/23     08 80 00   Glazing   1-14   09/23     08 88 13   Fire-Resistant Glazing   1-8   09/23     08 91 10   Glazed Aluminum Curtain Walls   1-19   09/23	3/16
08 71 00   Door Hardware   1-14   09/23     08 80 00   Glazing   1-14   09/23     08 88 13   Fire-Resistant Glazing   1-8   09/23     08 91 10   Glazed Aluminum Curtain Walls   1-19   09/23	3/16
08 80 00   Glazing   1-14   09/23     08 88 13   Fire-Resistant Glazing   1-8   09/23     08 91 10   Glazed Aluminum Curtain Walls   1-19   09/23	3/16
08 88 13     Fire-Resistant Glazing     1-8     09/23       08 91 10     Glazed Aluminum Curtain Walls     1-19     09/23	3/16
08 91 10 Glazed Aluminum Curtain Walls 1-19 09/23	3/16
	3/16
08 91 19     Fixed Louvers     1-8     09/23	3/16
Division 09 Finishes	
09 21 16.23Gypsum Board Shaft Wall Assemblies1-409/23	.3/16
09 22 16Non-Structural Metal Framing1-1009/23	3/16
09 29 00 Gypsum Board 1-10 09/23	3/16
09 30 00 Tiling 1-10 09/23	3/16
09 51 23Acoustical Panel Ceilings1-409/23	3/16
09 51 30Fabric-Faced Acoustical Ceilings1-409/23	3/16
09 65 13 Resilient Base 1-6 09/23	3/16
09 65 16     Resilient Sheet Flooring     1-10     09/23	3/16
09 65 19     Resilient Tile Flooring     1-6     09/23	3/16
09 66 23Resinous Matrix Terrazzo Flooring1-1409/23	3/16
09 68 13 Tile Carpeting 1-6 09/23	3/16
09 72 00     Wall Covering Panels     1-4     09/23	3/16
09 91 13 Exterior Painting 1-8 09/23	3/16
09 91 23 Interior Painting 1-6 09/23	3/16
09 96 00     Hi-Performance Coatings     1-4     09/23	3/16
Division 10 Specialties	
10 11 00     Visual Display Units     1-20     09/23	.3/16
10 14 16 Plaques 1-10 09/23	.3/16
10 14 23 Panel Signage 1-16 09/23	3/16

TABLE OF CONTENTS	QTA 30% SUBMITTAL
	2016-09-23
00 01 10	Page 3 of 8

Number	Section	Pages	Date Issued
10 21 13	Toilet Compartments	1-4	09/23/16
10 21 16	Shower and Dressing Compartments	1-12	09/23/16
10 22 13	Wire Mesh Partitions	1-10	09/23/16
10 22 39	Folding Panel Partitions	1-16	09/23/16
10 26 00	Wall and Door Protection	1-6	09/23/16
10 28 00	Toilet Accessories	1-6	09/23/16
10 43 13	Defibrillator Cabinets	1-6	09/23/16
10 44 13	Fire Protection Cabinets	1-6	09/23/16
10 44 16	Fire Extinguishers	1-4	09/23/16
Division 11	Equipment		
11 11 13	Compressed Air System	1-10	09/23/16
11.11.19	Vehicle Lubrication and Used Oil System	1-15	09/23/16
11 11 26	Car Wash Equipment	1-9	09/23/16
11 11 27	Windshield Washer Fluid System	1-14	09/23/16
11 11 28	Vacuum System	1-10	09/23/16
11 13 19	Loading Dock Equipment	1-20	09/23/16
11 14 80	Wash Bay Curtains	1-4	09/23/16
11 24 24	Fall Restraint Equipment	1-10	09/23/16
11 31 00	Appliances	1-22	09/23/16
Division 12	Furnishings	NA	
Division 13	Special Construction		
13 61 00	Gasoline Storage and Dispensing System	1-41	09/23/16
13 61 01	Gasoline Electrical System	1-17	09/23/16
13 61 02	Environmental Monitoring and Fuel Control System	1-12	09/23/16
13 61 03	Fuel Management and Revenue Control System	1-5	09/23/16
Division 14	Conveying Equipment		
14 20 00	Vertical Transportation, General	1-22	09/23/16
14 21 00	Heavy Duty Transit Type Machine Room-Less Elevators	1-28	09/23/16
14 31 00	Escalators	1-22	09/23/16
14 45 10	Electric Vehicle Lifts	1-5	09/23/16
14 xx xx	Five Year Extended Preventative and Routine Maintenance	1-24	09/23/16
	Service Agreement (service Agreement) Specifications for Elevators, Escalators, and Moving Walks at the Los Angeles International Airport in the City of Los Angeles		

# VOLUME 3

Number	Section	Pages	Date Issued
Division 21	Fire Suppression		
21 13 00	Fire Protection	1-14	09/23/16
Division 22	Plumbing		
22 05 00	Common Work Results for Plumbing	1-4	09/23/16
22 05 23	General-Duty Valves for Plumbing Piping	1-7	09/23/16
22 05 29	Hangers and Supports for Plumbing Piping and Equipment	1-12	09/23/16
22 05 48	Vibration Controls for Plumbing Piping and Equipment	1-12	09/23/16
22 05 53	Identification for Plumbing Piping and Equipment	1-7	09/23/16
22 07 00	Plumbing Insulation	1-6	09/23/16
22 11 00	Facility Water Distribution	1-16	09/23/16
22 11 13	Facility Water Distribution Piping	1-34	09/23/16
22 11 23	Facility Natural Gas Piping	1-20	09/23/16
22 13 00	Facility Sanitary Sewerage	1-13	09/23/16
22 13 13	Facility Sanitary Sewers	1-16	09/23/16
22 14 00	Facility Storm Drainage	1-14	09/23/16
22 40 00	Plumbing Fixtures	1-16	09/23/16
Division 23	Heating, Ventilating, and Air Conditioning		
23 00 00	Airport Mechanical Standards	1-18	09/23/16
23 01 30	HVAC Air Distribution System and Duct Cleaning	1-6	09/23/16
23 05 00	Common Work Results for HVAC	1-19	09/23/16
23 05 16	Expansion Fittings and Loops for HVAC Piping	1-11	09/23/16
23 05 23	General Duty Valves for HVAC Piping	1-22	09/23/16
23 05 29	Hangers and Supports for HVAC Piping and Equipment	1-11	09/23/16
23 05 48	Vibration and Seismic Controls for HVAC Piping & Equipment	1-9	09/23/16
23 05 53	Identification for HVAC Piping and Equipment	1-7	09/23/16
23 05 93	Testing, Adjusting and Balancing for HVAC Equipment	1-17	09/23/16
23 07 00	HVAC Insulation	1-21	09/23/16
23 08 00	Commissioning of HVAC Systems	1-8	09/23/16
23 21 13	Hydronic Piping	1-28	09/23/16
23 21 16	Hydronic Piping Specialties	1-7	09/23/16
23 21 23	Hydronic Pumps	1-3	09/23/16
23 23 00	Refrigerant Piping	1-14	09/23/16
23 25 00	HVAC Water Treatment	1-12	09/23/16
23 31 00	Metal Ducts and Casings	1-24	09/23/16
23 33 00	Air Duct Accessories	1-17	09/23/16
23 34 00	HVAC Fans	1-6	09/23/16

TABLE OF CONTENTS

Number	Section	Pages	Date Issued
23 36 00	Air Terminal Units	1-3	09/23/16
23 37 00	Air Outlets and Inlets	1-6	09/23/16
23 37 23	HVAC Gravity Ventilators	1-5	09/23/16
23 40 00	HVAC Air Cleaning Devices (UVGI)	1-6	09/23/16
23 42 00	Ultra Violet Germicidal Irradiation System	1-4	09/23/16
23 52 00	Hot Water Boilers	1-11	09/23/16
23 74 13	Central-Station Air-Handling Units	1-13	09/23/16
23 81 03	Packaged Rooftop Air-Conditioning Units	1-6	09/23/16
23 81 07	Variable Frequency Drives	1-15	09/23/16
23 81 19	Pre-Conditioned Air	1-25	09/23/16
23 81 23.16	HVAC for Telecom Rooms	1-11	09/23/16
23 81 26	Split-System Air-Conditioners (Ducted)	1-5	09/23/16
23 81 27	Ductless Split Air-Conditioners	1-5	09/23/16
23 82 19	Fan Coil Units	1-15	09/23/16
23 83 00	Variable Refrigerant Systems FC/CU/BC Units	1-8	09/23/16
Division 25	Integrated Automation		
25 20 00	Building Automation System	1-68	09/23/16

# VOLUME 4

Number	Section	Pages	Date Issued
Division 26	Electrical		
26 00 00	Airport Electrical Design Standards	1-8	09/23/16
26 05 02	Basic Electrical Requirements	1-9	09/23/16
26 05 03	Equipment Wiring Connections	1-3	09/23/16
26 05 13	Medium-Voltage Cables	1-4	09/23/16
26 05 16	Emergency Circuit Conductors and Cables	1-3	09/23/16
26 05 19	Low-Voltage Electrical Power Conductors and Cables	1-6	09/23/16
26 05 27	Grounding and Bonding for Electrical Systems	1-6	09/23/16
26 05 30	Hangers and Supports for Electrical Systems	1-11	09/23/16
26 05 33	Raceway and Boxes for Electrical Systems	1-10	09/23/16
26 05 34	Floor Boxes for Electrical Systems	1-3	09/23/16
26 05 44	Underground Ducts and Raceways for Electrical Systems	1-13	09/23/16
26 05 49	Vibration and Seismic Controls for Electrical System	1-6	09/23/16
26 05 54	Identification for Electrical Systems	1-7	09/23/16
26 05 73	Short Circuit & Overcurrent Protective Device Coordination	1-9	09/23/16
	Study		
26 07 00	Testing	1-13	09/23/16
26 09 13	Web-Based Power Monitoring Communications Systems	1-7	09/23/16

Number	Section	Pages	Date Issued
26 09 23	Lighting Control Devices and Control Panels	1-7	09/23/16
26 09 43	Network Lighting Control System	1-8	09/23/16
26 12 16	Substation: Vacuum Primary Breaker, VPI Transformers, Secondary Switchboard	1-8	09/23/16
26 13 13	Metal-Clad Switchgear (VACCLAD) – Medium Voltage	1-25	09/23/16
26 22 00	Low-Voltage Transformers	1-6	09/23/16
26 23 00	Metal-Enclosed Drawout Switchgear – Low Voltage	1-14	09/23/16
26 24 13	Switchboards	1-14	09/23/16
26 24 16	Panelboards	1-12	09/23/16
26 24 19	Motor-Control Centers	1-7	09/23/16
26 25 00	Enclosed Bus Assemblies	1-4	09/23/16
26 27 16	Electrical Cabinets and Enclosures	1-3	09/23/16
26 27 26	Wiring Devices	1-5	09/23/16
26 28 13	Fuses	1-2	09/23/16
26 28 19	Enclosed Switches	1-3	09/23/16
26 28 23	Enclosed Circuit Breakers	1-3	09/23/16
26 28 26	Enclosed Transfer Switches	1-12	09/23/16
26 32 13	Engine Generators	1-15	09/23/16
26 33 53	Static Uninterruptible Power System	1-21	09/23/16
26 43 13	Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits	1-6	09/23/16
26 51 00	Interior Lighting	1-7	09/23/16
26 56 00	Exterior Lighting	1-17	09/23/16
Division 27	Communications		
27 05 00	Basic Telecommunications Requirements	1-7	09/23/16
27 11 00	Telecommunications Room Build Out Requirements	1-13	09/23/16
27 21 00	Local Area Networks	1-12	09/23/16
27 31 00	Wireless Access Point System	1-8	09/23/16
27 53 00	Distributed Antenna System	1-19	09/23/16
Division 28	Electronic Safety and Security		
28 23 00	Video Management System	1-18	09/23/16
28 31 00	Fire Detection and Alarm	1-25	09/23/16
Division 31	Earthwork		
31 10 00	Site Clearing	1-7	09/23/16
31 20 00	Earth Moving	1-19	09/23/16
31 50 00	Excavation Support and Protection	1-6	09/23/16
Division 32	Exterior Improvements		
32 12 16	Asphalt Paving	1-11	09/23/16
TABLE OF CO	ONTENTS	QTA 30% ;	SUBMITTAL 2016-09-23
00 01 10			Page 7 of 8

Number	Section	Pages	Date Issued
32 13 13	Concrete Paving	1-19	09/23/16
32 13 73	Concrete Paving Joint Sealers	1-6	09/23/16
32 17 13	Parking Bumpers	1-2	09/23/16
32 17 23	Pavement Markings	1-3	09/23/16
32 17 26	Tactile Warning Surfacing	1-11	09/23/16
32 31 10	Site Furnishings	1-6	09/23/16
32 31 13	Chain Link Fence	1-6	09/23/16
32 84 00	Planting Irrigation	1-30	09/23/16
31 91 13	Soil Preparation	1-15	09/23/16
32 92 00	Turf and Grasses	1-16	09/23/16
32 93 00	Plants	1-24	09/23/16
Division 33	Utilities		
33 05 00	Common Work Results for Utilities	1-13	09/23/16
33 41 00	Storm Utility Drainage Piping	1-24	09/23/16
33 46 00	Subdrainage	1-11	09/23/16

#### **SECTION 21 13 00**

#### FIRE SPRINKLER SYSTEMS

#### PART 1 - GENERAL

#### 1.1 GENERAL AND SPECIAL CONDITIONS

- A. General and special conditions apply to the work in this section.
- B. The Contractor shall furnish all equipment, materials, tools, labor, engineering, drawings, etc. necessary for a complete fire protection system, with said systems being made ready for operation in accordance with the requirements of the Authorities Having Jurisdiction. The purpose of Owner furnished specifications is to convey to the Contractor the scope of work required, all of which the Contractor is responsible to furnish, install, adjust, and make operable. The omission by the Owner of any necessary system component as required by the Authorities Having Jurisdiction, in the specifications shall not relieve the Contractor of the responsibility for providing such necessity, without additional cost to the Owner. The Contractor shall visit the site before submitting his bid and shall examine all existing physical conditions that may be material to the performance of his work. No extra payments will be allowed to the Contractor as a result of extra work made necessary by his failure to do so. Any case of error, omission, discrepancy or lack of clarity shall be promptly identified to the Owner, Architect, and Engineer for clarification prior to the bid due date.
- C. The Contractor shall provide all devices and equipment required by these specifications. Under no circumstances will the Contractor delete any equipment or devices without the written directive of the Owner.

#### **1.2 SYSTEM ABBREVIATIONS AND DEFINITIONS**

- A. AHJ Authority Having Jurisdiction (City of Los Angeles).
- B. Approved Unless otherwise stated, materials, equipment or submittals approved by the Engineer.
- C. ANSI American National Standards Institute.
- D. Architect TranSystems
- E. ASTM American Society for Testing and Materials.
- F. AWS American Welding Society.
- G. AWWA American Water Works Association.
- H. Concealed Where used in connection with installation of piping or conduit and accessories, shall mean, "Hidden from sight" as in shafts, furred spaces, in soffits or above suspended ceilings.

- I. Contractor The Company awarded the prime contract for this work and any of its subcontractors, vendors, suppliers, or fabricators.
- J. Engineer Jensen Hughes.
- K. Exposed Where used in connection with installation of piping or conduit and accessories, shall mean "visible" or "not concealed."
- L. FM FM Global.
- M. FM Approved Materials or equipment approved by FM Global and included in the most recent edition of the FM Approval Guide.
- N. Furnish Supply materials.
- O. GPM Gallons per minute.
- P. Install Install materials, mount, and connect equipment or assemblies.
- Q. IRI Industrial Risk Insurers.
- R. ISO Insurance Services Office.
- S. NFPA National Fire Protection Association.
- T. Owner Sunroad Enterprises
- U. PIV Post indicating valve.
- V. Provide Furnish, install, and connect.
- W. PRV Pressure-reducing valve.
- X. PSI Pounds per square inch.
- Y. QR Quick-Response Sprinkler.
- Z. Remove Remove material and equipment and restore surface.
- AA. UL Underwriters Laboratories, Inc.
- BB. UL Listed Materials or equipment by Underwriters Laboratories and included in the most recent edition of the UL Fire Protection Equipment Directory.

# **1.3 SCOPE OF WORK**

- A. Provide complete fire protection system as outlined in the project specifications, including all labor, materials, permits, shop drawings and hydraulic calculations needed to furnish and install complete and functional automatic sprinkler systems throughout the QTA Building A and QTA Building B and all of the following:
  - 1. Wet pipe automatic sprinkler systems.

- 2. Class I standpipes in all stairways in accordance with LA Building Code Section 905.
- 3. Connect to site piping approximately 5 feet, 0 inches from the building.
- 4. Earthquake bracing and flexible couplings.
- 5. Coordinate all work with other trades. Install offsets to avoid clashes with other trades.
- 6. Coordination and interface of alarm initiating and supervisory devices with the fire alarm system.
- 7. Shop drawings.
- 8. Two (2) sets of operating instructions and valve diagrams.
- 9. As-built drawings. The Contractor will be required to provide as-built drawings on disk/CD or flash drive in Revit format, in addition to required reproducible and blueline drawings.
- 10. On-site project supervision.
- 11. Required signs in English at all control valves, main drains, auxiliary drains and inspector's test connections, etc., including hydraulic placards, in accordance with NFPA 13 requirements.
- 12. Cabinet containing the required number and type of spare sprinklers and corresponding wrenches, to be located in the pump room.
- 13. All required system testing in accordance with NFPA 13, 24, and 25.
- 14. Warranty on all materials and labor.
- 15. All permits, taxes and fees, including AHJ inspection and testing fees necessary to complete the specified work.

## **1.4 RELATED WORK**

- A. Materials and methods specified in other sections, included but not limited to:
  - 1. Cutting and patching.
  - 2. Fire extinguishers, cabinets, and accessories.
  - 3. Painting of finished surfaces at pipe penetrations by other than Contractor.
  - 4. Grading.
- B. Materials furnished and installed in this section but wired by others:
  - 1. Valve supervisory devices shall be furnished and installed by the Contractor but wired by the alarm contractor.
  - 2. Waterflow switches shall be furnished and installed by the Contractor but wired by the alarm contractor.

# 1.5 DESIGN CRITERIA

- A. Sprinkler System
  - 1. Office, Restrooms, and Corridors: Wet system. With K-Factor 5.6 sprinklers. Light Hazard with a design density of 0.15 gpm/sq. ft. over the hydraulically most remote 1,500 sq. ft. area with a hose demand of 100 gpm. Maximum protection area of 225 sq. ft. per sprinkler is required.
  - 2. Fueling Stations and Tire Storage: Wet system. With K-Factor 11.2 sprinklers. Extra Hazard Group I with a design density of 0.30 gpm/sq. ft. over the hydraulically most remote 2,500 sq. ft. area with a hose demand of 500 gpm. Maximum protection area of 100 sq. ft. per sprinkler is required.
  - 3. Storage, Car Wash and Car Maintenance: Wet system, with K-Factor 11.2 sprinklers. Ordinary Hazard Group II Occupancy with a design density of 0.20 gpm/sq. ft. over the hydraulically most remote 1,500 sq. ft. area with a hose demand of 250 gpm. Maximum

protection area of 16 ft. X 16 ft. with 200°F rated, extended coverage, ordinary hazard, standard response, upright sprinkler.

- 4. Office and Lobbies: Wet system, with K-Factor 5.6 sprinklers. Light Hazard Occupancy with a design density of 0.10 gpm/sq. ft. over the hydraulically most remote 1,500 sq. ft. area with a hose demand of 100 gpm. Maximum protection area of 225 sq. ft. per sprinkler is required.
- 5. Janitor Closets, Electrical, IDF, and Elevator Machine Rooms: Wet system, with K-Factor 5.6 sprinklers. Ordinary Hazard Group 1 Occupancy with a design density of 0.15 gpm/sq. ft. over the hydraulically most remote 1,500 sq. ft. area with a hose demand of 250 gpm. Maximum protection area of 130 sq. ft. per sprinkler is required.
- B. Water Supply
  - Pipe sizing shall be determined by hydraulic calculations in accordance with NFPA 13 1. requirements and shall be based upon a water supply test of 96 psi static and 88 psi residual at a flow of 1,245 gpm.

#### 1.6 **APPLICABLE STANDARDS**

- American National Standards Institute, Inc. (ANSI) Standards, current editions: A.
  - A21.10a Gray-Iron and Ductile-Iron Fittings, 2 inch through 48 inch for Water and Other 1. Liquids.
  - 2. A21.11 – Rubber-Gasket Joints for Cast-Iron and Ductile-Iron Pressure Pipe and Fittings.
  - 3. B16.1 – Cast-Iron Pipe Flanges and Flanged Fittings, 24, 125, 250, and 800 pounds.
  - B16.3 Malleable-Iron Threaded Fitting, Class 150 and 300. 4.
  - B16.4 Cast-Iron Threaded Fitting, Class 125 and 250. 5.
  - B18.2.1 Square and Hex Bolts and Screws. 6.
  - B18.2.2 Square and Hex Nuts. 7.
  - B36.10 Welded and Seamless Wrought Steel Pipe. 8.
  - B112.1 Hose Valves for Fire Protection Services. 9
- American Society for Testing and Materials (ASTM) Standards, current edition: B.
  - A 53 Specifications for Welded and Seamless Steel Pipe. 1
  - 2. A 307 – Carbon Steel Externally and Internally Threaded Standard Fasteners.
- C. American Standard Mechanical Engineers (ASME) Standards, current edition: B1.20.1 – Pipe Threads, General Purpose. 1.
- D.
  - American Water Works Association (AWWA) Standards, current editions: C200-75 – Steel Water Pipe 6 Inches and Larger. 1.
  - 2. C207-55 – Steel Pipe Flanges.
  - 3. C500-71 – Gate Valves – 3 through 48 inch – for Water and Other Liquids.
  - C105 Polyethylene Encasement. 4.
- American Welding Society (AWS) Standards, current edition: E.
  - D10.9 Qualification of Welding Procedures and Welders for Piping and Tubing, Level 1. AR-3.
  - 2. B2.1 – Specifications for Qualification of Welding Procedures and Welder for Piping and Tubing.

- F. Los Angeles Building Code (CBC), 2014 Edition.
- G. Los Angeles Electrical Code (CEC), 2014 Edition.
- H. Los Angeles Fire Code (CFC), 2014 Edition.
- I. Federal Specifications (Fed. Spec.):
  - 1. GG-G76D Gages, Pressure and Vacuum, Dial Indicating, (for Air, Steam, Oil, Water, Ammonia and Chloro-Floro Hydrocarbon Gases).
  - 2. WW-P-421c Pipe, Cast Gray and Ductile Iron, Pressure (for Water and Other Liquids).
  - 3. WW-P-521f Pipe Fittings, Flange Fittings and Flanges, Steel and Malleable Iron (Threaded and Butt-Welding) 150 Pound.
  - 4. WW-V-51E Valve, Angle, Check and Globe, Bronze (125, & Int. AM-2 150 and 200 Pound, Threaded End, Flange Ends, (GSA-FFS) Solder Ends and Brazed End, for Land Use).
  - 5. WW-V-58B Valves, Gate, Cast Iron; Threaded and Flanged (for Land Use).
- J. FM Global Publication:
  - 1. Approval Guide.
- K. National Fire Protection Association 13 (NFPA 13) "Standard for the Installation of Sprinkler Systems," 2013 Edition.
- L. National Fire Protection Association 14 (NFPA 14) "Standard of Standpipe and Hose System," 2013 Edition.
- M. National Fire Protection Association 24 (NFPA 24) "Standard for the Installation of Private Fire Service Mains," 2013 Edition.
- N. National Fire Protection Association 25 (NFPA 25) "Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems," 2014 Edition.
- O. Underwriters Laboratories, Inc. (UL) Publication: Fire Protection Equipment List (Annually with Quarterly Supplements).

#### 1.7 APPROVALS

A. Obtain approval from the City of Los Angeles. Contractor shall pay for all permits, inspections, and associated fees.

#### **1.8 SUBMITTALS**

- A. Shop Drawings
  - 1. Submit three sets of complete shop drawings, three sets of manufacturer's data and three sets of hydraulic calculations to Architect and Engineer for all necessary reviews prior to fabrication of materials.
  - 2. Contractor shall submit complete system packages. Partial system submittals will be rejected.
  - 3. Hydraulic calculations shall include a water supply graph and hydraulic cover sheet. The cover sheet shall include the name and location of the calculated area, ceiling height, occupancy, design criteria, sprinkler spacing, system type, sprinkler make, model, size, K-

factor and temperature rating, flow requirements, C-factor used, water supply data and source of information.

- 4. Prepare shop drawings with a minimum scale of 1/8 inch = 1-foot 0-inch for plans, and 1/4 inch = 1-foot 0-inch for details. Show all piping, sprinklers, hangers, type of pipe, tube connections, outlets, type of roof construction, and occupancy of each area, including ceiling and roof heights as required by NFPA 13. When welding is planned, shop drawings shall indicate the sections to be shop welded and the type of welded fittings to be used. All drawings shall be prepared using AutoCAD.
- 5. Design shall be based on these specifications and the appropriate NFPA standards.
- 6. Shop drawings shall include details of earthquake sway bracing, including the appropriate calculations.
- 7. Shop drawings shall include details of underground thrust blocking/restraints.
- B. Manufacturer's Data
  - 1. Provide data from manufacturer on the following devices, including installation, maintenance, and testing procedures, dimensions, wiring diagrams, etc. Where any devices that are provided or furnished involve work by someone other than the Contractor, submit additional data copies directly to the Contractor. At a minimum, the following data sheets shall be provided:
    - a. Sprinklers and escutcheons.
    - b. Pipe, fittings and hangers.
    - c. Control valves.
    - d. Fire stopping materials (including installation detail).
- C. As-Built Drawings
  - 1. Maintain at the site an up-to-date marked set of as-built drawings, which shall be corrected and delivered to the Owner upon completion of work.
  - 2. Upon completion, furnish the Owner with 3 sets of reproducible sepia prints, and one set in electronic format in Revit of each reviewed shop drawing, revised to show "as-built" conditions.
- D. Samples
  - 1. Provide one sample of each type of sprinkler and escutcheon.
- E. Final Inspection and Test
  - 1. The Contractor shall make arrangements with the Owner, Architect, and Engineer for final inspection and witnessing of the final acceptance tests. The Owner, Architect, and the Engineer will witness the final inspection.
  - 2. Perform all tests and inspections required by the referenced codes and standards, the AHJ, and the Owner.
  - 3. When the Engineer visits the job site for final inspection and tests after being advised by the Contractor that the work is complete and ready for test, if the work has not been completed or the final acceptance tests are unsatisfactory, the Contractor shall be responsible for the Engineer's extra time and expenses for re-inspection and witnessing the retesting of the work. Such extra fees shall be deducted from payments by the Owner to the Contractor.
  - 4. Upon completion of final inspections and tests, as required by appropriate NFPA Standards, submit copies of Standard Contractor's Material and Test Certificate.
- F. Operating Instructions

- 1. At the completion of the work, provide a small scale plan of building indicating the locations of all control valves, low point drains, and inspector's test valves. The plans shall be neatly drawn and color-coded to indicate the portion of the building protected by each system, framed under glass and permanently mounted on the wall at the sprinkler room.
- 2. Furnish one copy of NFPA 25 and bound set of printed operating and maintenance instructions to the Owner, and adequately instruct the Owner's maintenance personnel in proper operation and test procedures of all fire protection components provided, furnished, or installed.

## **1.9 SPARE PARTS**

- A. Provide and install one spare sprinkler cabinet, complete with 12 sprinklers of all types and temperature ratings used throughout the installation. The cabinet shall be equipped with sprinklers and special sprinkler wrenches required for each type of sprinkler installed.
- B. Confer with the Owner's representative for exact location of cabinet.

## 1.10 GUARANTEE

A. The Contractor shall guarantee all materials and workmanship for a period of one year beginning with the date of final acceptance by the Owner. The Contractor shall be responsible during the design, installation, testing and guarantee periods for any damage caused by his (or his subcontractors') work, materials, or equipment.

## **1.11 PRODUCT DELIVERY**

- A. Delivery of Materials: Delivery of all materials and equipment to the job site shall be scheduled to assure compliance with the predetermined construction schedules.
- B. Storage of Materials, Equipment and Fixtures: Contractor shall be responsible for storage of materials on job site, including furnishing of any storage facilities or structures required.
- C. Handling Materials and Equipment: Contractor shall be responsible for on-site handling of materials and equipment.

#### 1.12 QUALITY ASSURANCE

- A. Testing Agency: All materials shall be UL listed or FM approved for their intended use.
- B. Regulatory Agencies: State and local building codes and ordinances, and fire department requirements shall apply.
- C. The Contractor shall be fully experienced and licensed in all aspects of the fire protections systems herein specified.
- D. Similar materials shall be from a single manufacturer.

#### **1.13 JOB CONDITIONS**

A. Damage: Protect all unfinished work to prevent damage and furnish protection of all surrounding areas where necessary.

B. Leak Damage: The Contractor shall be responsible during the installation and testing periods of the sprinkler system for any damage to the work of others, to the building or its contents caused by leaks in any equipment, by unplugged or disconnected pipes or fittings, or by overflow, and shall pay for the necessary replacements or repairs to work of others damaged by such leakage.

# 1.14 EMERGENCY SERVICE

A. The Contractor shall provide emergency repair service for the sprinkler system within four hours of a request for such service by the Owner during the warranty period. This service shall be available on a 24-hour per day, seven-day per week basis.

# 1.15 TRAINING

A. The Contractor shall conduct two training sessions of four hours each to familiarize the facility personnel with the features, operation and maintenance of the sprinkler systems. Training sessions shall be scheduled by the Owner at a mutually agreeable time to the Contractor and the Owner.

# 1.16 PERMITS AND FEES

A. Pay for all permits, fees and charges required for this work.

# **PART 2 - MATERIALS**

## 2.1 GENERAL

- A. All components shall be used in accordance with the manufacturer's recommendations and its UL listing and/or FM approval.
- B. The naming of manufacturers in the specifications shall not be construed as eliminating the materials, products or services of other manufacturers and suppliers providing approved equivalent items.
- C. The substitutions of materials or products other than those named in the specifications are subject to proper approval of the Owner granted in writing.

# **2.2 ABOVEGROUND PIPE**

- A. Feed Mains and Branchline Piping
  - 1. Pipe shall be new, rated for 175-psi working pressure, conforming to ASTM specifications, and have the manufacturer's name and brand along with the applicable ASTM standard marked on each length of pipe.
  - 2. Pipe used shall be black steel and must comply with the specifications of the ASTM A 53 for welded and seamless steel pipe.
  - 3. Schedule 40 piping is required for sizes 2 inches and less. Pipe ends shall be threaded or roll grooved in accordance with NFPA 13.
  - 4. Schedule 10 pipe is acceptable in sizes 2<sup>1</sup>/<sub>2</sub> inches and larger. Pipe ends shall be welded or roll grooved in accordance with NFPA 13.
  - 5. All black steel sprinkler pipes shall be primed painted with exterior gloss paint. Coordinate with Architect for paint color.

B. Drain Piping
1. Hot-dipped galvanized piping shall be used for sprinkler drain pipes and gang drain pipes.

# 2.3 FITTINGS AND JOINTS

- A. Flexible Expansion Loop
  - 1. Provide UL listed flexible expansion loops for all seismic separations in accordance with NFPA 13.

#### 2.4 SPRINKLERS

- A. Listed lead-coated or corrosion-proof sprinklers shall be installed in all areas except enclosed areas such as offices.
- B. Pendent sprinklers shall be installed at quarter point or center of tile.

## 2.5 VALVES

A. Drain, trim, and test valves shall be approved.

## 2.6 SLEEVES FOR WALL/FLOOR PENETRATIONS

- A. Sleeves through walls and floors shall be of a type that can be made watertight and fire stopped.
- B. Sleeve sizes shall be as required by NFPA 13 for Earthquake Protection.

#### 2.7 SIGNS

- A. Provide standard metal signs in English in accordance with NFPA 13.
- B. Provide hydraulic calculation information signs at risers in accordance with NFPA 13.

#### 2.8 HANGERS AND BRACING

- A. All hanger components shall be of an approved and listed type.
  - 1. Earthquake Bracing Steel shapes listed in NFPA 13 shall be limited to maximum length indicated. The slenderness ratio shall not exceed 200 in accordance with NFPA 13. The Contractor shall submit calculations with shop drawings indicating least radius of gyration and maximum permissible length for each shape in accordance with NFPA 13.

#### **PART 3 - EXECUTION**

#### 3.1 GENERAL

#### A. Product Delivery

- 1. Delivery of Materials: Delivery of all materials and equipment to the job site shall be scheduled to assure compliance with the predetermined construction schedules.
- 2. Storage of Materials, Equipment, and Fixtures: Contractor shall be responsible for storage of materials on job site, including furnishing of any storage facilities or structures required.

3. Handling Materials and Equipment: Contractor shall be responsible for on-site handling of materials and equipment.

## B. Clean-up

- 1. Maintain the premises free from accumulation of waste materials or rubbish caused by this work.
- 2. At the completion of the work, removed all surplus materials, tools, etc., and leave the premises clean.
- C. Leak Protection
  - 1. Damage: Protect all unfinished work to prevent damage and furnish protection of all surrounding areas where necessary.
  - 2. Leak Damage: The Contractor shall be responsible during the installation and testing periods of the fire protection system for any damage to the work of others, to the building or its contents caused by leaks in any equipment, by unplugged or disconnected pipes or fittings, or by overflow, and shall pay for the necessary replacements or repairs to work of others damaged by such leakage.
- D. Safety
  - 1. All work shall be performed in compliance with the Occupational Safety and Health Act of 1970 and the Construction Safety Act Standards.
  - 2. Contractor shall attend all job safety meetings.

## **3.2 FABRICATION**

- A. Pipe Ends
  - 1. Ream and remove burrs after cutting pipe. Standard wall pipe ends shall be welded, threaded, cut grooved, or plain end.
  - 2. Thin wall pipe ends shall be plain end, welded or roll grooved in accordance with the fitting manufactures' recommendation.
  - 3. Threads shall be in accordance with ASME B1.20.1. Each thread on light wall pipe shall be gauged before the fitting is made-up.
- B. Grooved Ends
  - 1. Pipe minimum thickness, squareness and out-of roundness shall be in accordance with the coupling manufacturers specifications.
  - 2. Pipe surface shall be free of indentations, projections, or roll marks from the end of the pipe to the groove.
- C. Welding
  - 1. No field welding of sprinkler piping shall be permitted.
  - 2. Headers risers, feed mains, cross mains and branch lines may be shop welded using acceptable welding fittings. Welding methods shall comply with all the requirements of AWS B2.1.
  - 3. Certified records shall be maintained upon the completion of each weld, welder shall stamp an imprint of their identification into the side of the pipe adjacent to the weld.

# 3.3 INSTALLATION

A. General

- 1. A clean set of prints or shop drawings shall be maintained at the site and marked up to show any changes.
- 2. Piping shall be installed above ceilings except in areas where there is no ceiling. Install piping in exposed areas as high as possible using necessary fittings and auxiliary drains to maintain maximum clear headroom.

# 3.4 SPRINKLERS

- A. General
  - 1. Sprinklers below ceilings off of exposed piping shall be listed and approved regular bronze upright type, in upright position. Listed and approved regular bronze pendent type may be used where necessary due to clear height requirements, duct interference, etc.
  - 2. Sprig-ups shall be provided wherever necessary to provide proper deflector distances in accordance with NFPA 13 requirements.
- B. Sprinkler Guards and Water Shields
  - 1. Provide guards on sprinklers within 7 feet of finished floor or wherever sprinklers may be subject to mechanical damage.
- C. Drains
  - 1. Provide main drain valves at system control valves, sized in accordance with NFPA 13 and AHJ requirements that extend piping to exterior.
  - 2. Provide all auxiliary drains where necessary.
  - 3. Pipe all drains and auxiliary drains to locations where water drained will not damage stock, equipment, vehicles, planted areas, etc., or injure personnel.
  - 4. Plugs used for auxiliary drains shall be brass.
  - 5. All piping and fittings downstream of drain valve shall be galvanized.
  - 6. The Contractor shall comply with all water discharge restrictions.

# 3.5 VALVES

- A. General
  - 1. Valves shall be installed with sufficient clearance for operation, testing and maintenance.
  - 2. Where wafer bodied valves are used, they shall be installed so that the discs do not interfere with other components.
- B. Drain, Test, and Trim Valves
  - 1. Valves shall be installed no more than 7 feet, 0 inches above the finished floor and shall be accessible.

# 3.6 HANGERS, SUPPORTS, AND EARTHQUAKE BRACING

- A. General
  - 1. All piping must be substantially supported from building structure and only approved types of hangers shall be used. Piping lines under ducts shall not be supported from ductwork, but shall be supported from building structure with trapeze hangers where necessary or from steel angles supporting ductwork in accordance with NFPA 13.
  - 2. All thread rods shall not be bent.
  - 3. Hanger components shall be ferrous.

- B. Feed and Cross Mains
  - 1. Install at least one hanger per length of pipe up to 8 feet in length joined by grooved couplings.
  - 2. Use flexible couplings where more than two couplings are used per run.
- C. Earthquake Protection
  - 1. Install flexible joints and sway braces in accordance with NFPA 13, Section 9.3.
- D. Flexible Loop
  - 1. Use seismic expansion loop for all seismic separations.

## 3.7 SLEEVINGS, WALL & FLOOR PENETRATIONS

- A. Set Schedule 40 sleeves in place for all pipes passing through openings in fire resistance rated construction when required by UL listing for fire stopping method utilized.
- B. Provide clearance between the sprinkler piping and sleeves in accordance with NFPA and/or FM. The space between sleeve and pipe shall be filled with noncombustible, UL listed fire stopping materials. Provide chrome wall plates at each side of wall.
- C. Sleeves through floors shall be watertight. Penetrations through fire rated construction shall be adequately fire stopped to maintain the fire resistance rating required.

#### 3.8 SIGNS

- A. Valves
  - 1. Secure to each valve with corrosion resistant wire or chain, sign stating, "Control Valve."
- B. Hydraulic Design Information1. Secure to each system riser with corrosion resistant fasteners.

## **3.9 INSPECTOR'S TEST**

- A. Provide inspector's test connections, as specified in NFPA 13, at required points for testing each waterflow alarm device. Special discharge nozzle shall have same size orifice as smallest orifice sprinklers installed.
- B. Provide 1-inch sight glass if inspector's test discharge cannot be readily observed while operating valve.
- C. Pipe all inspector's test connections discharging to atmosphere to location where water drained will not damage stock, equipment, vehicles, planted areas, etc., or injure personnel. Contractor to coordinate with plumbing contractor for final location.
- D. Splash blocks shall be provided where inspector's test discharge could produce damage to surroundings.
- E. All pipe and fittings downstream of inspector's test valve shall be galvanized.

# **3.10 SYSTEM ACCEPTANCE**

- A. Tests
  - 1. General system test shall be coordinated with the owner's representatives for training and witnessed by the AHJ. Problems noted during testing such as air or water leaks, difficulty in operating valves, alarm failures, etc. shall be corrected before the Contractor leaves the job.
  - 2. Hydrostatically test all piping, including fire department connections between the check valve and connection, at 200 psi for two hours. If the highest static pressure at the lowest point in the system exceeds 150 psi, the system shall be tested at 50 psi more than the highest static pressure.
- B. Flow Tests
  - 1. Main drain shall be opened wide until pressure stabilizes then slowly closed, noting and recording flowing (residual) and static (non-flow) pressure.
- C. Valve Operation
  - 1. Operate each valve through its entire range. Adjust valve packing glands.
  - 2. Hose valves shall be capped during the test.
  - 3. Threads for hose valve/wall hydrant outlets and fire department inlets shall be verified to conform to those used by the AHJ.
- D. Water Flow and Supervisory Devices
  - 1. Coordinate testing of electric components with the alarm contractor.
  - 2. Each water flow device shall be tested in accordance with NFPA 72 by opening the inspectors test or alarm test valve.
  - 3. Each valve supervisory device shall be tested by operating the valve wheel/crank.
  - 4. Verify all signals have been noted by the fire alarm control panel and each audible alarm device operates.
- E. Contractor's material and test certificates shall be completed for each system/floor and signed by the Contractor and witnessed by the owner's representative/AHJ.
- F. Training
  - 1. General In addition to the tests required in Parts A through C and witnessed by the owner's representative(s), conduct a two-hour training session to familiarize the representatives with all operating features of the system, including control valve, drain and test valve locations and operations.
  - 2. Provide owner's representatives with:
    - a. A small-scale plan of the system/building showing locations of control, drain, and test valves.
    - b. Component manufacturers' inspection and testing manuals.
    - c. Two copies of NFPA 25.
    - d. Provide 12 spare sprinklers of all types and ratings that are installed, in a steel cabinet complete with special sprinkler wrenches. Install cabinet as directed by owner.

#### 3.11 ADJUSTMENT AND CLEANING

A. Cleaning: Flush all piping in accordance with NFPA Standards for test procedures.

# END OF SECTION 21 13 13

FIRE SPRINKLER SYSTEMS

21 13 13

## 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.
- B. 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.

#### 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

#### COMMON WORK RESULTS FOR PLUMBING

- 14. Factory Mutual Standards: FM
- 15. American gas Association: AGA
- 16. California State Fire Marshal Regulations: CSFM
- 17. National Sanitation Foundation: NSF
- 18. International Association of Plumbing & Mechanical Officials: IAPMO
- 19. Cast Iron Soil Pipe Institute: CISPI
- 20. Los Angeles City Disabled Access Division: LAC-DAV
- 21. Los Angeles Plumbing Code: LAPC
- 22. Los Angeles Department of Building and Safety: LADBS
- 23. 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 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

#### COMMON WORK RESULTS FOR PLUMBING

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.

#### PART 3 - EXECUTION

#### 3.1 INSTALLATION

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

#### COMMON WORK RESULTS FOR PLUMBING

## END OF SECTION

COMMON WORK RESULTS FOR PLUMBING

QTA 30% SUBMITTAL 09/23/2016 Page 4 of 4

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

#### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Gate valves.
  - 2. Ball valves.
  - 3. Plug valves.

## 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

# 2.1 AS MUCH AS POSSIBLE, ALL VALVES SHOULD BE FROM ONE MANUFACTURER

#### 2.2 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, nonrising 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.

#### 2.3 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 or soldered 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 or soldered 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 or soldered, 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.

#### 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 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.

#### 3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
  - 1. Shutoff Service: Ball or gate valves.
- 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 valveend 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 Steel Piping, NPS 2 and Smaller: Threaded ends.

4. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

#### 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 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. Iron Angle Valves: Class 125.
  - 3. Steel Ball Valves: Class 150, full-port.

# END OF SECTION
## 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. Formed steel channel.
  - 7. Firestopping relating to plumbing work.
  - 8. Firestopping accessories.
  - 9. Fastener systems.
  - 10. 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

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT 26 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 1 of 12

- 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:

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT 26 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 2 of 12

- 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. Vertical Support: Steel riser clamp.
  - 5. 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. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  - 5. Vertical Support: Steel riser clamp.
  - 6. 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.

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT 26 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 3 of 12

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 FORMED STEEL CHANNEL

- A. Manufacturers:
  - 1. B-Line.
  - 2. Tolco.
  - 3. Unistrut.

# 2.7 FIRESTOPPING

- A. Manufacturers:
  - 1. Dow Corning.

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT 26 05 29

- 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.

### 2.8 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.

### 2.9 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.

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT 26 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 5 of 12

- 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.

### 2.10 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.

### 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.

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT 26 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 6 of 12

## 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 or isolators 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 non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
  - 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 offcenter closure for hanger installation before pipe erection.
  - 6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
  - 7. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
  - 8. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  - 9. 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.
  - 10. 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.

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT 26 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 7 of 12

- 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. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
- 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.

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT 26 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 8 of 12

- 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 Ibeams for heavy loads.
- 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel Ibeams 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.

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT 26 05 29

- 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 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.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
- N. 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. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- E. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT 26 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 10 of 12

- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. 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.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. 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.
- J. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. 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.
- L. 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.
- M. 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 supports with copper lining and isolators for uninsulated copper piping.
  - 5. Suspend piping from inserts, using beam clamps with retaining clamp or locknut, steel fish plates, cantilever brackets or other accepted means.
  - 6. Suspend piping by rods with double nuts.

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT 26 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 11 of 12

- 7. Provide additional steel framing as required and accepted where overhead construction does not permit fastening hanger rods in required locations.
- 8. Support branch fixture water piping in chases with copper-plated metal brackets, secured to studs.

## 3.5 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.

## 3.6 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.

### 3.7 FIELD QUALITY CONTROL

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

# END OF SECTION

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT 26 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. ANSI S1.8 Reference Quantities for Acoustical Levels.
  - 2. ANSI S12.36 Survey Methods for the Determination of Sound Power Levels of Noise Sources.
  - 3. ISAT

### 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 the 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 room maximum sound levels, in Noise Criteria (NC) as defined by ANSI S1.8.
- 1.4 SUBMITTALS

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT 22 05 48 QTA 30% SUBMITTAL 09/23/2016 Page 1 of 12

- 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 Industries, Inc.
  - 2. Amber/Booth Company / a VMC Group Company.
  - 3. Vibrex / M.W. Sausse & Company, 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

VIBRATION AND SEISMIC CONTROLS FOR	QTA 30% SUBMITTAL
PLUMBING PIPING AND EQUIPMENT	09/23/2016
22 05 48	Page 2 of 12

motor with motor slide rails.

### 2.2 VIBRATION ISOLATORS

- A. Manufacturers:
  - 1. Mason Industries, Inc.
  - 2. Amber/Booth Company / a VMC Group Company
  - 3. Vibrex / M.W. Sausse & Company, 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 1.0g 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 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.
- 5. 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.

- 6. 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.

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT 22 05 48 QTA 30% SUBMITTAL 09/23/2016 Page 5 of 12

- 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. Amber/Booth Company / a VMC Group Company
  - 2. Mason Industries, Inc.
  - 3. Vibrex / M.W. Sausse & Company, Inc.
- B. Type B1: 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.
  - 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. 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 minimum 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 ICC-ES per ACI 318 appendix D which are qualified for seismic zones. 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 ICC-ES per ACI 318 appendix D which are qualified for seismic zones.

### 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.
- 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

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT 22 05 48 QTA 30% SUBMITTAL 09/23/2016 Page 8 of 12 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 0.5g 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 per the Airport Structural Design Standards.
- 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 pre-stressed 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.

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	

# b. Thickness: $\frac{1}{2}$ inch.

END OF SECTION

## 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.

#### 1.2 REFERENCES

- A. American Society of Mechanical Engineers: ASME
- B. American National Standards Institute: ANSI.
  - 1. ASME/ANSI 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.

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT 22 05 53 QTA 30% SUBMITTAL 09/23/2016 Page 1 of 7

- 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.

#### 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.

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT 22 05 53 QTA 30% SUBMITTAL 09/23/2016 Page 2 of 7

- B. Metal Tags:
  - 1. Manufacturers:
    - a. Seton.
    - b. Brady.
    - c. Kolbi.
  - 2. Stainless steel, 0.025" min. thickness and having pre-drilled holes or stamped holes 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 <sup>1</sup>/<sub>4</sub> inch high letters.
  - 3. Over 6 inches Outside Diameter of Insulation or Pipe: 2 1/2 inches high letters.
  - 4. Equipment: 1-3/4 inches high letters.
- C. Stencil Paint: Semi-gloss enamel, colors and lettering size conforming to ASME/ANSI A13.1.

#### 2.4 PIPE MARKERS

- A. Color and Lettering: Conform to ASME/ANSI A13.1.
- B. Plastic Pipe Markers:
  - 1. Manufacturers:
    - a. Seton.
    - b. Brady.

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT 22 05 53 QTA 30% SUBMITTAL 09/23/2016 Page 3 of 7

- 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

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT 22 05 53

- 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.

### 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 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

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT 22 05 53 QTA 30% SUBMITTAL 09/23/2016 Page 5 of 7

- 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/ANSI 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 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

IDENTIFICATION FOR PLUMBING	QTA 30% SUBMITTAL
PIPING AND EQUIPMENT	09/23/2016
22 05 53	Page 6 of 7

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.

END OF SECTION

## SECTION 22 07 00 PLUMBING INSULATION

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Plumbing piping 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 B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
    - b. ASTM C450 Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
    - c. ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
    - d. ASTM C585 Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
    - e. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
    - f. ASTM E96/E96M Standard Test Methods for Water Vapor Transmission of Materials.

PLUMBING INSULATION

### g. 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.

#### 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.

#### 1.5 WARRANTY

- A. Furnish one-year minimum.
- B. Furnish five year manufacturer warranty for manmade fiber.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURER

- A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
  - 1. CertainTeed.

# PLUMBING INSULATION

 $22\ 07\ 00$ 

- 2. Johns Manville.
- 3. Owens-Corning.

### 2.2 PIPE INSULATION

- A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.
  - 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-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.
- C. 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.

### 2.3 PIPE INSULATION JACKETS

- A. 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).
- B. ABS Plastic Pipe Jacket:
  - 1. Jacket: One piece molded type fitting covers and sheet material, off-white color.

PLUMBING INSULATION

 $22\ 07\ 00$ 

- 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).

#### 2.4 PIPE INSULATION ACCESSORIES

- A. Covering Adhesive Mastic: Compatible with insulation.
- B. Piping 2 inches diameter and smaller: Galvanized steel insulation protection shield, (SADDLE). MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.
- C. Piping 2-1/2 inches diameter and larger: Calcium silicate insulation insert. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.
- D. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self-adhesive closure. Thickness to match pipe insulation.
- E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- F. Adhesives: Compatible with insulation.

### 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. 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.
- D. 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.

# 3.3 PENETRATIONS

- A. 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.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. 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.

# 3.4 SCHEDULES

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS INCHES
Domestic Hot Water Supply and	P-1	1-14/ inches and smaller	1.5
Recirculation		1-1/2 inches and larger	2.0
Domestic Cold Water (Exposed)	P-1 or P-5	1-1/4 inches and smaller	0.75
		1-1/2 inches and larger	1.0

A. Water Supply Services Piping Insulation Schedule:

# PLUMBING INSULATION

Condensate Piping	P-1 or P-5	All sizes	0.5

# 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

END OF SECTION

PLUMBING INSULATION

# 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 bibbs.
  - 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 Water Works Association: AWWA

# FACILITY WATER DISTRIBUTION

 $22\ 11\ 00$ 

2. Underwriters Laboratories Inc.: U.L.

### 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.

### 1.4 CLOSEOUT SUBMITTALS

A. 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 alloy, with water soluble flux per ASTM B-13.
    - b. Press-connect Fittings: Bronze or copper shall conform to the material requirements of ASME B16.18 or ASME B16.22, and the performance requirements of IAPMO PS117, and ICC/ANSI LC1002 and NSF/ANSI 61-pw (if used in a potable water system.) Press-connect fittings ½-inch thru 4-inch for use with ASTM B88 copper tube shall have an EPDM sealing element, and an un-pressed fitting, leak identification feature. 2-1/2-inch thru 4-inch shall have a 420 stainless steel grip ring, PBT separator ring, and EPDM sealing

element. Sealing elements shall be verified for the intended use. Contractor shall be trained by a factory authorized representative and provide verification of training to the LAWA Inspector.

- 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 alloy, with water soluble flux per ASTM B-13.
    - b. Press-connect Fittings: Bronze or copper shall conform to the material requirements of ASME B16.18 or ASME B16.22, and the performance requirements of IAPMO PS117, and ICC/ANSI LC1002 and NSF/ANSI 61-pw (if used in a potable water system.) Press-connect fittings <sup>1</sup>/<sub>2</sub>-inch thru 4-inch for use with ASTM B88 copper tube shall have an EPDM sealing element, and an un-pressed fitting, leak identification feature. 2-1/2-inch thru 4-inch shall have a 420 stainless steel grip ring, PBT separator ring, and EPDM sealing element. Sealing elements shall be verified for the intended use. Contractor shall be trained by a factory authorized representative and provide verification of training to the LAWA Inspector.
- 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 B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for generalduty 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, cross-laminated PE film of 0.004-inch minimum thickness.
  - 6. Color: Black.

# 2.5 WATER METERS

- A. Displacement-Type Water Meters:
  - 1. Manufacturers:

- a. Badger Meter, Inc.
- b. Neptune Technology Group, Inc. c. Sensus.
- 2. Description:
  - a. Standard: AWWA C700, and C710 Standards.
  - b. Pressure Rating: 150 psig working pressure.
  - c. Temperature Rating:  $-40^{\circ}$  to  $+150^{\circ}$  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: Encoder type complying with AWWA C707; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by LAWA.
- 2.6 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. Dissimilar Materials: Brass ball valve and 6 inch long Brass nipple.
  - 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.
    - 4. Dissimilar Materials: Brass ball valve and 6 inch long Brass nipple.

# 2.7 PRESSURE GAGES

A. Manufacturers:

- 1. AMETEK, Inc.
- 2. H.O. Trerice Co.
- 3. Weiss Instruments
- B. Gage: ASME B40.1, with bourdon tube, rotary brass movement, brass socket, front calibration adj stment, black scale on white background.
  - 1. Case: Cast aluminum.
  - 2. Bourdon Tube: Copper plated brass.
  - 3. Dial Size: 6 inch diameter.

### 2.8 PRESSURE GAGE TAPS

- A. Manufacturers:
  - 1. AMETEK, Inc.
  - 2. H.O. Trerice Co.
  - 3. Weiss Instruments.

### 2.9 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.

# 2.10 WALL PENETRATION SYSTEMS

- A. Manufacturer:
  - 1. SIGMA Corporation.
  - 2. Or approved equal.

- 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 A53 / A53M, Schedule 40, zinc- coated steel pipe.

# 2.11 STEM TYPE THERMOMETERS

- A. Manufacturers:
  - 1. Ashcroft Inc.
  - 2. H.O. Trerice Co.
  - 3. Weiss Instruments.
- 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.

# 2.12 FLOW CONTROL VALVES

- A. Manufacturers:
  - 1. Bell & Gossett / Xylem Inc.
  - 2. Griswold Controls.
  - 3. FLOCON / Precision Instruments Company.
- 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.

# 2.13 WATER PRESSURE REDUCING VALVES

- A. Manufacturers:
  - 1. Zurn-Wilkins / Zurn Industries, LLC / Rexnord Corporation.
  - 2. Conbraco Industries / Apollo Valves / Aalberts Industries N.V.
  - 3. Watts Water Technologies Company.
- 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.

# 2.14 TEST PLUGS

- A. Manufacturers:
  - 1. Petersen Products Company.
  - 2. Sisco Manufacturing Company, Inc.
  - 3. Watts Water Technologies Company.
- 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.

# 2.15 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
  - 1. Manufacturers:
    - a. Watts Water Technologies Company.
    - b. Zurn Indistries, LLC / Rexnord Corporation.
    - c. Conbraco / Apollo Valves / Aalberts Industries, N.V.
  - 2. Standard: ASSE 1001.
  - 3. Equal to Watts No. 288A.
- B. Hose-Connection Vacuum Breakers:
  - 1. Manufacturers:
    - a. Watts Water Technologies Company.
    - b. Zurn Indistries, LLC / Rexnord Corporation.
    - c. Conbraco / Apollo Valves / Aalberts Industries, N.V.
  - 2. Standard: ASSE 1011.
  - 3. Equal to Watts No. NF8 or No. 8A.
- C. Pressure Vacuum Breakers:
  - 1. Manufacturers:
    - a. Watts Water Technologies Company.
    - b. Zurn Indistries, LLC / Rexnord Corporation.
    - c. Conbraco / Apollo Valves / Aalberts Industries, N.V.
  - 2. Standard: ASSE 1020.
  - 3. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.

- D. Spill-Resistant Vacuum Breakers:
  - 1. Manufacturers:
    - a. Watts Water Technologies Company.
    - b. Zurn Indistries, LLC / Rexnord Corporation.
    - c. Conbraco / Apollo Valves / Aalberts Industries, N.V.
  - 2. Standard: ASSE 1056.
  - 3. Operation: Continuous-pressure applications.
  - 4. Accessories:
    - a. Valves: Ball type, on inlet and outlet.

### 2.16 RELIEF VALVES

- A. Manufacturers:
  - 1. Conbraco / Apollo Valves / Aalberts Industries, N.V.
  - 2. Watts Water Technologies Company.
  - 3. Zurn-Wilkins / Zurn Industries, LLC / Rexnord Corporation.
- 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.

# 2.17 STRAINERS

- A. Manufacturers:
  - 1. Conbraco / Apollo Valves / Aalberts Industries, N.V.
  - 2. Watts Water Technologies Company.
  - 3. Zurn-Wilkins / Zurn Industries, LLC / Rexnord Corporation.

- 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.

# 2.18 HOSE BIBBS

- A. Manufacturers:
  - 1. Acorn Engineering Company, Inc. / Morris Group International.
  - 2. MIFAB, Inc.
  - 3. Jay R. Smith Mfg. Co. / Morris Group International.
- 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.

### 2.19 HYDRANTS

- A. Manufacturers:
  - 1. Acorn Engineering Company, Inc. / Morris Group International.
  - 2. MIFAB, Inc.
  - 3. Zurn Industries, LLC / Rexnord Corporation.
- B. Wall Hydrant: ASSE 1019; 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.

# 2.20 RECESSED VALVE BOX

- A. Manufacturers:
  - 1. IPS Corporation.
  - 2. Sioux Chief Manufacturing Company.
  - 3. Or approved equal.

- B. Washing Machine: Water tight recessed plastic, preformed rough-in box, <sup>1</sup>/<sub>2</sub>" copper connections with chrome <sup>1</sup>/<sub>4</sub> turn ball valves; integral water hammer arrestors; 2" center drain outlet.
- C. Refrigerator: Plastic water-tight recessed plastic, preformed rough-in box, <sup>1</sup>/<sub>2</sub>" copper connection with chrome <sup>1</sup>/<sub>4</sub> turn ball valve preformed rough-in box with brass valves with wheel handle slip finishing cover.

# 2.21 BACKFLOW PREVENTERS

- A. Manufacturers:
  - 1. Conbraco / Apollo Valves / Aalberts Industries, N.V.
  - 2. Watts Water Technologies Company.
  - 3. Zurn-Wilkins / Zurn Industries, LLC / Rexnord Corporation.
- 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.

# 2.22 WATER HAMMER ARRESTORS

- A. Manufacturers:
  - 1. MIFAB, Inc.
  - 2. Watts Water Technologies Company.
  - 3. Zurn-Wilkins / Zurn Industries, LLC / Rexnord Corporation.
- B. ASSE 1010; copper construction, bellows or piston type sized in accordance with PDI WH-201.
- C. Pre-charged suitable for 35 to 120 degrees temperature range, 125 PSI maximum, working pressure.

# 2.23 THERMOSTATIC MIXING VALVES

- A. Manufacturers:
  - 1. Watts Water Technologies Company.
  - 2. Zurn Industries, LLC / Rexnord Corporation
  - 3. Symmons Industries, Inc.
- 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 maximum operating pressure, 200 degrees maximum inlet temperature, for
  - 5. G.P.M. minimum flow.
- C. Point-of-Use Mixing Valves
  - 1. For lavatory or sink faucets -0.35 G.P.M. minimum flow capacity.
  - 2. Integral adjustable set-point and in-line check stops.
  - 3. 105 degree maximum outlet temperature.

### 2.24 PRESSURE BALANCED MIXING VALVES

- A. Manufacturers:
  - 1. Symmons Industries, Inc.
  - 2. Watts Water Technologies Company.
  - 3. Zurn Industries, LLC / Rexnord Corporation.
- 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.
- 2.25 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 / Pentair Inc. b. Or approved equal.
  - B. On cold water lines for the following:
    - 1. Coffee makers.
    - 2. Electric water coolers.
    - 3. Refrigerators.
    - 4. Ice makers.

# 2.26 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. Inlet: Threaded or solder joint.
  - 5. Outlet: Threaded, short nipple with garden-hose threads complying with ASME B1.20.7.

# 2.27 TRAP SEAL PRIMER SYSTEMS

- A. Trap-Seal Primer Systems:
  - 1. Manufacturers:
    - a. Precision Plumbing Products (PPP) Inc. Solo Prime for single traps.

- b. Precision Plumbing Products (PPP) Inc. Mini Prime for up to four traps.
- c. Or approved equal.
- 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.
- 8. Provide distribution box as required.

# PART 3 - EXECUTION

- 3.1 INSTALLATION ABOVE GROUND PIPING
  - A. Install Brass Ball Valve and 6" brass nipple connections wherever joining 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 gauge 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.

# 3.3 INSTALLATION – PRESS-CONNECT FITTINGS

A. Press-connect Fittings: Pipe ends shall be cut on a right angle (square) to the pipe. Pipe ends shall be reamed and chamfered, all grease, oil or dirt shall be removed from the pipe end with a clean rag. Visually examine the fitting sealing element to insure there is no damage and it is properly seated into the fitting. Insert pipe fully into the fitting. Make a mark with a felt tip pen on the pipe at the face of the fitting. Always examine the tube to insure it is fully inserted into the fitting prior to pressing the joint. Fittings shall be installed according to the most current edition of the manufacturer's installation guidelines using manufacturer recommended tools.

Sealing elements shall be verified for the intended use.

END OF SECTION

FACILITY WATER DISTRIBUTION

QTA 30% SUBMITTAL 09/23/2016 Page 16 of 16

# SECTION 22 11 13 - FACILITY WATER DISTRIBUTION PIPING

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. This Section includes water-distribution piping and related components outside the building for combined water service and fire-service mains.
- B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

### 1.3 DEFINITIONS

- A. EPDM: Ethylene propylene diene terpolymer rubber.
- B. LLDPE: Linear, low-density polyethylene plastic.
- C. PA: Polyamide (nylon) plastic.
- D. PE: Polyethylene plastic.
- E. PP: Polypropylene plastic.
- F. PVC: Polyvinyl chloride plastic.
- G. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
- H. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
  - 1. Wiring Diagrams: Power, signal, and control wiring for alarms.

# 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.
- B. Field quality-control test reports.

# 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

# 1.7 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
  - 2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
  - 3. Comply with standards of authorities having jurisdiction for fire-suppression waterservice piping, including materials, hose threads, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
- E. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fireservice-main products.
- F. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- G. NSF Compliance:
  - 1. Comply with NSF 14 for plastic potable-water-service piping.[ Include marking "NSFpw" on piping.]
  - 2. Comply with NSF 61 Annex G for materials for water-service piping and specialties for domestic water.

# 1.8 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

- 1. Ensure that valves are dry and internally protected against rust and corrosion.
- 2. Protect valves against damage to threaded ends and flange faces.
- 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
  - 1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
  - 2. Protect from weather. Store indoors and maintain temperature higher than ambient dewpoint temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

#### 1.9 PROJECT CONDITIONS

- A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
  - 1. Notify [Architect] [Construction Manager] [Owner] no fewer than [two] <Insert number> days in advance of proposed interruption of service.
  - 2. Do not proceed with interruption of water-distribution service without [Architect's] [Construction Manager's] [Owner's] written permission.

# 1.10 COORDINATION

A. Coordinate connection to water main with utility company.

# PART 2 - PRODUCTS

# 2.1 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.

- 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
- 2. Copper, Pressure-Seal Fittings:
  - a. <u><Double click here to find, evaluate, and insert list of manufacturers and products.></u>
  - b. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
  - c. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
- B. Hard Copper Tube: ASTM B 88, Type K, water tube, drawn temper.
  - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
  - 2. Copper, Pressure-Seal Fittings:
    - a. <<u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>>
    - b. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
    - c. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
- C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
- D. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

# 2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
  - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. 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.

- C. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.
  - 1. Grooved-End, Ductile-Iron Pipe Appurtenances:
    - a. <<u>Double click here to find, evaluate, and insert list of manufacturers and products.</u>>
    - b. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
    - c. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
- D. Flanges: ASME 16.1, Class 125, cast iron.

# 2.3 PE PIPE AND FITTINGS

- A. PE, ASTM Pipe: ASTM D 2239, SIDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than [160 psig (1100 kPa)] [200 psig (1380 kPa)].
  - 1. Insert Fittings for PE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
  - 2. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.
- B. PE, AWWA Pipe: AWWA C906, DR No. 7.3, 9, or 9.3; with PE compound number required to give pressure rating not less than [160 psig (1100 kPa)] [200 psig (1380 kPa)].
  - 1. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than [160 psig (1100 kPa)] [200 psig (1380 kPa)].
- C. PE, Fire-Service Pipe: ASTM F 714, AWWA C906, or equivalent for PE water pipe; FMG approved, with minimum thickness equivalent to FMG [Class 150] [and] [Class 200].
  - 1. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

# 2.4 PVC PIPE AND FITTINGS

- A. PVC, Schedule 40 Pipe: ASTM D 1785.
  - 1. PVC, Schedule 40 Socket Fittings: ASTM D 2466.
- B. PVC, Schedule 80 Pipe: ASTM D 1785.
  - 1. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
  - 2. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.

- C. PVC, AWWA Pipe: AWWA C900, [Class 150] [and] [Class 200], with bell end with gasket, and with spigot end.
  - 1. Comply with UL 1285 for fire-service mains if indicated.
  - 2. PVC Fabricated Fittings: AWWA C900, [Class 150] [and] [Class 200], with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
  - 3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
  - 4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - a. Gaskets: AWWA C111, rubber.
  - 5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

# 2.5 SPECIAL PIPE FITTINGS

- A. Ductile-Iron Rigid Expansion Joints:
  - 1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
  - 2. Description: Three-piece, ductile-iron assembly consisting of telescoping sleeve 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.
    - a. Pressure Rating: 250 psig (1725 kPa) minimum.
    - b. Expansion Required: <**Insert inches (mm)**>.
- B. Ductile-Iron Flexible Expansion Joints:
  - 1. <a></a> <a>
  - 2. Description: Compound, ductile-iron fitting with combination of flanged and mechanicaljoint ends complying with AWWA C110 or AWWA C153. Include two gasketed balljoint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
    - a. Pressure Rating: 250 psig (1725 kPa) minimum.
    - b. Offset: **<Insert inches (mm)**>.
    - c. Expansion Required: <**Insert inches** (**mm**)>.
- C. Ductile-Iron Deflection Fittings:
  - 1. <a></a> <a>
  - 2. Description: Compound, ductile-iron coupling fitting with sleeve and 1 or 2 flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with

#### FACILITY WATER DISTRIBUTION PIPING

QTA 30% SUBMITTAL 2016-09-23 Page 6 of 34 AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

a. Pressure Rating: 250 psig (1725 kPa) minimum.

### 2.6 JOINING MATERIALS

- A. Refer to Section 330500 "Common Work Results for Utilities" for commonly used joining materials.
- B. Brazing Filler Metals: AWS A5.8, BCuP Series.
- C. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

# 2.7 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Tubular-Sleeve Pipe Couplings:
  - 1. < Double click here to find, evaluate, and insert list of manufacturers and products.>
  - 2. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
    - a. Standard: AWWA C219.
    - b. Center-Sleeve Material: [Manufacturer's standard] [Carbon steel] [Stainless steel] [Ductile iron] [Malleable iron].
    - c. Gasket Material: Natural or synthetic rubber.
    - d. Pressure Rating: [150 psig (1035 kPa)] [200 psig (1380 kPa)] <Insert pressure> minimum.
    - e. Metal Component Finish: Corrosion-resistant coating or material.
- C. Split-Sleeve Pipe Couplings:
  - 1. <<u>Double click here to find, evaluate, and insert list of manufacturers and products.</u>>
  - 2. Description: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.
    - a. Standard: AWWA C219.
    - b. Sleeve Material: [Manufacturer's standard] [Carbon steel] [Stainless steel].
    - c. Sleeve Dimensions: Of thickness and width required to provide pressure rating.
    - d. Gasket Material: O-rings made of EPDM rubber, unless otherwise indicated.
    - e. Pressure Rating: [150 psig (1035 kPa)] [200 psig (1380 kPa)] <Insert pressure> minimum.
    - f. Metal Component Finish: Corrosion-resistant coating or material.

- D. Flexible Connectors:
  - 1. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
  - 2. Ferrous-Metal Piping: Stainless-steel hose covered with stainless-steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.
- E. Dielectric Fittings:
  - 1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
  - 2. Dielectric Unions:
    - a. Description:
      - 1) Standard: ASSE 1079.
      - 2) Pressure Rating: [125 psig (860 kPa) minimum at 180 deg F (82 deg C)] [150 psig (1035 kPa)] [250 psig (1725 kPa)].
      - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
  - 3. Dielectric Flanges:
    - a. Description:
      - 1) Standard: ASSE 1079.
      - 2) Factory-fabricated, bolted, companion-flange assembly.
      - 3) Pressure Rating: [125 psig (860 kPa) minimum at 180 deg F (82 deg C)] [150 psig (1035 kPa)] [175 psig (1200 kPa)] [300 psig (2070 kPa)].
      - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
  - 4. Dielectric-Flange Insulating Kits:
    - a. Description:
      - 1) Nonconducting materials for field assembly of companion flanges.
      - 2) Pressure Rating: [150 psig (1035 kPa)] <Insert pressure>.
      - 3) Gasket: Neoprene or phenolic.
      - 4) Bolt Sleeves: Phenolic or polyethylene.
      - 5) Washers: Phenolic with steel backing washers.
  - 5. Dielectric Nipples:
    - a. Description:
      - 1) Standard: IAPMO PS 66
      - 2) Electroplated steel nipple complying with ASTM F 1545.
      - 3) Pressure Rating: [300 psig (2070 kPa) at 225 deg F (107 deg C)] <Insert pressure and temperature>.

- 4) End Connections: Male threaded or grooved.
- 5) Lining: Inert and noncorrosive, propylene.

#### 2.8 CORROSION-PROTECTION PIPING ENCASEMENT

- A. Encasement for Underground Metal Piping:
  - 1. Standards: ASTM A 674 or AWWA C105.
  - 2. Form: [Sheet] [Sheet or tube] [Tube].
  - 3. Material: LLDPE film of 0.008-inch (0.20-mm) minimum thickness.
  - 4. Material: LLDPE film of 0.008-inch (0.20-mm) minimum thickness, or high-density, crosslaminated PE film of 0.004-inch (0.10-mm) minimum thickness.
  - 5. Material: High-density, crosslaminated PE film of 0.004-inch (0.10-mm) minimum thickness.
  - 6. Color: [Black] [Natural] <Insert color>.

### 2.9 GATE VALVES

- A. AWWA, Cast-Iron Gate Valves:
  - 1. <<u>Double click here to find, evaluate, and insert list of manufacturers and products.</u>>
  - 2. Nonrising-Stem, Metal-Seated Gate Valves:
    - a. Description: Gray- or ductile-iron body and bonnet; with cast-iron or bronze double-disc gate, bronze gate rings, bronze stem, and stem nut.
      - 1) Standard: AWWA C500.
      - 2) Minimum Pressure Rating: 200 psig (1380 kPa).
      - 3) End Connections: Mechanical joint.
      - 4) Interior Coating: Complying with AWWA C550.
  - 3. Nonrising-Stem, Resilient-Seated Gate Valves:
    - a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
      - 1) Standard: AWWA C509.
      - 2) Minimum Pressure Rating: 200 psig (1380 kPa).
      - 3) End Connections: Mechanical joint.
      - 4) Interior Coating: Complying with AWWA C550.
  - 4. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:
    - a. Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.
      - 1) Standard: AWWA C509.
      - 2) Minimum Pressure Rating: 250 psig (1725 kPa).
      - 3) End Connections: Push on or mechanical joint.

- 4) Interior Coating: Complying with AWWA C550.
- 5. OS&Y, Rising-Stem, Metal-Seated Gate Valves:
  - a. Description: Cast- or ductile-iron body and bonnet, with cast-iron double disc, bronze disc and seat rings, and bronze stem.
    - 1) Standard: AWWA C500.
    - 2) Minimum Pressure Rating: 200 psig (1380 kPa).
    - 3) End Connections: Flanged.
- 6. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:
  - a. Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductileiron gate, resilient seats, and bronze stem.
    - 1) Standard: AWWA C509.
    - 2) Minimum Pressure Rating: 200 psig (1380 kPa).
    - 3) End Connections: Flanged.
- B. UL/FMG, Cast-Iron Gate Valves:
  - 1. <<u>Double click here to find, evaluate, and insert list of manufacturers and products.</u>>
  - 2. UL/FMG, Nonrising-Stem Gate Valves:
    - a. Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.
      - 1) Standards: UL 262 and FMG approved.
      - 2) Minimum Pressure Rating: 175 psig (1207 kPa).
      - 3) End Connections: Flanged.
  - 3. OS&Y, Rising-Stem Gate Valves:
    - a. Description: Iron body and bonnet and bronze seating material.
      - 1) Standards: UL 262 and FMG approved.
      - 2) Minimum Pressure Rating: 175 psig (1207 kPa).
      - 3) End Connections: Flanged.
- C. Bronze Gate Valves:
  - 1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
  - 2. OS&Y, Rising-Stem Gate Valves:
    - a. Description: Bronze body and bonnet and bronze stem.
      - 1) Standards: UL 262 and FMG approved.
      - 2) Minimum Pressure Rating: 175 psig (1207 kPa).
      - 3) End Connections: Threaded.

- 3. Nonrising-Stem Gate Valves:
  - a. Description: Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable-iron handwheel.
    - 1) Standard: MSS SP-80.

### 2.10 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Tapping-Sleeve Assemblies:
  - 1. <<u>Double click here to find, evaluate, and insert list of manufacturers and products.</u>>
  - 2. Description: Sleeve and valve compatible with drilling machine.
    - a. Standard: MSS SP-60.
    - b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
    - c. Valve: AWWA, cast-iron, nonrising-stem, [metal] [resilient]-seated gate valve with one raised face flange mating tapping-sleeve flange.
- B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches (125 mm) in diameter.
  - 1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
- C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

# 2.11 CHECK VALVES

- A. AWWA Check Valves:
  - 1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
  - 2. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.
    - a. Standard: AWWA C508.
    - b. Pressure Rating: 175 psig (1207 kPa).
- B. UL/FMG, Check Valves:
  - 1. <a></a> <a>
  - 2. Description: Swing-check type with pressure rating; rubber-face checks, unless otherwise indicated; and ends matching piping.

- a. Standards: UL 312 and FMG approved.
- b. Pressure Rating: [175 psig (1207 kPa)] [250 psig (1725 kPa)].

# 2.12 DETECTOR CHECK VALVES

- A. Detector Check Valves:
  - 1. <<u>Double click here to find, evaluate, and insert list of manufacturers and products.</u>>
  - 2. Description: Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.
    - a. Standards: UL 312 and FMG approved.
    - b. Pressure Rating: 175 psig (1207 kPa).
    - c. Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.
  - 3. Description: Iron body, corrosion-resistant clapper ring and seat ring material, flanged ends, with connections for bypass and installation of water meter.
    - a. Standards: UL 312 and FMG approved.
    - b. Pressure Rating: 175 psig (1207 kPa).

# 2.13 [CORPORATION VALVES] [AND] [CURB VALVES]

- A. Manufacturers:
  - 1. <<u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>
- B. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.
  - 1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
  - 2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
  - 3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.
- C. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.
- D. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches (75 mm) in diameter.

1. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

### 2.14 WATER METERS

- A. Water meters will be furnished by utility company.
- B. Manufacturers:
  - 1. <<u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>
- C. Displacement-Type Water Meters:
  - 1. Description: With bronze main case.
    - a. Standard: AWWA C700.
    - b. Registration: Flow in [gallons (liters)] [cubic feet (cubic meters)].
- D. Turbine-Type Water Meters:
  - 1. Description:
    - a. Standard: AWWA C701.
    - b. Registration: Flow in [gallons (liters)] [cubic feet (cubic meters)].
- E. Compound-Type Water Meters:
  - 1. Description:
    - a. Standard: AWWA C702.
    - b. Registration: Flow in [gallons (liters)] [cubic feet (cubic meters)].
- F. Remote Registration System:
  - 1. Description: Utility company standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
    - a. Standard: AWWA C706.
    - b. Registration: Flow in [gallons (liters)] [cubic feet (cubic meters)].
- G. Remote Registration System:
  - 1. Description: Utility company standard; encoder type. Include meter modified with signaltransmitting assembly, low-voltage connecting wiring, and remote register assembly.
    - a. Standard: AWWA C707.
    - b. Registration: Flow in [gallons (liters)] [cubic feet (cubic meters)].
    - c. Data-Acquisition Units: Comply with utility company requirements for type and quantity.

d. Visible Display Units: Comply with utility company requirements for type and quantity.

# 2.15 DETECTOR-TYPE WATER METERS

- A. Detector-Type Water Meters:
  - 1. <<u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>>
- B. Description: Main line, proportional meter with second meter on bypass. Register flow in [gallons (liters)] [cubic feet (cubic meters)].
  - 1. Standards: AWWA C703, UL listed, and FMG approved.
  - 2. Pressure Rating: 150 psig (1035 kPa).
  - 3. Bypass Meter: [AWWA C701, turbine] [AWWA C702, compound]-type, bronze case.
    - a. Size: At least one-half nominal size of main-line meter.
- C. Description: Main-line turbine meter with strainer and second meter on bypass. Register flow in [gallons (liters)] [cubic feet (cubic meters)].
  - 1. Standards: AWWA C703, UL listed, and FMG approved.
  - 2. Pressure Rating: 175 psig (1207 kPa).
  - 3. Bypass Meter: AWWA C701, turbine-type, bronze case.
    - a. Size: At least NPS 2 (DN 50).
- D. Remote Registration System:
  - 1. Description: Utility company standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
    - a. Standard: AWWA C706.
    - b. Registration: Flow in [gallons (liters)] [cubic feet (cubic meters)].
- E. Remote Registration System:
  - 1. Description: Utility company standard; encoder type. Include meter modified with signaltransmitting assembly, low-voltage connecting wiring, and remote register assembly.
    - a. Standard: AWWA C707.
    - b. Registration: Flow in [gallons (liters)] [cubic feet (cubic meters)].
    - c. Data-Acquisition Units: Comply with utility company requirements for type and quantity.
    - d. Visible Display Units: Comply with utility company requirements for type and quantity.

### 2.16 PRESSURE-REDUCING VALVES

- A. Water Regulators:
  - 1. < Double click here to find, evaluate, and insert list of manufacturers and products.>
  - 2. Standard: ASSE 1003.
  - 3. Pressure Rating: Initial pressure of 150 psig (1035 kPa).
  - 4. Size: <**Insert NPS (DN)**>.
  - 5. Design Flow Rate: <**Insert gpm** (**L**/**s**)>.
  - 6. Design Inlet Pressure: <**Insert psig** (**kPa**)>.
  - 7. Design Outlet Pressure Setting: <Insert psig (kPa)>.
  - 8. Body: Bronze[ with chrome-plated finish] for NPS 2 (DN 50) and smaller; cast iron[ with interior lining complying with AWWA C550 or that is FDA approved] for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
  - 9. Valves for Booster Heater Water Supply: Include integral bypass.
  - 10. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
- B. Water Control Valves:
  - 1. <a><br/>
    </a> **Ouble click here to find, evaluate, and insert list of manufacturers and products.**
  - 2. Description: Pilot-operation, diaphragm-type, single-seated main water control valve with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.
    - a. Pressure Rating: Initial pressure of 150 psig (1035 kPa) minimum.
    - b. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDAapproved, interior epoxy coating; or stainless-steel body.
      - 1) Size: <**Insert NPS (DN**)>.
      - 2) Pattern: [Angle] [Globe]-valve design.
      - 3) Trim: Stainless steel.
    - c. Design Flow Rate: <**Insert gpm** (**L**/**s**)>.
    - d. Design Inlet Pressure: <**Insert psig** (**kPa**)>.
    - e. Design Outlet Pressure Setting: <Insert psig (kPa)>.
    - f. End Connections: Threaded for NPS 2 (DN 50) and smaller; [flanged] <Insert type> for NPS 2-1/2 (DN 65) and larger.

# 2.17 RELIEF VALVES

- A. Air-Release Valves:
  - 1. < Double click here to find, evaluate, and insert list of manufacturers and products.>
  - 2. Description: Hydromechanical device to automatically release accumulated air.
    - a. Standard: AWWA C512.
    - b. Pressure Rating: [300 psig (2070 kPa)] <Insert pressure>.
    - c. Body Material: [Cast iron] <Insert material>.
    - d. Trim Material: Stainless steel[, brass, or bronze].

- e. Water Inlet Size: <**Insert NPS** (**DN**)>.
- f. Air Outlet Size: <**Insert NPS (DN)**>.
- g. Orifice Size: <**Insert inch (mm)**>.
- h. Design Air-Release Capacity: <**Insert cfm** (**L**/**s**)> at <**Insert psig** (**kPa**)> pipeline pressure.
- B. Air/Vacuum Valves:
  - 1. <<u>Double click here to find, evaluate, and insert list of manufacturers and products.</u>>
  - 2. Description: Direct-acting, float-operated, hydromechanical device with large orifice to automatically release accumulated air or to admit air during filling of piping.
    - a. Standard: AWWA C512.
    - b. Pressure Rating: [300 psig (2070 kPa)] <Insert pressure>.
    - c. Body Material: [Cast iron] <Insert material>.
    - d. Trim Material: Stainless steel[, brass, or bronze].
    - e. Inlet and Outlet Size: <**Insert NPS (DN)**>.
    - f. Orifice Size: <**Insert inch (mm)**>.
    - g. Design Air Capacity: <**Insert cfm** (**L**/**s**)> at <**Insert psig** (**kPa**)> differential pressure.
- C. Combination Air Valves:
  - 1. <<u>Double click here to find, evaluate, and insert list of manufacturers and products.</u>>
  - 2. Description: Float-operated, hydromechanical device to automatically release accumulated air or to admit air.
    - a. Standard: AWWA C512.
    - b. Pressure Rating: [300 psig (2070 kPa)] <Insert pressure>.
    - c. Body Material: [Cast iron] <Insert material>.
    - d. Trim Material: Stainless steel[, brass, or bronze].
    - e. Inlet and Outlet Size: <**Insert NPS** (**DN**)>.
    - f. Orifice Size: <**Insert inch (mm)**>.
    - g. Design Air Capacity: <**Insert cfm** (**L**/**s**)> at <**Insert psig** (**kPa**)> differential pressure.

# 2.18 VACUUM BREAKERS

- A. Pressure Vacuum Breaker Assembly:
  - 1. <a></a> <a>
  - 2. Standard: ASSE 1020.
  - 3. Operation: Continuous-pressure applications.
  - 4. Pressure Loss: [5 psig (35 kPa)] <Insert pressure> maximum, through middle 1/3 of flow range.
  - 5. Size: <**Insert NPS (DN**)>.
  - 6. Design Flow Rate: <**Insert gpm** (L/s)>.
  - 7. Selected Unit Flow Range Limits: <**Insert gpm** (L/s)>.
  - 8. Pressure Loss at Design Flow Rate: <**Insert psig** (**kPa**)>.
  - 9. Accessories: Ball valves on inlet and outlet.

# 2.19 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:
  - 1. <<u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>>
  - 2. Standard: [ASSE 1013] [or] [AWWA C511].
  - 3. Operation: Continuous-pressure applications.
  - 4. Pressure Loss: [12 psig (83 kPa)] <Insert pressure> maximum, through middle 1/3 of flow range.
  - 5. Size: <**Insert NPS (DN)**>.
  - 6. Design Flow Rate: <**Insert gpm** (L/s)>.
  - 7. Selected Unit Flow Range Limits: <**Insert gpm** (L/s)>.
  - 8. Pressure Loss at Design Flow Rate: <**Insert psig** (**kPa**)> for NPS 2 (DN 50) and smaller; <**Insert psig** (**kPa**)> for NPS 2-1/2 (DN 65) and larger.
  - 9. Body: Bronze for NPS 2 (DN 50) and smaller; [cast iron with interior lining complying with AWWA C550 or that is FDA approved] [steel with interior lining complying with AWWA C550 or that is FDA approved] [stainless steel] for NPS 2-1/2 (DN 65) and larger.
  - 10. End Connections: Threaded for NPS 2 (DN 50) and smaller; [flanged] <Insert type> for NPS 2-1/2 (DN 65) and larger.
  - 11. Configuration: Designed for [horizontal, straight through] [vertical inlet, horizontal center section, and vertical outlet] [vertical] <Insert configuration> flow.
  - 12. Accessories:
    - Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
    - b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
- B. Double-Check, Backflow-Prevention Assemblies:
  - 1. <a></a> <a>
  - 2. Standard: [ASSE 1015] [or] [AWWA C510].
  - 3. Operation: Continuous-pressure applications, unless otherwise indicated.
  - 4. Pressure Loss: [5 psig (35 kPa)] <Insert pressure> maximum, through middle 1/3 of flow range.
  - 5. Size: <**Insert NPS (DN)**>.
  - 6. Design Flow Rate: <**Insert gpm** (**L**/**s**)>.
  - 7. Selected Unit Flow Range Limits: <**Insert gpm** (**L**/**s**)>.
  - 8. Pressure Loss at Design Flow Rate: <**Insert psig** (**kPa**)> for NPS 2 (DN 50) and smaller; <**Insert psig** (**kPa**)> for NPS 2-1/2 (DN 65) and larger.
  - 9. Body: Bronze for NPS 2 (DN 50) and smaller; [cast iron with interior lining complying with AWWA C550 or that is FDA approved] [steel with interior lining complying with AWWA C550 or that is FDA approved] [stainless steel] for NPS 2-1/2 (DN 65) and larger.
  - 10. End Connections: Threaded for NPS 2 (DN 50) and smaller; [flanged] <Insert type> for NPS 2-1/2 (DN 65) and larger.
  - 11. Configuration: Designed for [horizontal, straight through] <Insert configuration> flow.

- 12. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
- C. Reduced-Pressure-Detector, Fire-Protection Backflow Preventer Assemblies:
  - 1. <<u>Double click here to find, evaluate, and insert list of manufacturers and products.</u>>
  - 2. Standards: ASSE 1047 and UL listed or FMG approved.
  - 3. Operation: Continuous-pressure applications.
  - 4. Pressure Loss: [12 psig (83 kPa)] <Insert pressure> maximum, through middle 1/3 of flow range.
  - 5. Size: <**Insert NPS (DN)**>.
  - 6. Design Flow Rate: <**Insert gpm** (**L**/**s**)>.
  - 7. Selected Unit Flow Range Limits: <**Insert gpm** (**L**/**s**)>.
  - 8. Pressure Loss at Design Flow Rate: <**Insert psig** (**kPa**)>.
  - 9. Body: [Cast iron with interior lining complying with AWWA C550 or that is FDA approved] [Steel with interior lining complying with AWWA C550 or that is FDA approved] [Stainless steel].
  - 10. End Connections: Flanged.
  - 11. Configuration: Designed for [horizontal, straight through] [vertical inlet, horizontal center section, and vertical outlet] [vertical] <Insert configuration> flow.
  - 12. Accessories:
    - a. Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
    - b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
    - c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
- D. Double-Check, Detector-Assembly Backflow Preventers:
  - 1. <a></a> <a>
  - 2. Standards: ASSE 1048 and UL listed or FMG approved.
  - 3. Operation: Continuous-pressure applications.
  - 4. Pressure Loss: [5 psig (35 kPa)] <Insert pressure> maximum, through middle 1/3 of flow range.
  - 5. Size: <**Insert NPS (DN)**>.
  - 6. Design Flow Rate: <**Insert gpm** (L/s)>.
  - 7. Selected Unit Flow Range Limits: <**Insert gpm** (L/s)>.
  - 8. Pressure Loss at Design Flow Rate: <**Insert psig** (**kPa**)>.
  - 9. Body: [Cast iron with interior lining complying with AWWA C550 or that is FDA approved] [Steel with interior lining complying with AWWA C550 or that is FDA approved] [Stainless steel].
  - 10. End Connections: Flanged.
  - 11. Configuration: Designed for [horizontal, straight through] [vertical inlet, horizontal center section, and vertical outlet] [vertical] <Insert configuration> flow.
  - 12. Accessories:
    - a. Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
- b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
- E. Backflow Preventer Test Kits:
  - 1. < Double click here to find, evaluate, and insert list of manufacturers and products.>
  - 2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with testprocedure instructions.

#### 2.20 WATER METER BOXES

- A. Description: Cast-iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.
  - 1. Option: Base section may be cast-iron, PVC, clay, or other pipe.
- B. Description: Cast-iron body and double cover for disc-type water meter, with lettering "WATER METER" in top cover; and with separate inner cover; air space between covers; and slotted, open-bottom base section of length to fit over service piping.
- C. Description: Polymer-concrete body and cover for disc-type water meter, with lettering "WATER" in cover; and with slotted, open-bottom base section of length to fit over service piping. Include vertical and lateral design loadings of 15,000 lb minimum over 10 by 10 inches (6800 kg minimum over 254 by 254 mm) square.

# 2.21 CONCRETE VAULTS

- A. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857 and made according to ASTM C 858.
  - 1. Ladder: ASTM A 36/A 36M, steel or polyethylene-encased steel steps.
  - 2. Manhole: ASTM A 48/A 48M Class No. 35A minimum tensile strength, gray-iron traffic frame and cover.
    - a. Dimension: 24-inch (610-mm) minimum diameter, unless otherwise indicated.
  - 3. Manhole: ASTM A 536, Grade 60-40-18, ductile-iron traffic frame and cover.
    - a. Dimension: 24-inch- (610-mm-) minimum diameter, unless otherwise indicated.
  - 4. Drain: ASME A112.6.3, cast-iron floor drain with outlet of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

#### 2.22 PROTECTIVE ENCLOSURES

A. Freeze-Protection Enclosures:

- 1. <a><br/>
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- 2. Description: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of 40 deg F (4 deg C) when external temperatures reach as low as minus 34 deg F (minus 36 deg C).
  - a. Standard: ASSE 1060.
  - b. Class I: For equipment or devices other than pressure or atmospheric vacuum breakers.
  - c. Class I-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
    - 1) Housing: Reinforced[-aluminum] [or] [-fiberglass] <Insert housing> construction.
      - a) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
      - b) Drain opening for units with drain connection.
      - c) Access doors with locking devices.
      - d) Insulation inside housing.
      - e) Anchoring devices for attaching housing to concrete base.
    - 2) Electric heating cable or heater with self-limiting temperature control.
- B. Weather-Resistant Enclosures:
  - 1. < Double click here to find, evaluate, and insert list of manufacturers and products.>
  - 2. Description: Uninsulated enclosure designed to protect aboveground water piping, equipment, or specialties from weather and damage.
    - a. Standard: ASSE 1060.
    - b. Class III: For equipment or devices other than pressure or atmospheric vacuum breakers.
    - c. Class III-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
      - 1) Housing: Reinforced[-aluminum] [or] [-fiberglass] <Insert housing> construction.
        - a) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
        - b) Drain opening for units with drain connection.
        - c) Access doors with locking devices.
        - d) Anchoring devices for attaching housing to concrete base.
- C. Expanded-Metal Enclosures:
  - 1. < Double click here to find, evaluate, and insert list of manufacturers and products.>
  - 2. Description: Enclosure designed to protect aboveground water piping, equipment, or specialties from damage.

- a. Material: ASTM F 1267, expanded metal side and top panels, of weight and with reinforcement of same metal at edges as required for rigidity.
- b. Type: Type[ I, expanded] [ II, expanded and flattened].
- c. Class: Class[1, uncoated carbon steel] [2, hot-dip, zinc-coated carbon steel] [3, corrosion-resisting steel].
- d. Finish: Manufacturer's enamel paint.
- e. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
- f. Locking device.
- g. Lugs or devices for securing enclosure to base.
- D. Enclosure Bases:
  - 1. Description: [4-inch- (100-mm-)] [6-inch- (150-mm-)] minimum thickness precast concrete, of dimensions required to extend at least 6 inches (150 mm) beyond edges of enclosure housings. Include openings for piping.

# 2.23 FIRE HYDRANTS

- A. Dry-Barrel Fire Hydrants:
  - 1. <<u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>
  - Description: Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
    - a. Standard: AWWA C502.
    - b. Pressure Rating: [150 psig (1035 kPa) minimum] [250 psig (1725 kPa)].
  - 3. Description: Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
    - a. Standards: UL 246, FMG approved.
    - b. Pressure Rating: [150 psig (1035 kPa) minimum] [250 psig (1725 kPa)].
    - c. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
    - d. Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
    - e. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
    - f. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
- B. Wet-Barrel Fire Hydrants:
  - 1. <<u>Double click here to find, evaluate, and insert list of manufacturers and products.</u>>
  - 2. Description: Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, NPS 6 (DN 150) threaded or flanged inlet, and base section with NPS 6 (DN 150) mechanical-joint inlet. Include interior coating according to AWWA C550.

- a. Standard: AWWA C503.
- b. Pressure Rating: 150 psig (1035 kPa) minimum.
- 3. Description: Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, NPS 6 (DN 150) threaded or flanged inlet, and base section with NPS 6 (DN 150) mechanical-joint inlet.
  - a. Standards: UL 246 and FMG approved.
  - b. Pressure Rating: 150 psig (1035 kPa) minimum.
  - c. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
  - d. Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
  - e. Direction of Opening: Open hydrant valves by turning operating nut to left or counterclockwise.
  - f. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

# 2.24 FLUSHING HYDRANTS

- A. Post-Type Flushing Hydrants:
  - 1. <<u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>
  - 2. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
    - a. Pressure Rating: 150 psig (1035 kPa) minimum.
    - b. Outlet: One, with horizontal discharge.
    - c. Hose Thread: NPS 2-1/2 (DN 65), with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
    - d. Barrel: Cast-iron or steel pipe with breakaway feature.
    - e. Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
    - f. Security: Locking device for padlock.
    - g. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
    - h. Inlet: NPS 2 (DN 50) minimum.
    - i. Operating Wrench: One for each unit.
- B. Ground-Type Flushing Hydrants:
  - 1. < Double click here to find, evaluate, and insert list of manufacturers and products.>
  - 2. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
    - a. Pressure Rating: 150 psig (1035 kPa) minimum.
    - b. Outlet: One, with [vertical] [angle] discharge.
    - c. Hose Thread: NPS 2-1/2 (DN 65), with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
    - d. Barrel: Cast-iron or steel pipe.
    - e. Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
    - f. Inlet: NPS 2 (DN 50) minimum.
    - g. Hydrant Box: Cast iron with cover, for ground mounting.
    - h. Operating Wrench: One for each unit.

- C. Post-Type Sampling Station:
  - 1. <<u>Double click here to find, evaluate, and insert list of manufacturers and products.</u>>
  - 2. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
    - a. Pressure Rating: 100 psig (690 kPa) minimum.
    - b. Sampling Outlet: One unthreaded nozzle with handle.
    - c. Valve: Bronze body with bronze-ball or plunger closure. Include operating handle.
    - d. Drain: Tubing with separate manual vacuum pump.
    - e. Inlet: NPS 3/4 (DN 20) minimum.
    - f. Housing: Weatherproof material with locking device. Include anchor device.
    - g. Operating Wrench: One for each unit.

# 2.25 FIRE DEPARTMENT CONNECTIONS

- A. Fire Department Connections:
  - 1. < Double click here to find, evaluate, and insert list of manufacturers and products.>
  - 2. Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- (460-mm-) high brass sleeve; and round escutcheon plate.
    - a. Standard: UL 405.
    - b. Connections: Two NPS 2-1/2 (DN 65) inlets and one [NPS 4 (DN 100)] [NPS 6 (DN 150)] outlet.
    - c. Connections: [Three] [Four] NPS 2-1/2 (DN 65) inlets and one NPS 6 (DN 150) outlet.
    - d. Connections: Six NPS 2-1/2 (DN 65) inlets and one [NPS 6 (DN 150)] [NPS 8 (DN 200)] outlet.
    - e. Inlet Alignment: [Inline, horizontal] [Square].
    - f. Finish Including Sleeve: [Polished chrome-plated] [Rough chrome-plated] [Polished bronze].
    - g. Escutcheon Plate Marking: "[AUTO SPKR] [&] [STANDPIPE]."

# 2.26 ALARM DEVICES

- A. Alarm Devices, General: UL 753 and FMG approved, of types and sizes to mate and match piping and equipment.
- B. Water-Flow Indicators: Vane-type water-flow detector, rated for 250-psig (1725-kPa) working pressure; designed for horizontal or vertical installation; with 2 single-pole, double-throw circuit switches to provide isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal when cover is removed.
- C. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position.

D. Pressure Switches: Single pole, double throw; designed to signal increase in pressure.

# PART 3 - EXECUTION

#### 3.1 EARTHWORK

A. Refer to Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

#### 3.2 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- C. Do not use flanges or unions for underground piping.
- D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- E. Underground water-service piping [NPS 3/4 to NPS 3 (DN 20 to DN 80)] <Insert pipe size range> shall be[ any of] the following:
  - 1. Soft copper tube, [ASTM B 88, Type K (ASTM B 88M, Type A)] [ASTM B 88, Type L (ASTM B 88M, Type B)]; [wrought-copper, solder-joint fittings; and brazed] [copper, pressure-seal fittings; and pressure-sealed] joints.
  - 2. PE, ASTM pipe; [insert fittings for PE pipe; and clamped] [molded PE fittings; and heat-fusion] joints.
  - 3. PVC, Schedule [40 pipe; PVC, Schedule 40] [80 pipe; PVC, Schedule 80] socket fittings; and solvent-cemented joints.
  - 4. NPS 1 to NPS 3 (DN 25 to DN 80) fiberglass, AWWA RTRP, Class [150] [200] [250]; RTRF; and bonded joints.
- F. Underground water-service piping [NPS 4 to NPS 8 (DN 100 to DN 200)] <Insert pipe size range> shall be[ any of] the following:
  - 1. Soft copper tube, [ASTM B 88, Type K (ASTM B 88M,Type A)] [ASTM B 88, Type L (ASTM B 88M, Type B)]; wrought-copper, solder-joint fittings; and brazed joints.
  - 2. Ductile-iron, [push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed] [mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical] [grooved-end pipe; ductile-iron-pipe appurtenances; and grooved] joints.
  - 3. PE, AWWA pipe; PE, AWWA fittings; and heat-fusion joints.
  - 4. PVC, Schedule [40 pipe; PVC, Schedule 40] [80 pipe; PVC, Schedule 80] socket fittings; and solvent-cemented joints.
  - 5. NPS 4 and NPS 6 (DN 100 and DN 150): NPS 6 (DN 150) PVC, AWWA Class 150 pipe; PVC, AWWA Class 150 [fabricated] [or] [molded] fittings; and gasketed joints.

- NPS 8 (DN 200): PVC, AWWA Class 200 pipe; [PVC, AWWA Class 200 fabricated] [push-on-joint, ductile-iron] [mechanical-joint, ductile-iron] fittings; and gasketed joints.
- G. Water Meter Box Water-Service Piping [NPS 3/4 to NPS 2 (DN 20 to DN 50)] <Insert pipe size range> shall be same as underground water-service piping.
- H. Aboveground[ and Vault] Water-Service Piping [NPS 3/4 to NPS 3 (DN 20 to DN 80)] <Insert pipe size range> shall be[ any of] the following:
  - 1. Hard copper tube, [ASTM B 88, Type K (ASTM B 88M, Type A)] [ASTM B 88, Type L (ASTM B 88M, Type B)]; [wrought-copper, solder-joint fittings; and brazed] [copper, pressure-seal fittings; and pressure-sealed] joints.
  - 2. PVC, Schedule 80 pipe; PVC, Schedule 80 [socket fittings; and solvent-cemented] [threaded fittings; and threaded] joints.
  - 3. NPS 1 to NPS 2 (DN 25 to DN 50) fiberglass, AWWA RTRP, Class [150] [200] [250]; RTRF; and bonded joints.
- I. Aboveground [and vault ]water-service piping [NPS 4 to NPS 8 (DN 100 to DN 200)] <Insert pipe size range> shall be[ any of] the following:
  - 1. Hard copper tube, [ASTM B 88, Type K (ASTM B 88M, Type A)] [ASTM B 88, Type L (ASTM B 88M, Type B)]; wrought-copper, solder-joint fittings; and brazed joints.
  - 2. Ductile-iron, grooved-end pipe; ductile-iron, grooved-end appurtenances; and grooved joints.
  - 3. PVC, Schedule 80 pipe; PVC, Schedule 80 [socket fittings; and solvent-cemented] [threaded fittings; and threaded] joints.
- J. Underground Fire-Service-Main Piping [NPS 4 to NPS 12 (DN 100 to DN 300)] <Insert pipe size range> shall be[ any of] the following:
  - 1. Ductile-iron, [push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed] [mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical] [grooved-end pipe; ductile-iron-pipe appurtenances; and grooved] joints.
  - 2. PE, Class [150] [200], fire-service pipe; molded PE fittings; and heat-fusion joints.
  - 3. PVC, AWWA Class 150 pipe listed for fire-protection service; PVC Class 150 fabricated or molded fittings; and gasketed joints.
  - 4. PVC, AWWA Class 200 pipe listed for fire-protection service; PVC Class 200 fabricated fittings; and gasketed joints.
- K. Aboveground[ and Vault] Fire-Service-Main Piping [NPS 4 to NPS 12 (DN 100 to DN 300)] <Insert pipe size range> shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.
- L. Underground Combined Water-Service and Fire-Service-Main Piping [NPS 6 to NPS 12 (DN 150 to DN 300)] <Insert pipe size range> shall be[ any of] the following:
  - 1. Ductile-iron, [push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed] [mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical] [grooved-end pipe; ductile-iron-pipe appurtenances; and grooved] joints.

- 2. PVC, AWWA Class [150] [200] pipe listed for fire-protection service; PVC fabricated or molded fittings of same class as pipe; and gasketed joints.
- M. Aboveground[ and Vault] Combined Water Service and Fire-Service-Main Piping [NPS 6 to NPS 12 (DN 150 to DN 300)] <Insert pipe size range> shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

# 3.3 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.
- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  - 1. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast-iron, nonrising-stem, [metal] [resilient] [high-pressure, resilient]-seated gate valves with valve box.
  - 2. Underground Valves, NPS 4 (DN 100) and Larger, for Indicator Posts: UL/FMG, castiron, nonrising-stem gate valves with indicator post.
  - 3. Use the following for valves in vaults and aboveground:
    - a. Gate Valves, NPS 2 (DN 50) and Smaller: Bronze, [nonrising] [rising] stem.
    - b. Gate Valves, NPS 3 (DN 80) and Larger: [AWWA, cast iron, OS&Y rising stem, metal seated] [AWWA, cast iron, OS&Y rising stem, resilient seated] [UL/FMG, cast iron, OS&Y rising stem].
    - c. Check Valves: [AWWA C508] [UL/FMG], swing type.
  - 4. Pressure-Reducing Valves: Use for water-service piping in vaults and aboveground to control water pressure.
  - 5. Relief Valves: Use for water-service piping in vaults and aboveground.
    - a. Air-Release Valves: To release accumulated air.
    - b. Air/Vacuum Valves: To release or admit large volume of air during filling of piping.
    - c. Combination Air Valves: To release or admit air.
  - 6. Detector Check Valves: Use for water-service piping in vaults and aboveground to detect unauthorized use of water.

# 3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. See Section 330500 "Common Work Results for Utilities" for piping-system common requirements.

## 3.5 PIPING INSTALLATION

- A. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.
- B. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.
- C. Make connections larger than NPS 2 (DN 50) with tapping machine according to the following:
  - 1. Install tapping sleeve and tapping valve according to MSS SP-60.
  - 2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
  - 3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
  - 4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.
- D. Make connections NPS 2 (DN 50) and smaller with drilling machine according to the following:
  - 1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
  - 2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
  - 3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
  - 4. Install corporation valves into service-saddle assemblies.
  - 5. Install manifold for multiple taps in water main.
  - 6. Install curb valve in water-service piping with head pointing up and with service box.
- E. Comply with NFPA 24 for fire-service-main piping materials and installation.
  - 1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
  - 2. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
- F. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
  - 1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
- G. Install PE pipe according to ASTM D 2774 and ASTM F 645.
- H. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
- I. Bury piping with depth of cover over top at least [30 inches (750 mm)] <Insert dimension>, with top at least [12 inches (300 mm)] <Insert dimension> below level of maximum frost penetration, and according to the following:
  - 1. Under Driveways: With at least [36 inches (910 mm)] <Insert dimension> cover over top.
  - 2. Under Railroad Tracks: With at least [48 inches (1220 mm)] <Insert dimension> cover over top.

- 3. In Loose Gravelly Soil and Rock: With at least [12 inches (300 mm)] <Insert dimension> additional cover.
- J. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
- K. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
  - 1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
- L. Sleeves are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- M. Mechanical sleeve seals are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- N. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
- O. See Section 211200 "Fire-Suppression Standpipes," Section 211313 "Wet-Pipe Sprinkler Systems," and Section 211316 "Dry-Pipe Sprinkler Systems" for fire-suppression-water piping inside the building.
- P. See Section 221116 "Domestic Water Piping" for potable-water piping inside the building.

# 3.6 JOINT CONSTRUCTION

- A. See Section 330500 "Common Work Results for Utilities" for basic piping joint construction.
- B. Make pipe joints according to the following:
  - 1. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.
  - 2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
  - 3. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
  - 4. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
  - 5. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
  - 6. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
  - 7. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
    - a. Dielectric Fittings for [NPS 2 (DN 50)] <Insert pipe size> and Smaller: Use dielectric [nipples] [unions].

- b. Dielectric Fittings for [NPS 2-1/2 to NPS 4 (DN 65 to DN 100)] <Insert pipe size range>: Use dielectric [flanges] [flange kits] [nipples].
- c. Dielectric Fittings for [NPS 5 (DN 125)] <Insert pipe size> and Larger: Use dielectric flange kits.

# 3.7 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
  - 1. Concrete thrust blocks.
  - 2. Locking mechanical joints.
  - 3. Set-screw mechanical retainer glands.
  - 4. Bolted flanged joints.
  - 5. Heat-fused joints.
  - 6. Pipe clamps and tie rods.
  - 7. **<Insert devices**>.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
  - 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
  - 2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
  - 3. Bonded-Joint Fiberglass, Water-Service Piping: According to AWWA M45.
  - 4. Fire-Service-Main Piping: According to NFPA 24.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

# 3.8 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
- C. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- D. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.
- E. MSS Valves: Install as component of connected piping system.
- F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.
- G. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves.[ Install fullsize valved bypass.]

H. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

# 3.9 DETECTOR-CHECK VALVE INSTALLATION

- A. Install in vault or aboveground.
- B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.
- C. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers.

#### 3.10 WATER METER INSTALLATION

- A. Install water meters, piping, and specialties according to utility company's written instructions.
- B. Water Meters: Install [displacement] [turbine]-type water meters, NPS 2 (DN 50) and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.
- C. Water Meters: Install [compound] [turbine]-type water meters, NPS 3 (DN 80) and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
- D. Water Meters: Install detector-type water meters in meter vault according to AWWA M6. Include shutoff valves on water meter inlets and outlets and full-size valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

#### 3.11 ROUGHING-IN FOR WATER METERS

A. Rough-in piping and specialties for water meter installation according to utility company's written instructions.

#### 3.12 VACUUM BREAKER ASSEMBLY INSTALLATION

- A. Install pressure vacuum breaker assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

## 3.13 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

- B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
- C. Do not install bypass piping around backflow preventers.
- D. Support NPS 2-1/2 (DN 65) and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

# 3.14 WATER METER BOX INSTALLATION

- A. Install water meter boxes in paved areas flush with surface.
- B. Install water meter boxes in grass or earth areas with top [2 inches (50 mm)] <Insert dimension> above surface.

#### 3.15 CONCRETE VAULT INSTALLATION

A. Install precast concrete vaults according to ASTM C 891.

# 3.16 PROTECTIVE ENCLOSURE INSTALLATION

- A. Install concrete base level and with top approximately [2 inches (50 mm)] <Insert measurement> above grade.
- B. Install protective enclosure over valves and equipment.
- C. Anchor protective enclosure to concrete base.

# 3.17 FIRE HYDRANT INSTALLATION

- A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.
- C. AWWA Fire Hydrants: Comply with AWWA M17.
- D. UL/FMG Fire Hydrants: Comply with NFPA 24.

# 3.18 FLUSHING HYDRANT INSTALLATION

A. Install post-type flushing hydrants with valve below frost line and provide for drainage. Support in upright position. Include separate gate valve or curb valve and restrained joints in supply piping.

- B. Install ground-type flushing hydrants with valve below frost line and provide for drainage. Install hydrant box flush with grade. Include separate gate valve or curb valve and restrained joints in supply piping.
- C. Install sampling stations with valve below frost line and provide for drainage. Attach weatherresistant housing and support in upright position. Include separate curb valve in supply piping.

# 3.19 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install ball drip valves at each check valve for fire department connection to mains.
- B. Install protective pipe bollards [on two sides of] [on three sides of] <Describe arrangement> each fire department connection. Pipe bollards are specified in Section 055000 "Metal Fabrications."

# 3.20 ALARM DEVICE INSTALLATION

- A. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.
- B. Supervisory Switches: Supervise valves in open position.
  - 1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
  - 2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
- C. Locking and Sealing: Secure unsupervised valves as follows:
  - 1. Valves: Install chain and padlock on open OS&Y gate valve.
  - 2. Post Indicators: Install padlock on wrench on indicator post.
- D. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.
- E. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.
- F. Connect alarm devices to building fire alarm system. Wiring and fire-alarm devices are specified in Section 283111 "Digital, Addressable Fire-Alarm System" and Section 283112 "Zoned (DC Loop) Fire-Alarm System."

# 3.21 CONNECTIONS

- A. See Section 330500 "Common Work Results for Utilities" for piping connections to valves and equipment.
- B. Connect water-distribution piping to [utility water main] [existing water main] <Insert piping system>. Use [tapping sleeve and tapping valve] [service clamp and corporation valve] <Insert method>.

- C. Connect water-distribution piping to interior [domestic water] [and] [fire-suppression] piping.
- D. Connect waste piping from concrete vault drains to [sanitary sewerage system. See Section 221313 "Facility Sanitary Sewers" for connection to sanitary-sewer] [storm-drainage system. See Section 334100 "Storm Utility Drainage Piping" for connection to storm-sewer] piping.
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

# 3.22 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
  - 1. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
- C. Prepare reports of testing activities.

#### 3.23 IDENTIFICATION

- A. Install continuous underground[detectable] warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."
- B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Section 330500 "Common Work Results for Utilities" for identifying devices.

# 3.24 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
  - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
  - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in

NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.

- 3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
  - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
  - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
  - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
  - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- B. Prepare reports of purging and disinfecting activities.

END OF SECTION 22 11 13

# SECTION 22 11 23 FACILITY NATURAL-GAS PIPING

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. Section Includes:
  - 1. Natural gas piping above grade.
  - 2. Unions and flanges.
  - 3. Strainers.
  - 4. Natural gas pressure regulators.
  - 5. Natural gas pressure relief valves.

# 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. American Gas Association: AGA.

# 1.3 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints.
- 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 hangers. Submit 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. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
  - 6. Pressure regulators. Indicate pressure ratings and capacities.
  - 7. Mechanical sleeve seals.

- 8. Escutcheons.
- 9. Supports.
- 10. Remote meter reading accessories.
- 11. 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, 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 inches and smaller; welded for pipe 2-1/2 inches and larger.
- 2.2 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.
- 2.3 REGULATOR VENT PIPING, ABOVE GRADE

- A. Indoors: Same as natural gas piping, above grade.
- B. Outdoors: PVC pipe, tubing, and fittings, UL 651.
- 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 brazed joints.
- 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.

# 2.5 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.

# 2.6 NATURAL GAS PRESSURE REGULATORS

- A. Manufacturers:
  - 1. Equimeter.

- 2. American.
- 3. Pietro Fiorentini.
- 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 psi.
  - 7. Furnish sizes 2 inches and smaller with threaded ends. Furnish sizes 2-1/2 inches and larger with flanged ends.

#### 2.7 NATURAL GAS PRESSURE RELIEF VALVES

- A. Manufacturers:
  - 1. Fisher.
  - 2. American.
  - 3. Pietro Fiorentini.
- 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.

## 2.8 GAS VENT TERMINALS

- A. <sup>3</sup>/<sub>4</sub> in. and one (1) in. aluminum threaded vent terminal with 16 x 16 mesh 0.018 gauge stainless steel screen.
- B. 1<sup>1</sup>/<sub>4</sub> 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 orings, and spiral-wound metal gaskets.
    - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground.

#### 2.9 VALVES

- A. Manual Shut-off Valves Inside Building.
  - 1. Manufacturer:
    - a. Nordstrom.
    - b. Fisher
    - c. Grinnell

- 2. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
  - a. CWP Rating: 125 psig.
  - b. Threaded Ends: Comply with ASME B1.20.1.
  - c. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
  - d. Tamperproof Feature: Locking feature for valves where required.
  - e. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
  - f. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
  - g. Threaded cast iron body, 125 PSIG WOG.
- 3. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
  - a. CWP Rating: 125 psig.
  - b. Flanged Ends: Comply with ASME B16.5 for steel flanges.
  - c. Tamperproof Feature: Locking feature for valves where required.
  - d. Service Mark: Initials "WOG" shall be permanently marked on valve body.
  - e. 2<sup>1</sup>/<sub>2</sub> in. to 4-in.: Flanged cast iron body lubricated tapered plug type, 175 psig WOG.
- 4. Provide 2 wrenches for each size used.
  - a. Attach wrench to each valve.
- B. Ball Valves
  - 1. Manufacturer:
    - a. Contromatics.
    - b. Cornbraco
    - c. NIBCO

- 2. 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.
- C. 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.

#### D. 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.
- E. Cast-Iron, Non-lubricated Plug Valves: MSS SP-78.
  - 1. Manufacturers:
    - a. McDonald.
    - b. Mueller Co.
    - c. Xomox Corporation.
  - 2. Body: Cast iron, complying with ASTM A126, 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 "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.
- F. Cast Lubricated Plug Valves Inside Building:
  - 1. 2-inch and smaller: Cast iron body, threaded, equal to Nordstrom Valves, Inc. Figure 114.

- 2. 2<sup>1</sup>/<sub>2</sub> inch to 4-inch: Flanged cast iron body lubricated tapered plug type, 175 psig WOG, equal to Nordstrom Valves, Inc. Figure 115.
- 3. Valves  $2\frac{1}{2}$  inch and larger shall be flanged.
- 4. Provide 2 wrenches for each size used.
- 5. Attach wrench to each valve.
- 6. 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.

#### 2.10 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: 60 psi.
  - 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 2 inches and smaller; flanged for valves

NPS 2-1/2 inches and larger.

#### 2.11 GAS SAFETY SHUTOFF VALVES

- A. Gas safety shut-off valves shall be FM and 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 V AC., 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 inches and smaller shall be threaded, 2 1/2 inches and larger shall be flanged. Flanged valves shall be provided with companion flange set by valve manufacturer.
  - 1. Gas safety shut-off valves 2 inches and smaller
    - a. Manufacturer:
      - 1) Maxon Corporation Series 808.
      - 2) Or Approved Equal.
  - 2. 2 1/2 inches and larger. All valves shall be provided with trim package 1-1.
    - a. Manufacturer:
      - 1) Maxon Corporation Series 808-CP.
      - 2) Or Approved Equal.
- 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.
- 2.12 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

#### 2.35 SLEEVES

- A. Steel Pipe Sleeves: ASTM A53/A53M, 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.
- 2.14 MECHANICAL SLEEVE SEALS
- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 1. Manufacturers:
    - a. Link-Seal.
    - 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.
- 2.15 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'.
- 2.16 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 chromeplated 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.
- 2.17 PRESSURE GUAGES
- A. 4<sup>1</sup>/<sub>2</sub> in. diameter, black enamel coated steel case ring with shatterproof glass, <sup>1</sup>/<sub>2</sub> in. bronze bellows with brass socket, blow out on back of case, <sup>1</sup>/<sub>4</sub> 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

FACILITY NATURAL-GAS PIPING

QTA 30% SUBMITTAL 09/23/2016 Page 13 of 20

 $22\ 11\ 23$ 

system and as noted.

#### 2.18 REMOTE METER READING EQUIPMENT

- A. Electronic hard wired transmitter to provide gas consumption readings for every individual tenant and concession to the building management system.
- 2.19 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 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.
- 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. Welders must be qualified in accordance with either API 1104 or ASME IX Boiler and Pressure Vessel Code and as required by local code.
- H. Support horizontal gas piping as follows:
  - 1.  $\frac{1}{2}$  in. 6 ft. on center.
  - 2. <sup>3</sup>/<sub>4</sub> in. or 1 in. 8 ft. on center.
  - 3.  $1\frac{1}{4}$  in. or larger 10 ft. on center.
  - 4. Vertical piping at every floor.
- I. 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 22 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 D2774.
- 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.
- 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

# FACILITY NATURAL-GAS PIPING

QTA 30% SUBMITTAL 09/23/2016 Page 18 of 20

22 11 23

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.
- 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.
- F. Do not install gas shut-off valves above ceiling.
- 3.7 HANGER AND 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
# SECTION 22 13 00 FACILITY SANITARY SEWERAGE

# PART 1 - GENERAL

# 1.1 SUMMARY

- A. Section Includes:
  - 1. Sanitary sewer piping, buried within 5 feet of the building.
  - 2. Sanitary sewer piping above grade.
  - 3. Floor drains.
  - 4. Floor sinks.
  - 5. Interceptors.
  - 6. Cleanouts.
  - 7. Backwater valves.

# 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. 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.
- E. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- 1.4 CLOSEOUT SUBMITTALS
  - A. Project Record Documents: Record actual locations of equipment and clean-outs.

#### 1.5 WARRANTY

A. Furnish one-year minimum warranty.

# PART 2 - PRODUCTS

- 2.1 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING.
  - A. Cast Iron 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 Corporation.
      - c. Ideal Corporation.

- 4. Manufacturers: Heavy Duty Cast or Ductile Iron Couplings
  - a. MG Piping Products.
  - b. Victaulic.

# 2.2. SANITARY SEWER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI, ASTM A888, service weight, hubless.
  - 1. Fittings: Cast iron, CISPI, ASTM A888.
  - 2. Joints: CISPI, ASTM C564, rubber gaskets and stainless steel clamp-and-shield assemblies, NSF listed.
- B. Copper Tube: ASTM B306, Type DWV.
  - 1. Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper.
  - 2. Solder Joints: ASTM B32, Alloy Grade Sb5 tin-antimony.

# 2.3 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. Furnish materials in accordance with state of California Codes and City of Los Angeles Department of Building and Safety Standards.
- D. 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. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
- 7. Top or Strainer Material: Nickel bronze.
- 8. Top of Body and Strainer Finish: Nickel bronze.
- 9. Top Shape: Round or square.
- 10. Trap Material: Cast iron.
- 11. 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:
    - a. For built-up membrane, provide a flashing clamp.
    - b. For elastomeric type floor, provide a 4-inch wide top flange at required height.
    - c. Provide strainer 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, and adjustable extension and 6-inch diameter cast strainer.

## 2.4 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 <sup>1</sup>/<sub>2</sub> or <sup>3</sup>/<sub>4</sub> 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. Furnish materials in accordance with State of California Codes and City of Los Angeles Department of Building and Safety Standards.
- E. Cast-Iron Floor Sinks Except as Noted:
  - 1. Standard: ASME A112.6.3.
  - 2. Pattern: Indirect waste receptors.
  - 3. Body Material: Gray iron.
  - 4. Outlet: Bottom.
  - 5. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
  - 6. Top or Strainer Material: Cast iron.
  - 7. Top of Body and Strainer Finish: Cast iron.
  - 8. Top Shape: Round, square.
  - 9. Top Loading Classification: Heavy Duty.
  - 10. Trap Material: Cast iron.
  - 11. Trap Pattern: P-trap.
  - 12. 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:
    - a. For built up membrane, provide a flashing clamp.
    - b. For elastomeric type floor, provide a four inch wide top flange at required height. Provide strainers with a nickel bronze finish except as noted.
    - c. 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 and an adjustable extension neck and 6-inch diameter cast strainer.

### 2.3 CLEANOUTS

- A. Manufacturers:
  - 1. J.R. Smith.
  - 2. Zurn.
  - 3. MiFAB.
- B. 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.
- C. 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.

## 2.4 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.

#### 2.5 OIL INTERCEPTORS

- A. Manufacturers:
  - 1. Zurn Industries, LLC/Rexnord Corporation.
  - 2. Pro-Cast Product, Inc.
  - 3. Jensen Precast.
- B. Construction:
  - 1. Material: Epoxy coated fabricated steel or precast concrete.

### FACILITY SANITARY SEWAGE

QTA 30% SUBMITTAL 09/23/2016 Page 6 of 13

 $22\ 13\ 00$ 

- 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.

# 2.6 SEDIMENT INTERCEPTORS

- A. Manufacturers:
  - 1. Zurn Industries, LLC/Rexnord Corporation.
  - 2. Pro-Cast Product, Inc.
  - 3. Jensen Precast.
- B. Construction:
  - 1. Material: Epoxy coated fabricated steel or precast 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.

# 2.7 MAINTENANCE HOLES

A. Coordinate with Civil Engineer.

# 2.8 CLEANOUTS

- A. Manufacturers:
  - 1. J.R. Smith.
  - 2. Zurn.

- 3. MiFAB.
- B. 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.
- C. 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.

### 2.9 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, Bolton access cover, horizontal or vertical type, threaded or hubless ends.

### 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 minimum separation of from other piping services in accordance with code.

### 3.2 PIPING APPLICATION

- A. 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; NSF listed, and hubless-coupling joints.

- 2. Copper DWV tube, copper drainage fittings, and soldered joints.
- 3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- B. 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; NSF Listed, and hubless-coupling joints.
  - 2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- C. 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; NSF Listed, and hubless-coupling joints.
  - 2. Copper DWV tube, copper drainage fittings, and soldered joints.
- D. 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.
- E. 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. Provide basic piping installation as required.
- B. Install seismic restraints on piping.
- C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- D. 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."
- E. 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.

- F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. 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.
- G. 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 4 and smaller.
  - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow for piping NPS 4 (DN80) and smaller at 1/4 inch per foot minimum.
  - 3. Horizontal sanitary drainage piping: 1 percent downward in direction of flow for piping NPS 4 and larger (with AHJ approval).
  - 4. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- H. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- I. 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 nonrigid 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. 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.
- 3. 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.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. 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.
- H. Install supports for vertical copper tubing every 10 feet.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

# 3.5 SANITARY PIPING INSTALLATION

A. 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 135 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 sinks for easy access and maintenance.
  - 2. Set floor sinks 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 1inch total depression.
  - 3. Install floor sinks 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 sinks connected to sanitary building drain, unless otherwise indicated.
- F. Assemble open drain fittings and install with top of hub 2 inches above floor.
- G. Install floor-sink, trap-seal primer fittings on inlet to floor sinks that require trap-seal primer connection.
  - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.

- H. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- J. Do not install vent caps at wall penetrations.
- K. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- 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.
- M. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- N. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- O. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- P. Install through-penetration firestop assemblies in plastic at floor penetrations.
- Q. Assemble open drain fittings and install with top of hub 2 inches above floor.
- R. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- S. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- T. Install vent caps on each vent pipe passing through roof.
- U. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- V. Install separators and interceptors, including trapping, venting and sampling box, according to authorities having jurisdiction and with clear space for servicing.

# END OF SECTION

# SECTION 22 13 13 - FACILITY SANITARY SEWERS

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Hub-and-spigot, cast-iron soil pipe and fittings.
  - 2. Hubless cast-iron soil pipe and fittings.
  - 3. Ductile-iron, gravity sewer pipe and fittings.
  - 4. Ductile-iron, pressure pipe and fittings.
  - 5. PVC pipe and fittings.
  - 6. Nonpressure-type transition couplings.
  - 7. Pressure-type pipe couplings.
  - 8. Expansion joints and deflection fittings.
  - 9. Backwater valves.
  - 10. Cleanouts.
  - 11. Encasement for piping.
  - 12. Manholes.
  - 13. Concrete.

### 1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Pipe and fittings.
  - 2. Non-pressure and pressure couplings
  - 3. Expansion joints and deflection fittings.
  - 4. Backwater valves.
  - 5. Cleanouts.
- B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

# 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
  - 1. Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
  - 2. Show system piping in profile. Draw profiles to horizontal scale of not less than 1 inch equals 50 feet (1:500) and to vertical scale of not less than 1 inch equals 5 feet (1:50). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
- B. Product Certificates: For each type of pipe and fitting.
- C. Field quality-control reports.

# 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

### 1.7 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
  - 1. Notify [Architect] [Construction Manager] [Owner] no fewer than [two] <Insert number> days in advance of proposed interruption of service.
  - 2. Do not proceed with interruption of service without [Architect's] [Construction Manager's] [Owner's] written permission.

# PART 2 - PRODUCTS

# 2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, [Service class] [Service and Extra-Heavy classes] [and] [Extra-Heavy class].
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

# 2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI-Trademark, Shielded Couplings:
  - 1. Description: ASTM C 1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
  - 2. <<u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>>
- C. Heavy-Duty, Shielded Couplings:
  - 1. Description: ASTM C 1277 and ASTM C 1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
  - 2. <a><br/>
     </a> <u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>
- D. Cast-Iron, Shielded Couplings:
  - 1. Description: ASTM C 1277 with ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.
  - 2. <a><br/>
     </a> <u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>
- E. Unshielded Couplings:
  - 1. Description: ASTM C 1277 and ASTM C 1461, rigid, sleeve-type, reducing- or transition-type mechanical coupling, with integral, center pipe stop, molded from ASTM C 1440, thermoplastic elastomer (TPE) material; with corrosion-resistant-metal tension band and tightening mechanism on each end.
  - 2. <a><br/>
     </a> <u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>

### 2.3 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

- A. Pipe: ASTM A 746, for push-on joints.
- B. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, for push-on joints.
- C. Compact Fittings: AWWA C153/A21.53, ductile iron, for push-on joints.
- D. Gaskets: AWWA C111/A21.11, rubber.

#### 2.4 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS

- A. Push-on-Joint Piping:
  - 1. Pipe: AWWA C151/A21.51.
  - 2. Standard Fittings: AWWA C110/A21.10, ductile or gray iron.
  - 3. Compact Fittings: AWWA C153/A21.53.

- 4. Gaskets: AWWA C111/A21.11, rubber, of shape matching pipe and fittings.
- B. Mechanical-Joint Piping:
  - 1. Pipe: AWWA C151/A21.51, with bolt holes in bell.
  - 2. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, with bolt holes in bell.
  - 3. Compact Fittings: AWWA C153/A21.53, with bolt holes in bells.
  - 4. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
  - 5. Gaskets: AWWA C111/A21.11, rubber, of shape matching pipe, fittings, and glands.

### 2.5 PVC PIPE AND FITTINGS

- A. PVC Cellular-Core Sewer Piping:
  - 1. Pipe: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
  - 2. Fittings: ASTM D 3034, [SDR 35] <Insert SDR>, PVC socket-type fittings.
- B. PVC Corrugated Sewer Piping:
  - 1. Pipe: ASTM F 949, PVC corrugated pipe with bell-and-spigot ends for gasketed joints.
  - 2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
  - 3. Gaskets: ASTM F 477, elastomeric seals.
- C. PVC Profile Sewer Piping:
  - 1. Pipe: ASTM F 794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
  - 2. Fittings: ASTM D 3034, PVC with bell ends.
  - 3. Gaskets: ASTM F 477, elastomeric seals.
- D. PVC Type PSM Sewer Piping:
  - 1. Pipe: ASTM D 3034, [SDR 35] <Insert SDR>, PVC Type PSM sewer pipe with belland-spigot ends for gasketed joints.
  - 2. Fittings: ASTM D 3034, PVC with bell ends.
  - 3. Gaskets: ASTM F 477, elastomeric seals.
- E. PVC Gravity Sewer Piping:
  - 1. Pipe and Fittings: ASTM F 679, [**T-1**] [**T-2**] wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.
- F. PVC Pressure Piping:
  - 1. Pipe: AWWA C900, [Class 100] [Class 150] [and] [Class 200] PVC pipe with bell-and-spigot ends for gasketed joints.
  - 2. Fittings: AWWA C900, [Class 100] [Class 150] [and] [Class 200] PVC pipe with bell ends.

- 3. Gaskets: ASTM F 477, elastomeric seals.
- G. PVC Water-Service Piping:
  - 1. Pipe: ASTM D 1785, [Schedule 40] [and] [Schedule 80] PVC, with plain ends for solvent-cemented joints.
  - 2. Fittings: [ASTM D 2466, Schedule 40] [and] [ASTM D 2467, Schedule 80] PVC, socket type.

# 2.6 NONPRESSURE-TYPE TRANSITION COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
  - 1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
  - 2. For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
  - 3. For Fiberglass Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
  - 4. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
  - 5. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Unshielded, Flexible Couplings:
  - 1. Description: Elastomeric sleeve with[ **stainless-steel shear ring and**] corrosion-resistantmetal tension band and tightening mechanism on each end.
  - 2. <a><br/>
    <u>Couble click here to find, evaluate, and insert list of manufacturers and products.></u></a>
- D. Shielded, Flexible Couplings:
  - 1. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
  - 2. <a><br/>
     </a> **Couble click here to find, evaluate, and insert list of manufacturers and products.**
- E. Ring-Type, Flexible Couplings:
  - 1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
  - 2. < <u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>
- F. Nonpressure-Type, Rigid Couplings:
  - 1. Description: 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.
  - 2. <<u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>>

# 2.7 PRESSURE-TYPE PIPE COUPLINGS

- A. <a><br/>
   <br/>
   <br/>
- B. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.
- C. Metal, bolted, sleeve-type, reducing or transition coupling; for joining underground pressure piping. Include [150-psig (1035-kPa)] [200-psig (1380-kPa)] <Insert value> minimum pressure rating and ends of same sizes as piping to be joined.
- D. Center-Sleeve Material: [Manufacturer's standard] [Carbon steel] [Stainless steel] [Ductile iron] [Malleable iron].
- E. Gasket Material: Natural or synthetic rubber.
- F. Metal Component Finish: Corrosion-resistant coating or material.

# 2.8 EXPANSION JOINTS AND DEFLECTION FITTINGS

- A. Ductile-Iron, Flexible Expansion Joints:
  - 1. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig (1725-kPa) minimum working pressure and for offset and expansion indicated.
  - 2. <a><br/>
     <u>Ouble click here to find, evaluate, and insert list of manufacturers and products.></u></a>
- B. Ductile-Iron Expansion Joints:
  - 1. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include rating for 250-psig (1725-kPa) minimum working pressure and for expansion indicated.
  - 2. <a><br/>
     </a> <u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>
- C. Ductile-Iron Deflection Fittings:
  - 1. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include rating for 250-psig (1725-kPa) minimum working pressure and for up to 15 degrees of deflection.
  - 2. <<u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>

# 2.9 BACKWATER VALVES

- A. Cast-Iron Backwater Valves:
  - 1. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.

- 2. <a><br/>
   </a> <a><br/>
   </a> <a><br/>
   </a> <a><br/>
   </a> </a>
- 3. Horizontal type; with swing check valve and hub-and-spigot ends.
- 4. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
- 5. Terminal type; with bronze seat, swing check valve, and hub inlet.
- B. PVC Backwater Valves:
  - 1. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.
  - 2. <a><br/>
     </a> <u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>

# 2.10 CLEANOUTS

- A. Cast-Iron Cleanouts:
  - 1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
  - 2. < <u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>
  - 3. Top-Loading Classification(s): [Light Duty] [Medium Duty] [Heavy Duty] [and] [Extra-Heavy Duty].
  - 4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
- B. PVC Cleanouts:
  - 1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.
  - 2. <a><br/>
     </a>
     2.

# 2.11 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.
- B. Material: [Linear low-density polyethylene film of 0.008-inch (0.20-mm)] [or] [high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm)] minimum thickness.
- C. Form: [Sheet] [or] [tube].
- D. Color: [Black] [or] [natural] <Insert color>.

# 2.12 MANHOLES

A. Standard Precast Concrete Manholes:

- 1. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
- 2. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
- 3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
- 4. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
- 5. Riser Sections: 4-inch (100-mm) minimum thickness, of length to provide depth indicated.
- 6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
- 7. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
- 8. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
- 9. Steps: [Individual FRP steps or FRP ladder] [Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP] [ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP] 
  Insert material>; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than [60 inches (1500 mm)]
- 10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
- 11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
- B. Designed Precast Concrete Manholes:
  - 1. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44 in AASHTO HL), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
  - 2. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
  - 3. Joint Sealant: ASTM C 990 (ASTM 990M), bitumen or butyl rubber.
  - 4. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
  - 5. Steps: [Individual FRP steps or FRP ladder] [Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP] [ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP] 
    Insert material>; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than [60 inches (1500 mm)]
  - 6. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust

manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

- 7. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
- C. Fiberglass Manholes:
  - 1. Description: ASTM D 3753.
  - 2. <<u>Couble click here to find, evaluate, and insert list of manufacturers and products.</u>>
  - 3. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
  - 4. Ballast: Increase thickness of concrete base as required to prevent flotation.
  - 5. Base Section: Concrete, 6-inch (150-mm) minimum thickness.
  - 6. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
  - Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than [60 inches (1500 mm)] <Insert dimension>.
  - 8. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
  - 9. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
- D. Manhole Frames and Covers:
  - 1. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser, with 4-inch- (100-mm-) minimum-width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
  - 2. Material: [ASTM A 536, Grade 60-40-18 ductile] [ASTM A 48/A 48M, Class 35 gray] iron unless otherwise indicated.
- E. Manhole-Cover Inserts:
  - 1. Description; Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
  - 2. <a><br/>
     </a>
     <u>Acceleration of the second </u>
  - 3. Type: [Solid] [Drainage with vent holes] [Valve].

# 2.13 CONCRETE

- A. General: Cast-in-place concrete complying with ACI 318, ACI 350 (ACI 350M), and the following:
  - 1. Cement: ASTM C 150/C 150M, Type II.
  - 2. Fine Aggregate: ASTM C 33/C 33M, sand.
  - 3. Coarse Aggregate: ASTM C 33/C 33M, crushed gravel.
  - 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.
  - 1. Reinforcing Fabric: ASTM A 1064/A 1064M, steel, welded wire fabric, plain.
  - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420-MPa) deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
  - 1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
    - a. Invert Slope: [1] [2] percent through manhole.
  - 2. Benches: Concrete, sloped to drain into channel.
    - a. Slope: [4] [8] percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.
  - 1. Reinforcing Fabric: ASTM A1064/A 1064M, steel, welded wire fabric, plain.
  - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420-MPa) deformed steel.

# PART 3 - EXECUTION

#### 3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

# 3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipejacking process of microtunneling.
- F. Install gravity-flow, nonpressure, drainage piping according to the following:
  - 1. Install piping pitched down in direction of flow, at minimum slope of [1] [2] <Insert number> percent unless otherwise indicated.
  - 2. Install piping [NPS 6 (DN 150)] <Insert pipe size> and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
  - 3. Install piping with [36-inch (915-mm)] [48-inch (1220-mm)] [60-inch (1520-mm)] [72-inch (1830-mm)] <Insert dimension> minimum cover.
  - 4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
  - 5. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
  - 6. Install ductile-iron, gravity sewer piping according to ASTM A 746.
  - 7. Install PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 1668.
  - 8. Install PVC corrugated sewer piping according to ASTM D 2321 and ASTM F 1668.
  - 9. Install PVC profile sewer piping according to ASTM D 2321 and ASTM F 1668.
  - 10. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
  - 11. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
- G. Install force-main, pressure piping according to the following:
  - 1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
  - 2. Install piping with [36-inch (915-mm)] [48-inch (1220-mm)] [60-inch (1520-mm)] [72-inch (1830-mm)] <Insert dimension> minimum cover.
  - 3. Install ductile-iron pressure piping according to AWWA C600 or AWWA M41.
  - 4. Install ductile-iron special fittings according to AWWA C600.
  - 5. Install PVC pressure piping according to AWWA M23 or to ASTM D 2774 and ASTM F 1668.
  - 6. Install PVC water-service piping according to ASTM D 2774 and ASTM F 1668.
- H. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105/A21.5:
  - 1. Hub-and-spigot, cast-iron soil pipe.

- 2. Hubless cast-iron soil pipe and fittings.
- 3. Ductile-iron pipe and fittings.
- 4. Expansion joints and deflection fittings.
- I. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

# 3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping according to the following:
  - 1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
  - 2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
  - 3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
  - 4. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
  - 5. Join PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
  - 6. Join PVC corrugated sewer piping according to ASTM D 2321.
  - 7. Join PVC profile sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
  - 8. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
  - 9. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
  - 10. Join dissimilar pipe materials with nonpressure-type, flexible[ or rigid] couplings.
- B. Join force-main, pressure piping according to the following:
  - 1. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.
  - 2. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
  - 3. Join PVC pressure piping according to AWWA M23 for gasketed joints.
  - 4. Join PVC water-service piping according to ASTM D 2855.
  - 5. Join dissimilar pipe materials with pressure-type couplings.
- C. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
  - 1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
    - a. [Unshielded] [Shielded] flexible[ or rigid]couplings for pipes of same or slightly different OD.
    - b. Unshielded, increaser/reducer-pattern, flexible[ **or rigid**]couplings for pipes with different OD.

- c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
- 2. Use pressure pipe couplings for force-main joints.

# 3.4 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Install FRP manholes according to manufacturer's written instructions.
- D. Form continuous concrete channels and benches between inlets and outlet.
- E. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops [3 inches (76 mm)] <Insert dimension> above finished surface elsewhere unless otherwise indicated.
- F. Install manhole-cover inserts in frame and immediately below cover.

# 3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

# 3.6 BACKWATER VALVE INSTALLATION

- A. Install horizontal-type backwater valves in piping manholes or pits.
- B. Install combination horizontal and manual gate-type valves in piping and in manholes.
- C. Install terminal-type backwater valves on end of piping and in manholes. Secure units to sidewalls.

# 3.7 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
  - 1. Use Light-Duty, top-loading classification cleanouts in [earth or unpaved foot-traffic] <Insert other> areas.
  - 2. Use Medium-Duty, top-loading classification cleanouts in [paved foot-traffic] <Insert other> areas.
  - 3. Use Heavy-Duty, top-loading classification cleanouts in [vehicle-traffic service] <Insert other> areas.
  - 4. Use Extra-Heavy-Duty, top-loading classification cleanouts in [roads] <Insert area>.

- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, [18 by 18 by 12 inches (450 by 450 by 300 mm)] <Insert dimensions> deep. Set with tops [1 inch (25 mm)] <Insert dimension> above surrounding grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

### 3.8 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."
- B. Connect force-main piping to building's sanitary force mains specified in Section 221316 "Sanitary Waste and Vent Piping." Terminate piping where indicated.
- C. Make connections to existing piping and underground manholes.
  - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch (150-mm) overlap with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
  - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
  - 3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of, and be flush with, inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.
    - a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
    - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
  - 4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- D. Connect to [grease] [oil] [and] [sand] interceptors specified in Section 221323 "Sanitary Waste Interceptors."

# 3.9 CLOSING ABANDONED SANITARY SEWER SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
  - 1. Close open ends of piping with at least [8-inch- (203-mm-)] <Insert dimension> thick, brick masonry bulkheads.
  - 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
  - 1. Remove manhole and close open ends of remaining piping.
  - 2. Remove top of manhole down to at least [36 inches (915 mm)] <Insert dimension> below final grade. Fill to within [12 inches (300 mm)] <Insert dimension> of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
- C. Backfill to grade according to Section 312000 "Earth Moving."

# 3.10 IDENTIFICATION

- A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
  - 1. Use[ warning tape or] detectable warning tape over ferrous piping.
  - 2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

# 3.11 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.
  - 1. Submit separate report for each system inspection.
  - 2. Defects requiring correction include the following:
    - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    - d. Infiltration: Water leakage into piping.
    - e. Exfiltration: Water leakage from or around piping.
  - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
  - 4. Reinspect and repeat procedure until results are satisfactory.

- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
  - 1. Do not enclose, cover, or put into service before inspection and approval.
  - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
  - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
  - 4. Submit separate report for each test.
  - 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
    - a. Fill sewer piping with water. Test with pressure of at least 10-foot (3-m) head of water, and maintain such pressure without leakage for at least 15 minutes.
    - b. Close openings in system and fill with water.
    - c. Purge air and refill with water.
    - d. Disconnect water supply.
    - e. Test and inspect joints for leaks.
  - 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    - a. Test plastic gravity sewer piping according to ASTM F 1417.
    - b. Test concrete gravity sewer piping according to ASTM C 1628.
  - 7. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than [150 psig (1035 kPa)] <Insert value>.
    - a. Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
    - b. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
  - 8. Manholes: Perform hydraulic test according to ASTM C 969 (ASTM C 969M).
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

# 3.12 CLEANING

A. Clean dirt and superfluous material from interior of piping.[ Flush with potable water.]

END OF SECTION 22 13 13

# 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. Roof drains.
  - 5. Downspout nozzles.
  - 6. Area drains.
  - 7. Cleanouts.
  - 8. Interceptors.

# 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 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. 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.
- D. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.
- E. 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 / Anaco / McWane Inc.; Husky SD 4000.
- b. Clamp-All Products / NORMA Group.
- c. Ideal-Tridon / Ideal Clamp Products, Inc.
- 4. Manufacturers Heavy Duty Cast Iron or Ductile Iron Couplings
  - a. MG Coupling / MG Piping Products Company.
  - b. Victaulic Company.
  - c. Or Approved Equal.
- 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.
    - a. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - b. 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 / Anaco / McWane Inc.; Husky SD 4000.
  - b. Clamp-All Products / NORMA Group.
  - c. Ideal-Tridon / Ideal Clamp Products, Inc.
- 4. Manufacturers Heavy Duty Cast Iron or Ductile Iron Couplings
  - a. MG Coupling / MG Piping Products Company.
  - b. Victaulic Company.
  - c. Or Approved Equal.
- 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.
  - a. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  - b. Gaskets: AWWA C111, rubber.
- 3. Flanges: ASME 16.1, Class 125, cast iron.
- 2.3 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.

# 2.4 ROOF AND OVERFLOW DRAINS

- A. Manufacturers:
  - 1. Jay R. Smith Mfg. Co. / Morris Group International
  - 2. Zurn Industries, LLC / Rexnord Corporation.
  - 3. MIFAB, Inc.
- 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.
- C. Overflow Drain (OD-1):
  - 1. Same as RD-1, with 2" min. height water dam.

### 2.5 DOWNSPOUT NOZZLES

- A. Manufacturers:
  - 1. Jay R. Smith Mfg. Co. / Morris Group International
  - 2. Zurn Industries, LLC / Rexnord Corporation.
  - 3. MIFAB, Inc.
- B. Product Description: Nickel or Polished bronze body and round wall flange with straight bottom section and screened outlet.

#### 2.6 AREA DRAINS

- A. Manufacturers:
  - 1. Jay R. Smith Mfg. Co. / Morris Group International
  - 2. Zurn Industries, LLC / Rexnord Corporation.
  - 3. MIFAB, Inc.
- 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.

## 2.7 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.
- B. Downspout Boots:
  - 1. Description: ASTM A48/A48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
  - 2. Description: ASTM A74, Service class, hub-and-spigot, cast-iron soil pipe.
- C. Conductor Nozzles:
  - 1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
- D. Overflow Outlet:
  - 1. Stainless steel type 304 with hinged perforated cover similar to J.R. Smith 1775, vandal proof.

#### 2.8 FLASHING MATERIALS

- A. Copper Sheet: ASTM B152/B152M, 12 oz./sq. ft. thickness.
- B. Zinc-Coated Steel Sheet: ASTM A653/A653M, 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 D4068, 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 B32, lead-free alloy.
- G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.
#### 2.9 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.

#### 2.10 SEDIMENT INTERCEPTORS

- A. Manufacturers:
  - 1. Jay R. Smith Mfg. Co. / Morris Group International
  - 2. Zurn Industries, LLC / Rexnord Corporation.
- B. Sediment Interceptor: Epoxy coated cast iron, Stainless steel or Precast concrete body and secured cover with removable stainless steel sediment bucket.

## 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, non-pressure 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, non-pressure 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, non-pressure 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 heavyduty shielded, cast-iron couplings; and coupled joints.
- 3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

#### 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 underground, ductile-iron, special pipe fittings according to AWWA C600.
  - 1. Install encasement on piping according to ASTM A674 or AWWA C105.
- D. 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.
- E. Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.
- F. 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 A674 or AWWA C105.
- G. 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.
- H. 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.
- I. 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.
- J. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab

is without membrane waterproofing.

- K. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- L. 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 nonrigid 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 135 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 TRAINING

A. Provide minimum of 12 hours (3 shifts total) classroom and hands on training to LAWA Maintenance personnel. Notify LAWA 72 hours in advance.

# END OF SECTION

FACILITY STORM DRAINAGE

QTA 30% SUBMITTAL 09/23/2016 Page 14 of 14

22 14 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. International Association of Plumbing and Mechanical Officials: IAPMO.
  - 2. 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. CALGreen Submittal/Tier Level Performance Requirements: Obtain LAWA requirements for the project.
- D. Shop Drawings: Diagram power, signal and control wiring.
- E. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

## PLUMBING FIXTURES

F. 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

NOTE:	* - Already complies with CALGreen Tier 1
	** - Already complies with CALGreen Tier 1 & 2

# 2.1 GENERAL

A. The following gallons per flush or flow in gallons per minute are required water use baseline for project:

Plumbing Fixture	LAWA/CALGreen -	LAWA/CALGreen –	
	Baseline Flow	Tier 1	
Water Closets Flushometer valve	1.28 gallons per flush	1.12 gallons per flush	
Urinals Flushometer valve	0.125** gallons per flush	0.125** gallons per flush	
Lavatory Faucet	0.5 gallons per minute at 60 psi	0.35 gallons per minute at 60 psi	
Showers Heads	1.5** gallons per minute	1.5** gallons per minute	
Pantry Sinks	1.5 gallons per minute	1.5 gallons per minute	
Mon Sinks	Per ASME A112.18.1, 4.0	Per ASME A112.18.1, 4.0	
Mop Shiks	gallons per minute	gallons per minute	
Water Closet Gravity tank	1.28 gallons per flush	1.12 gallons per flush	
Kitchen Faucets	1.8 gallons per minute at 60 psi	1.5 gallons per minute at 60 psi	
Metering Faucets	0.20 gallons per cycle	0.18 gallons per cycle	
Wash Fountains	1.8 gallons per minute at 60 psi	1.5 gallons per minute at 60 psi	
Metering Faucets for Wash	0.20 gallons per minute at 60 psi	0.18 gallons per minute at 60 psi	
Fountains		0.10 ganons per minute at 00 psi	
NOTE: When applicable, the more stringent requirement is shown in this table.			

# 2.2 FLUSH VALVE WATER CLOSETS

- A. Manufacturers: Vitreous China.
  - 1. American Standard / American Standard Brands.\* Afwall Model Number 2257.001 (Basis of Design Product)
  - 2. Kohler Company.

## PLUMBING FIXTURES

 $22\ 40\ 00$ 

- 3. Toto USA, Inc.
- B. 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.
- C. 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.
- D. Disabled Access: Where required.
- E. Manufacturers: Flush Valves.
  - 1. Sloan Valve Company.\*
  - 2. Zurn Industries, LLC / Rexnord Corporation.
  - 3. American Standard / American Standard Brands.\*
- F. Exposed Flush Valve: ASME A112.18.1; exposed Chrome Plated (C.P.), diaphragm type with oscillating handle, escutcheon, seat bumper, integral screwdriver stop, and vacuum breaker 1.28 maximum gallon per flush per Table listed in sub-section 2.1 above. If Tier 1 is required in the project, maximum gallon per flush shall be 12% less, Tier 2 20% less, than the baseline flow listed in the Table.
- H. Water Closet Flushometers:
  - 1. Sensor Operated Hard Wired:
    - a. Concealed diaphragm type, chrome plated, sensor operated flushometer valve.
    - b. Low consumption valves shall have dual filtered type diaphragm kit for flush discharge accuracy.
    - c. 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.
    - d. Valve shall include self-adaptive infrared sensor with indicator light, courtesy flush override button, (2) chrome plated wall cover plates (for 2-gang electrical box) with vandal resistant screws.
    - e. Valve body, cover tailpiece and control stop will be in conformance with ASTM Alloy Classification for Semi-Red Brass.
    - f. Valve shall be in compliance with the applicable sections of ASSE 1037, ANSI/ASME 112.19.6, and Military Specification V-29193 Standards. Sloan

PLUMBING FIXTURES

QTA 30% SUBMITTAL 09/23/2016 Page 3 of 16

Valve Company Optima 152-1.28 ES-S.

- I. Seats:
  - 1. Manufacturers:
    - a. Olsonite / Bemis 95CT (Basis of Design Product)
    - b. American Standard / American Standard Brands.
    - c. Kohler Company.
  - 2. Seat: Shall be white heavy-duty plastic, open front, extended back, self-sustaining hinge, brass bolts, without cover.
- J. Carriers:
  - 1. Manufacturers:
    - a. Jay R. Smith Mfg. Co. / Morris Group International 0600 (Basis of Design Product)
    - b. Zurn Industries, LLC / Rexnord Corporation.
    - c. MIFAB, Inc.
  - 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 1,000 pound load rating.

PLUMBING FIXTURES

QTA 30% SUBMITTAL 09/23/2016 Page 4 of 16 3. Set bowls for physically handicapped with top of seat 17 to 19 inches above floor per ADA requirements 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 / American Standard Brands\*\* 6590.001 (Basis of Design Product)
  - 2. Sloan Valve Company.\*\*
  - 3. Kohler Company.\*\*
- B. 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.
- C. Manufacturers: Flush Valves.
  - 1. Sloan Valve Company\*\* WEUS-1010.1311-0.13 ES-S (Basis of Design Product)
  - 2. American Standard / American Standard Brands.\*\*
  - 3. Zurn Industries, LLC / Rexnord Corporation.\*\*
- 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.
    - b. Low consumption valves shall have dual filtered type diaphragm kit for flush discharge accuracy.
    - c. Valve shall be non-hold-open, solenoid operator, skirted high back pressure vacuum breaker with bottom hex coupling nut, back-check control stop will

PLUMBING FIXTURES

QTA 30% SUBMITTAL 09/23/2016 Page 5 of 16

have free spinning vandal resistant stop cap and sweat solder adapter kit with cast set screw wall flange.

- d. 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.
- e. Valve, body, cover, tailpiece and control stop shall be in conformance with ASTM Alloy Classification for Semi-Red Brass.
- f. Valve shall be Sloan Valve Company 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. Jay R. Smith Mfg. Co. / Morris Group International. 0636 or 0637 (Basis of Design Product)
    - b. Zurn Industries, LLC / Rexnord Corporation.
    - c. MIFAB, Inc.
  - 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, elastomeric 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 / American Standard Brands.
  - 2. Kohler Company.
  - 3. Crane Plumbing / American Standard Brands.
- B. Manufacturers: Integral basin type.
  - 1. Corian / E. I. du Pont de Nemours and Company (DuPont) self-draining with integral bowl or approved equal

## PLUMBING FIXTURES

- 2. Corian / E. I. du Pont de Nemours and Company (DuPont) integral Linear Lavatory
  - a. Or approved equal. See separate "Linear Lavatory" document.
- C. Manufacturers:
  - 1. Deck mounted Faucets. Sensor-Operated Hard-wired
    - a. Sloan Valve Company\* Solis EAF-275 Chrome Plated (Basis of Design Product)
    - b. Chicago Faucets / the Geberit Group.\*
    - c. American Standard / American Standard Brands.\*
  - 2. Deck mounted Faucets. Push Operated
    - a. Chicago Faucets / the Geberit Group.\* 844-E2605-665 PSHABCP (Basis of Design Product)
- D. Wall Hung Basins: size as required, with 4 inch high back; drillings on 4 inch or 8 inch centers or single holE 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 / American Standard Brands.
  - 2. BrassCraft Mfg. / Masco Corporation.
  - 3. Chicago Faucets / the Geberit Group.
- 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:

## PLUMBING FIXTURES

- a. Jay R. Smith Mfg. Co. / Morris Group International.
- b. Zurn Industries, LLC / Rexnord Corporation.
- c. MIFAB, Inc.
- K. Lavatory insulation kit where required: Tru-Bro, Plumerex, or approved equal.
- L. Waste Outlets:
  - 1. Manufacturers:
    - a. American Standard / American Standard Brands.
    - b. Brasscraft Mfg. / Masco Corporation.
    - c. Chicago Faucets / the Geberit Group.
  - 2. Descriptions:
    - 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 without 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:

- 1. Manufacturers:
  - a. Jay R. Smith Mfg. Co. / Morris Group International.
  - b. American Standard / American Standard Brands.
  - c. Chicago Faucets / the Geberit Group.

#### PLUMBING FIXTURES

- 2. Descriptions:
  - 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 Manufacturing Company.
    - b. Franke.
    - c. Just Manufacturing.
- B. Manufacturers: Faucets.
  - 1. Chicago Faucets / the Geberit Group.\*
  - 2. Sloan Valve Company.
  - 3. American Standard / American Standard Brands.\*
- C. Warewashing Sink:
  - 1. Three compartment, self-rimming, counter-mounting, stainless-steel commercial sink with two integral metal drain boards in counter with five (5) holes, faucet openings eight (8) inches on centers.
  - 2. Sink shall be No. 18 USSG genuine 18-8 solid stainless steel and shall be bonded to and reinforced with heavy gauge formed metal.
  - 3. Underside shall be sound deadened.
  - 4. Provide one piece with bowls welded integrally to tops.

#### PLUMBING FIXTURES

- 5. Horizontal and vertical corners of bowls shall be rounded to 1-3/4 inch radius.
- 6. Joints shall be welded and ground smooth.
- 7. Bottom shall be pitched to drain outlet and drilled for trim as required.
- 8. Provide wood strips for fastening top to cabinets.
- 9. 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 Mfg. / Masco Corporation.
    - b. Chicago Faucets / the Geberit Group.
    - c. Zurn Industries, LLC / Rexnord Corporation.
- E. Waste Outlets:
  - 1. Manufacturers:
    - a. American Standard / American Standard Brands.
    - b. Brasscraft Mfg. / Masco Corporation.
    - c. Chicago Faucets / the Geberit Group.
  - 2. Descriptions:
    - a. Type: All Sinks.
      - (1) Provide 316 stainless steel open strainer waste with 1 <sup>1</sup>/<sub>2</sub> inch 17 gauge copper tubing tailpiece.
      - (2) 1-1/2 in. x 2 in., cast brass P-trap without cleanout, with 17 gauge copper tubing.
      - (3) Connect to concealed waste piping using C.P. cast brass wall outlet nipple with C.P. brass set screw and escutcheon.

## PLUMBING FIXTURES

QTA 30% SUBMITTAL 09/23/2016 Page 10 of 16

- (4) 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 Manufacturing Company.
  - 2. Haws Corporation.
  - 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 DRINKING FOUNTAINS

- A. Drinking Fountains (combination high-low fountains at new construction):
  - 1. Manufacturers:
    - a. Elkay Manufacturing Company.
    - b. Halsey Taylor.
    - c. Haws Corporation.
  - 2. Type wall mount.
  - 3. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-

#### PLUMBING FIXTURES

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 BOTTLE FILLING STATIONS (OPTIONAL):

- A. Manufacturers:
  - 1. Elkay Manufacturing Company.
  - 2. Halsey Taylor.
  - 3. Haws Corporation.
- B. Type: Wall mount.
- C. Description: Accessible, recessed in wall, with stainless steel finish preferred.
  - 1. Locations:
    - a. At or directly adjacent to restroom entry
    - b. Above drinking fountain, recessed into wall, and/or
    - c. Directly adjacent to drinking fountains, recessed into wall.
    - d. All electrical to be hardwired, with no plug in for power.
    - e. No advertising allowed other than manufacturer name.
    - f. No batteries allowed for any function.

## PLUMBING FIXTURES

- g. No sensors. Manual operation only for dispensing water into bottles.
- h. Station to include drain connected to drinking fountain.
- i. Station shall have filter.

#### 2.9 FIXTURE SUPPORTS

- A. Manufacturers:
  - 1. Jay R. Smith Mfg. Co. / Morris Group International.
  - 2. MIFAB, Inc.
  - 3. Zurn Industries, LLC / Rexnord Corporation.
- 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.

#### 2.10 MOP SINKS

- A. Enameled Cast Iron or Terrazzo
- B. Manufacturers:
  - 1. Commercial Enameling Company (CECO) 871 (Basis of Design Product)
  - 2. American Standard / American Standard Brands.
  - 3. Kohler Company.
- 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.

#### PLUMBING FIXTURES

QTA 30% SUBMITTAL 09/23/2016 Page 13 of 16

- 2. Manufacturers:
  - a. Chicago Faucets / the Geberit Group 305-VB-R (Basis of Design Product)
  - b. Speakman.
  - c. T & S Brass and Bronze Works, Inc.

#### E. Accessories:

- 1. 5 feet of 1/2 inch diameter plain end reinforced plastic rubber hose.
- 2. Hose clamp hanger.
- 3. Mop hanger.

# 2.11 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers:
  - 1. Manufacturers:
    - a. Engineered Brass Company.
    - b. Truebro / IPS Corporation.
    - c. Zurn Industries, LLC / Rexnord Corporation.
  - 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.

## 2.12 GARBAGE DISPOSER

- A. Garbage disposer to be stainless steel grinder, chamber and blades, fully sound insulated, 1horsepower, 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.

## PLUMBING FIXTURES

- B. Install and secure fixtures in place with wall supports, carriers and bolts.
- C. Seal fixtures to wall and floor surfaces with sealant color to match fixture.

# 3.2 PLUMBING FIXTURE INSTALLATION

- A. 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.
- B. 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 or gate valves if supply stops are not specified with fixture. Valves as required.
- C. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- D. 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.
- E. Install toilet seats on water closets.
- F. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- G. 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.
- H. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- I. Install traps on fixture outlets.
  - 1. Exception: Omit trap on fixtures with integral traps.

## PLUMBING FIXTURES

- 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- J. 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 water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, or gate valve. Install valves in locations where they can be easily reached for operation.
- D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- E. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.
- F. Do not install filter until after domestic water piping system has been disinfected and flushed.

## END OF SECTION

## PLUMBING FIXTURES

QTA 30% SUBMITTAL 09/23/2016 Page 16 of 16

## SECTION 23 00 00 AIRPORT MECHANICAL STANDARDS

#### MISSION STATEMENT

The goal of this section is to provide guidance to the users of this document in the design of Mechanical (HVAC, Plumbing and Fire Protection) systems to LAWA standards. The LAWA Mechanical Design Standards are a compilation of general design and construction practices that are already in place in our facilities, as well as recent discoveries that should be implemented throughout the facilities to maximize the performance of existing systems, minimize maintenance costs and improve the travelling public's experience. These standards are by no means an exhaustive description of all items practiced in our facilities; however, this document does present LAWA's standards for most of the major mechanical systems. If any discrepancy is found between these standards and the LAWA Design & Construction Handbook, the more restrictive standards shall take precedence.

#### A. GENERAL

- 1. All systems and equipment shall comply with applicable building and mechanical codes, LAWA criteria, and the scope of project work.
- 2. Provide design, engineering, permits, installation, and start-up, testing, adjusting, balancing, and commissioning of complete HVAC, plumbing and fire protection systems. The Contractor shall review all the documents and comply with the requirements.
- 3. Address the presence of hazardous materials. There is a high probability that portions of the existing HVAC systems, piping, insulation and the like may contain lead based-paint, asbestos containing materials (ACM's) and/or other materials classified as toxic or hazardous by LAWA or Federal regulations. The Contractor, and the Contractor's designer, must consider the impact of hazardous materials on this project.
- 4. Designs shall utilize systems and products that are/ have:
  - a. Long-life, industrial quality.
  - b. Readily-available products and components with service support available.
  - c. Maintainable arrangements with multiple units.
  - d. Readily available spare parts and materials that incorporate multiple equipment elements in key systems that can be provided for reduced capacity operation when portions are down for maintenance or failure.

- 5. The Design Consultant/Contractor shall perform a quality control review of all documents for completeness, constructability, coordination with all building trades.
- 6. Plan Coordination: Work shall be coordinated with all disciplines to ensure that size and location of all required chases, soffits, access panel requirements, etc., are indicated on the plans. All pipes larger than 6" shall be drawn as double lines. Duct layout larger than 6" diameter shall be drawn as double lines.
- 7. Sectional Views and Elevations: Sectional views and elevations that clearly define the details and space constraints shall be developed from floor plans included within the construction drawings. All equipment rooms shall have a minimum of two composite floors to ceiling sections with the cutting plane through the major axes that defines equipment sizes, and piping, and their relationship to architectural, structural, and electrical installations. Identify the clearances necessary to perform preventive maintenance and space requirements for equipment servicing/disassembly by dimensioning, noting and/or cross-hatching.
- 8. Equipment Rooms: All equipment rooms shall be designed and located to facilitate the removal, transport and replacement of the largest equipment component housed within the room. Room locations shall be depicted in plan view with expanded details shown by part plan at a scale no less than 1/4" = 1' 0". All pipes and ducts larger than 6" shall be drawn as double lines. All rooms shall be adequately ventilated and provided with hose bibbs and floor drains.
- 9. Large Equipment Installation Sequencing: In conjunction with other design disciplines, provide the necessary scheduling, sequencing, movement and positioning of large equipment into the building during construction, including provisions for temporary removal/replacement of existing building components.
- 10. Special and LAWA-Furnished Equipment: Special types of equipment, including LAWA-furnished and contractor-installed materials, shall be coordinated for correct rough-in and attachment requirements.
- 11. Interferences: AC units, valves, fans, piping, ducts, valves, pumps, and other equipment shall be reviewed for interferences that would prevent proper installation of each system.
- 12. Clearances: AC units, valves, fans, piping, ducts, valves, pumps, and other equipment shall have adequate clearance on all sides as well as above and other interferences where space is limited.
- 13. Accessibility: AC units, valves, fans, piping, ducts, valves, pumps, and other equipment shall be coordinated with building construction, beams, column walls, etc., to provide adequate clearances and accessibility for maintenance. Piping and ducts shall be coordinated with other engineering disciplines. Clearances and locations shall

be demonstrated graphically.

- 14. Penetrations: Piping/utility and duct penetrations through floors, walls, and roofs shall be coordinated and identified on the architectural and structural construction drawings. Proper cross-referencing between drawings shall be provided. Details for protection of all penetrations of fire resistive construction are required on plans submitted for construction approval permit.
- 15. Construction of New Buildings over Existing Utilities: Buildings or other structures shall not be constructed over existing or new utility lines except where such utility lines serve the buildings or structures. Utilities shall be relocated as required.
- 16. Equipment Protection and System Protection: Project specifications shall clearly indicate that all equipment and systems intended for a project shall be properly protected from damage, corrosion, and weather during shipment, in-transit storage, job-site storage, field/shop prep, installation, and checkout until the work is accepted by LAWA. Ends of piping, valves, and fittings shall be protected from abuse and the entry of moisture. Electrical equipment controls, and insulation shall be protected against moisture and water damage. LAWA may, at Contractor's risk and expense, disallow or reject the installation of previously approved equipment, if it is later determined to have deteriorated considerably during the Contractor's custody, such as during shipment, storage, and/or installation.
- 17. Special Support and Anchors: All equipment including piping supports, anchors, supports-guides, and pre-insulated versions thereof, which exert force on the structure other than those forces produce by gravity, and equipment shall be designed to a factor of 1.5G and detailed on the drawings and coordinated with structural engineer and appropriate fire protection drawings.
- 18. All equipment shall be arranged for maximum service access, while reserving space for future equipment and future uses. Ensure that all components and equipment are easily accessible for maintenance and replacement.
- 19. Install valves as needed to isolate each piece of equipment for maintenance and replacement requirements.
- 20. All piping, conduits and ductwork shall be concealed from public view, unless approved by LAWA.

## HEATING, VENTILATION AND AIR CONDITIONING SYSTEMS

## A. SUBMITTALS

1. Design Phase: A complete package of design calculations and information on the plans shall be provided for review by LAWA. The calculations packages shall be completed

in a bound and indexed format and shall be distributed with the final plans and specifications. Calculations shall be provided with whatever markings or notations that are needed to make them clearly understandable.

- a. The following data and calculations are the minimum requirements for submission:
  - 1) All calculations and designs.
  - 2) Catalog cuts showing capacities and selection points for all equipment.
  - 3) Heat and mass balances for all systems.
  - 4) Pressure drop calculations.
- 2. Instrumentation Design: Include process diagrams, P&I diagrams, wiring diagrams, and catalog information on all equipment. Coordinate design with all vendor control packages to achieve sequences of operation.
- 3. Provide system schematics for chilled water, heating hot water, water treatment and associated plumbing systems.
- 4. Submit type of chemical water treatment system and approach proposed for chilled water and heating hot water systems, with sufficient literature to validate approach and technology, along with references from projects and users where system has been employed for at least one year. Specific emphasis should be given to successful treatment programs in connecting new hydronic systems to existing buildings.
- 5. Project specifications shall clearly indicate that the Contractor shall submit, as a minimum, the following to demonstrate compliance with these requirements.
  - a. Shop drawings showing all the duct layout, piping, AC equipment, pumps, valves, and other equipment including piping accessories to complete the work.
  - b. Describe phasing of project implementation and strategy.
  - c. Manufacturer's product catalog.
  - d. HVAC system air balance report.
  - e. Copy of manufacturer equipment warranty documents shall be submitted during project closeout.
  - f. Supplement, as appropriate, with graphic material to convey the design intent.

- g. Describe approach to commissioning of systems. Identify roles and responsibilities of key players.
- h. Training Schedule. LAWA to attend the equipment operations training. LAWA EFMD personnel shall be properly trained in the operation and maintenance of all installed HVAC system for minimum of 8 hours (4 hours classroom training and 4 hours hands-on) prior to final acceptance by LAWA.
- i. All installed HVAC equipment shall be provided with minimum of three sets of As-built drawings and CD's (AutoCAD drawings in DWG file electronic format, drawn in the latest AutoCAD version), warranty documents and maintenance manuals during closeout period prior to final acceptance by LAWA.

## B. DESIGN

- 1. All HVAC packaged rooftop unit larger than 5 tons and pumps shall have motors in Variable Frequency/adjustable Speed Drives, Maximum distance allowed between VFD's and motors served shall be in accordance with CEC and manufacturers application guidelines.
- 2. Provide manufacturer's recommended space for a service access envelope around each AC unit, AHU, Pump, Boiler, Fan, Cooling Tower, Heat Exchanger, VAV box, Fan coil, Fans and accessories for service in all dimensions.
- 3. Provide note on the plan that the bottom of the VAV box shall be located maximum of 12 inches above ceiling for inspection and maintenance access of damper, coils, control panel, valves and other accessories.
- 4. Provide minimum of 24 inches clear space around the VAV box and Fan coil units for inspection and maintenance access.
- 5. All HVAC equipment hung or mounted shall be provided with vibration isolators and seismic restraints unless otherwise noted per manufacturer recommendation.
- 6. No Air Handling unit or AC unit shall be relocated outside the designated Mechanical Room.
- 7. No Air Handling unit or AC unit shall be relocated or built on the roof unless otherwise approved by LAWA EFMD.

#### C. CALCULATIONS

1. Calculations and compliance documentation for California Title 24, Part 6 energy code. Provide detailed engineering calculations for all systems prior to construction to confirm final sizes and equipment and system efficiencies and submit for approval by

#### AIRPORT MECHANICAL STANDARDS

QTA 30% SUBMITTAL 09/23/2016 Page 5 of 18

23 00 00

LAWA. Performance Criteria identify minimum levels of quality, materials and workmanship. Calculations to confirm overall system coefficient of performance meets or exceeds the basis of design presented in this document.

- 2. Cooling and heating load calculations shall be per the ASHRAE method. Load calculations will also conform to the California Energy Commission T-24 calculations, including safety factors. Cooling and heating load calculations shall be provided in formal submittal format for review at the completion of design development.
- 3. Define occupant density per ASHRAE Standard 62.

# D. TESTING, ADJUSTING AND BALANCING

Project specifications shall clearly indicate the following.

- 1. All installed HVAC system shall be air and water balanced by a certified third party balancing company approved by LAWA.
- 2. Testing Agency:
  - a. Total System Balance shall be performed by an independent, non-affiliated agency certified by the Associated Air Balance Council (AABC) which specializes in the balancing and testing, ventilating, and air conditioning systems, to balance, adjust, and test air moving and distribution systems, water systems and steam systems.
  - b. Minimum of 5 years as air balance and testing agency and proof of having successfully completed at least 5 projects of similar size and scope.
  - c. All work shall comply with applicable procedures and standard of "National Standards for Field Measurements and Instrumentation, Total System Balance" by the Associated Air Balance Council.
- 3. Test and Balance Reports
  - a. The Test and Balance agency shall prepare and submit minimum of three (3) copies of the Test and Balance Analysis to LAWA within five (5) working days of completion. This report shall contain, at a minimum:
    - 1) AABC Certification credential(s) for the responsible Air Balance Company Engineer of record and all certified technicians involved in the project.
    - 2) Project Summary and comments.

- 3) Table of contents and test forms for all systems.
- 4) Calibration certificates for all test equipment.
- 5) Drawings:
  - a) Full scale single line schematic drawings showing actual duct runs and outlet/inlet locations.
  - b) Drawings shall be in AutoCAD version 2002 or later format.
- 6) Copy of AABC National performance guaranty.
- 7) Copy of data for all supply fans.
- 8) Copy of data for the Coils.
- 9) Copy of data for the pumps.
- 4. Guarantee
  - a. Air Balance Testing agency shall provide an extended warranty of 90 days after completion of test and balance work for recheck or resetting of any outlet, supply air fan, VAV box, return/exhaust fan or pump as listed in test report
- E. BUILDING COMMISSIONING {23 08 00}
  - 1. Project Specifications shall clearly indicate the following:
    - a. An independent certified Building Commissioning agent shall provide commissioning services.
    - b. Minimum guidelines of commissioning shall be per ASHRAE Guideline: HVAC & R Technical Requirements for The Commissioning Process.
    - c. All installed HVAC system shall be commissioned prior to final acceptance by LAWA.
- F. HVAC PIPING {23 21 13, 23 23 00, 23 05 53}
  - 1. Equipment Vents: Schedule 40 black steel or Type L hard drawn copper pipe.
  - 2. Piping Identification Markings and Color Codes: Piping and Duct Identification Markings and Color Codes shall be in accordance with ANSI A13.1 standards. Markings shall include arrows indicating direction of flow. Markings shall be installed at a minimum of every 20' on straight runs where there are no visibility obstructions.

AIRPORT MECHANICAL STANDARDS

QTA 30% SUBMITTAL 09/23/2016 Page 7 of 18

23 00 00

In areas where visibility of pipe or duct is obstructed or numerous other pipes and ducts exist, markings shall be installed as approved to enable pipes and ducts to be easily traced along its entire path. Pipes shall be marked and color-coded.

- 3. Installation methods shall be in accordance to the latest edition of the Los Angeles Plumbing Code.
  - a. No piping connections shall be made through hot tapping method or cold tapping method. Provide connections with standard tee fittings and reducers.
  - b. Dielectric fittings and unions shall not be used on any piping. Provide a brass ball valve and a 6" brass nipple at each location where the piping transitions from copper to steel.
- 4. Thermometers and pressure gauges shall be provided on chilled and hot water supply and return lines at every Air Handling Unit

## G. MECHANICAL/MECHANICAL STORAGE/PUMP ROOM

- 1. No equipment other than Mechanical shall be allowed in the Mechanical room, mechanical storage room and pump room.
- 2. Mechanical rooms, mechanical storage rooms and pump rooms shall not be converted for lease space or similar.
- 3. No Air Handling unit or AC unit shall be relocated outside the designated Mechanical Room.

## H. COMPUTER ROOM (SMALL ROOM) {23 81 23.163}

- 1. Provide new split system AC unit manufactured by Liebert, Stulz-ATS or APC. It includes microprocessor, dirty filter alarm, humidifier, electric reheat, disconnect switch, oversized evaporator fan motor, condensate pump and tank, as well as phenolic coating on the condenser coil.
- 2. Condenser unit shall be on the roof, with minimum 4" mounting pad, vibration isolator, and 10.0 mils phenolic baked exterior coating corrosion protection.
- 3. Interlock split system AC units with Building Automation System (BAS) for remote monitoring and control.

## I. UPS/BATTERY ROOM {23 81 26}

- 1. Provide new split system manufactured by Carrier, Data-Aire, or Compu-Aire.
- 2. Condenser unit shall be on the roof, with minimum 4" mounting pad, vibration

isolator, and 10.0 mils phenolic baked exterior coating corrosion protection.

- 3. Battery Rooms shall be ventilated according to the type of batteries. Rooms with wet cell batteries shall be provided with a minimum six air changes per hour, and dry cell battery rooms shall be provided with a minimum of four air changes per hour and per the requirement of the Fire Marshall.
- 4. Battery rooms shall be maintained under negative pressurization by the exhaust system. Make-up air shall be through a diffuser from the AHU system.
- 5. Interlock exhaust fan with the Air Handling Unit (AHU) or AC unit and connect to BAS for remote monitoring and control.

## J. ELECTRICAL ROOM {23 81 26}

- 1. Provide new split system AC unit manufactured by Carrier, Data-Aire or Compu-Aire. It includes a wall mounted microprocessor, dirty filter alarm, humidifier, electric reheat, disconnect switch, oversized evaporator fan motor, condensate pump and tank, as well as phenolic coating on the condenser coil.
- 2. Condenser unit shall be on the roof, with minimum 4" mounting pad, vibration isolator, and 10.0 mils phenolic baked exterior coating corrosion protection.
- 3. Interlock split system AC units with BAS for remote monitoring and control.

# K. ELEVATOR MACHINE ROOM {23 81 26}

- 1. Provide new split system AC unit manufactured by Carrier, Data-Aire or Compu-Aire. It includes a wall mounted microprocessor, dirty filter alarm, humidifier, electric reheat, disconnect switch, oversized evaporator fan motor, condensate pump and tank, as well as phenolic coating on the condenser coil.
- 2. Condenser unit shall be on the roof, with minimum 4" mounting pad, vibration isolator, and 10.0 mils phenolic baked exterior coating corrosion protection.
- 3. Interlock split system AC units with BAS for remote monitoring and control.

# L. GENERAL EXHAUST {23 34 00}

- 1. The toilet rooms and janitor closets shall be under negative pressure and interconnected where possible to common exhaust fans.
- 2. Each restroom and janitor room shall be provided with adequate exhaust ventilation at minimum of 12 air changes per hour. Make up air shall be forced air from AC unit. Transfer air from ceiling or adjacent room not acceptable.

- 3. Provide with a minimum six air changes per hour ventilation rate.
- 4. Interlock the exhaust fan with the AHU and connect to BAS for remote monitoring and control.
- M. AIR SIDE DESIGN {23 31 00, 23 33 00, 23 36 00}
  - 1. Duct systems shall be designed with maximum velocities as follows:
    - a. Supply Ductwork: 1900 feet per minute for main ductwork. Pressure drop of 0.10 inch water gage per hundred feet for main ducts and 0.05 inch water gage per hundred feet for ducts downstream of VAV boxes.
    - b. Exhaust / Return Ductwork: 1800 feet per minute for main ductwork. Pressure drop of 0.10 inch water gage per hundred feet.
    - c. Ductwork shall be fabricated for appropriate pressure class.
  - 2. All occupied spaces shall meet room noise criteria (NC) of NC-35, except for conference and meeting rooms that shall be less than NC-30.
  - 3. Within ceiling spaces, flexible duct shall be used to connect the supply air diffuser/register to the rigid duct. Flexible duct shall not exceed 7 feet in length.
  - 4. Manual volume dampers shall be provided for every supply air outlet. The damper shall be located on the branch line serving the supply air outlet at the take-off from the main duct. Manual volume dampers shall be accessible. Provide access opening to manual volume dampers located in areas with gypsum board ceiling with the identification streamer/ tag in addition to Young regulator for remote operated manual volume dampers.
  - 5. Select and schedule new VAV terminal units per LAWA's approval.
    - a. All VAV terminal units shall be seismically braced to meet current code requirements. VAV boxes shall be supported without regard to adjacent ductwork and must be self-supporting. VAV terminal units shall be designed to resist seismic forces in all directions. Tension only bracing is not allowed; Compression struts are required. See Airport Structural Design Standards for additional information.
    - b. Unit support for VAV terminal units shall be designed by a California licensed Civil or Structural Engineer.
    - c. Unit support for VAV terminal units shall be submitted to LAWA for approval.

- 6. Within lease space, all VAV boxes, ductwork and registers/ grilles/ diffusers shall be new.
- 7. Within the lease space, the new VAV box shall have stand-alone DDC controls, BACnet compatible, open protocol, capable of future integrations with the building BAS.
- 8. Existing Ductwork:
  - a. Within lease space, if modifications are done to the existing ductwork only, any existing duct and register/grille/diffusers shall be cleaned by a third party certified duct cleaner. A video of the before and after cleaning shall be provided.

## N. AIR HANDLING UNIT (AHU) {23 74 13}

- 1. Provide 65% pre-filter, carbon filter, ionization unit and MERV 13 final filter as well as ultraviolet light for the coil. If possible, make revisions to the existing equipment to add these items. If not, advise LAWA.
- 2. Connect the AHU to BAS for remote monitoring and control.
- 3. Replace existing air handling units older than 20 years at LAX terminals with new units unless otherwise noted by LAWA. Units shall be listed by the California Energy Commission and comply with T-24 requirements.
- 4. All AHU higher than 15 tons shall be factory tested, witnessed and certified by LAWA EFMD personnel and LAWA Inspector prior to shipping to the job site.

# O. BUILDING AUTOMATION SYSTEM (BAS) {25 20 00}

- 1. Investigate if the building has an existing BAS that can be reused.
- 2. The BAS shall monitor and control all building mechanical systems and equipment. Each mechanical system shall be complete with factory controls, and shall be specified with accessory integration modules, hardware, computer cards, and software required for full and complete integration to the BAS. The BAS shall monitor mechanical equipment for failure alarms, and all operating set point variables shall be capable of being reset.
- 3. BAS shall include equipment graphical representation and floor plans showing layout of equipment and control points.
- 4. Direct Digital Control: The digital algorithms and pre-defined arrangements included in the BAS software to provide direct closed-loop control for the designated

## AIRPORT MECHANICAL STANDARDS

QTA 30% SUBMITTAL 09/23/2016 Page 11 of 18

23 00 00

equipment and controlled variables. Inclusive of Proportional, Derivative and Integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like. BAS shall have web based monitoring and control capabilities.

- 5. The BAS shall consist of networked controllers capable of stand-alone control and integrations with the existing building BAS.
- P. Terminal HVAC System and Pump {23 74 13}
  - 1. Submit schematic piping flow diagrams and control valves for the Terminal pump rooms and HVAC systems. Schedule all coil and pump sizes and estimated capacities. Include all control valves in piping diagram. Provide test and balance data indicating the existing flow distribution in the Central Terminal Area (CTA). List all control valves. Identify all chilled water pumps, including branch pumps at ends of existing loop to any coils or systems. Verify if there are any existing 3-way valves or other valve-bypasses, which are diverting flow to the return system.
  - 2. Prepare a load calculation to determine design criteria and recommended capacities.
  - 3. Submit summary report to LAWA as part of Basis of Design Submittal to whether the pump can be simply adjusted for flow, left alone, impeller or motor changed or whether a complete pump change-out is required.
  - 4. Work shall be phased to keep building operations uninterrupted.
  - 5. The system design shall provide flexibility in terms of operation and renovation. Ensure that all components and equipment are readily accessible for maintenance and replacement.
  - 6. The operation, reliability and redundancy of the existing CUP systems shall be maintained throughout the construction. All work requiring a temporary shutdown of services shall be coordinated with LAWA to minimize disruptions.
  - 7. Site investigation: The Contractor shall conduct a site investigation and thorough survey and prepare drawings as necessary to complete construction documents and phasing plans.
  - 8. Field Painting: Provide field painting of all equipment, piping, and miscellaneous appurtenances. Provide labeling and identification of all equipment and piping. LAWA to select colors.
  - 9. All systems shall be properly cleaned and flushed and tested prior to energizing.
  - 10. Accessibility: Install all components, valves, control devices, etc. where they are accessible for operation and maintenance without use of portable ladders. Provide

# AIRPORT MECHANICAL STANDARDS

QTA 30% SUBMITTAL 09/23/2016 Page 12 of 18

23 00 00
platforms, stairways, fixed ladders, etc. as required.

- 11. Pipe Sizing: Piping shall be sized for maximum flows in the chilled water pipe not to exceed 12 feet per second in mains and 10 feet per second in branches to coils and pumps. Maximum pipe velocity of 12 feet per second (fps) for piping 8" and larger. All piping shall be sized to not exceed a pressure drop of 4-ft head per 100 feet of piping. The dedicated branch coil piping runs out to each coil shall be sized for the individual coil size and chiller flow capacity calculated at new design conditions.
- 12 Provide individual sub-meter for the chilled water and heating hot water lines from the CUP to each tenant area with option for future remote data gathering connection

# PLUMBING SYSTEMS

- A. SUBMITTTALS
  - 1. Design Phase: A complete package of design calculations and information on the plans shall be provided for review by LAWA. Calculations and plans shall be provided with whatever markings or notations that are needed to make them clearly understandable.
- B. DESIGN
  - 1. The plumbing system designer shall consider using such techniques as controlling hot water temperatures, water pressures, providing faucets with flow restrictors. The economic use of thermal insulation, automatic shutdown of water heating and circulating systems, use of occupancy sensor for automatic flushing, use of automatic closing faucets, and using minimum energy consuming equipment to provide maximum energy efficiency. The plumbing system designer should understand how the building consumes energy. When this is understood, energy conservation design practices should become integrated into the building allowing it to operate more efficiently and use less energy, while meeting the needs of the user.
  - 2. Provide information on the existing plumbing lines and plumbing system that are affected by new work. Provide separate riser diagrams for the water, waste/ vent, and gas systems. The water riser shall show the entire system from the main water meter to the most remote plumbing fixture outlet. The waste/vent riser shall show the entire system from the street sewer main point of connection to the most remote plumbing fixture outlet. The gas riser shall show the entire system from the main gas meter to the most remote gas outlet.

## C. CALCULATIONS

- 1. Existing Plumbing Systems:
  - a. Provide a table of the fixture unit count with the total of existing fixtures and

## AIRPORT MECHANICAL STANDARDS

new fixtures. If the number of new fixtures is more than the number of removed fixtures, Provide hydraulic calculations of the water system.

- b. If pipe sizing for modified system is per Appendix A of the LA Plumbing Code, verify that the pipe sizing criteria corresponds with the existing plumbing system.
- D. PIPING {22 11 00, 22 13 00, 22 14 00}
  - 1. Piping should meet the following requirements:
    - a. Discharge line from Trash Compactor ABS (to where it meets the Point of Connection to the existing waste line).
    - b. AC unit condensate drains Copper Type M.
    - c. Equipment vents Black Carbon Steel, ASTM A53, Type S (Seamless) or Type E (Electric-Resistance Welded), Grade B, Schedule 40 or Copper Type L.
- <u>NOTE</u>: 50-50 solder shall not be used for any pipe jointing. No direct buried copper piping shall be permitted inside or outside terminals or other buildings. The use of ferrous metal pipe and fittings under slabs shall be reviewed by LAWA on a case by case basis.
  - 2. Installation methods shall be in accordance to the latest edition of the Los Angeles Plumbing Code.
    - a. No piping connections shall be made through hot tapping method or cold tapping method. Provide connections with standard tee fittings and reducers.
    - b. Dielectric fittings and unions shall not be used on any piping. Provide a brass ball valve and a 6" brass nipple at each location where the piping transitions from copper to steel.
  - 3. Horizontal drainage pipe shall be provided with a cleanout at its upper terminal, and each run of piping, that is more than 75 feet in total developed length shall be provided with a cleanout for each 75 feet, or fraction thereof, in length of such piping.

## E. VALVES {220523, 230523}

- 1. Isolation valves shall be class 150 lug type butterfly valves for piping 2-1/2" and larger and bronze ball valves for piping 2" and under.
- 2. Butterfly valves 6" and larger shall have worm gears.
- 3. Valves 8 feet and higher above the floor to have chain wheel operators.

## AIRPORT MECHANICAL STANDARDS

QTA 30% SUBMITTAL 09/23/2016 Page 14 of 18

- 4. Shut off valves shall be provided on every branch line from the main line.
- 5. Valves shall be accessible.
- F. PUMPS {220610}
  - 1. Terminal Pump Room:
    - a. Pumps shall be base mounted horizontal, split-case or end suction centrifugal type. Pumps located on ground or grade level will be mounted to concrete bases with vibration pads. Pumps located on structural floors shall have concreted filled inertia vibration bases. All pumps to have flex connections, isolation valves, strainer, spring loaded check valves, pressure gauge, and flow measurement device. Pumps manufacturer shall be Armstrong, Bell & Gossett, or Taco.
  - 2. In-Line Circulating Pumps {22 34 00}
    - a. Pumps shall be all stainless steel for domestic water service. Provide a line size ball valve on suction and discharge side of pump. Provide unions or bolted flange connection on each side of pump. Pressure gage and thermostat are required on in-line circulators.
    - b. The designer shall study water usage periods and shall operate pumps just prior to usage periods and limit operation as much as possible. A 7-day 12- hour timer should be installed to control such pump operation especially during peak demand periods as an energy reduction measure.
  - 3. Submersible Pumps {22 13 00, 22 14 00}
    - a. Generally, submersible pumps are avoided where possible except electric power manholes where high voltage switches or tap boxes are installed. Diaphragm actuated pumps are preferred rather than float actuated pumps.
  - 4. Sump Pumps {22 14 00}
    - a. Commercial type duplex sump pump is required. Explosion proof motor is required in a mechanical/electrical equipment room containing high voltage switchgear or motor control panels.
    - b. Mechanical alternator, check valves, automatic float switch with rod, rod guide, copper float, and high water alarm bell shall be provided on duplex pump.
    - c. Pumps shall be of the wet-pit type complete with gas tight sump cover, vent, curb ring, grease lubricated, including alemite fittings extended to pump base

AIRPORT MECHANICAL STANDARDS

QTA 30% SUBMITTAL 09/23/2016 Page 15 of 18

23 00 00

plate.

- d. Pumps shall be heavy duty, vertical centrifugal, open non-corrosive impeller type with vertical drip-proof type motor with anti-friction grease lubricated bearings.
- e. Pumps shall be provided with separate circuit and circuit breaker.
- f. Where pumps are installed to provide protection for mechanical/electrical equipment and/or critical equipment, in addition to high water alarm bell in the area, alarm contacts should be provided for a central monitoring system.
- 5. Sewer Ejector Pumps {22 13 00}
  - a. Sewer ejector pump design and selection design criteria are the same as those listed for "Sump Pumps" except sewer ejector pumps shall be of the standard three (3) inch, non-clog type specifically designed and installed for purpose intended.
- G. Restroom {22 05 00, 22 05 23, 22 11 00, 22 13 00, 22 40 00}
  - 1. Public and Private Restroom Design including Janitorial plumbing fixtures and accessories shall be in compliance with LAWA Public Restroom Design Guidelines and Specification Updated Version July 7, 2008.
  - 2. All exposed metal work at fixtures shall be brass with chromium plate. All faucets, fittings, supply stops for fixtures, and similar devices shall be one (1) manufacturer unless otherwise required. Each fixture shall contain standardized interchangeable operating units made up of separate renewable stem, seat, washer retainer, and nut. All faucets and fittings must close with the water pressure. All fixtures shall be installed with supply stops/valves accessible at the fixtures. Fixtures shall be electronic with manual over-ride.
  - 3. Provide a pipe chase, minimum 30" with door.
  - 4. Provide a separate header for each restroom for the cold water and hot water lines.
  - 5. Each restroom hot and cold water supply shall be provided with accessible shut off valves.
    - a. Provide a shut-off valve at each header within the restroom, in the accessible pipe chase.
  - 6. Waste cleanout for maintenance shall be provided for each plumbing fixture.
  - 7. Each restroom shall be provided with floor drain and trap primer.

## AIRPORT MECHANICAL STANDARDS

- 8. Public restroom shall be provided with hose bib connection for cleaning.
- 9. Each private or public restroom with flushometer valve water closet and/or urinal shall be provided with water hammer arrester in the domestic cold water line.
- H. Standard Water Heaters {22 33 00, 22 34 00}
  - 1. Water Heaters shall adhere to the following:
    - a. Water heaters shall be completely copper lined.
    - b. Gas water heaters shall have automatic gas shut-off device and be equipped with an American Gas Association certified draft hood. Water heaters shall utilize electric ignition devices.
    - c. Electric water heaters shall be U. L. listed.
    - d. Electric water heaters shall be provided with submersed type thermostat. e) All standard water heaters shall have a three (3) year limited warranty.
    - e. Energy saver water heaters shall meet ASHRAE Standards for Energy Efficiencies, latest edition.
    - f. Water heater drains shall have valves and shall be plumbed to a floor drain with Copper Type L piping.
    - g. All water heaters shall be readily accessible.
    - h. Electric water heaters located in ceiling/attic spaces shall be accessible by permanent ladder or stairway, an unobstructed walkway (minimum 24" in width) and a 30"x30" minimum work platform with lights located over the walkway and service area. Locate the switch at the access opening.
- I. Roof and Overflow Drains {22 14 00}
  - 1. Roof and overflow drains shall be compatible with roof system. The designer shall use two (2) inches per hour as a minimum rainfall intensity guideline for sizing roof drains.
- J. Backflow Preventers {22 11 00}
  - 1. Where the service line provides potable water for domestic service, a backflow preventer shall be installed on any domestic water line serving other closed or chemically treated systems that could foreseeably contaminate the potable water line.
  - 2. Guidelines for selection of backflow prevention shall be in accordance with LADWP

#### AIRPORT MECHANICAL STANDARDS

QTA 30% SUBMITTAL 09/23/2016 Page 17 of 18 Water Service Rule 16-D, August 2006 or latest revision. Copy can be obtained from the Los Angeles Department of Water and Power. Water quality and Distribution division, 111 North Hope Street, Room 1213, Los Angeles, California 90012.

- K. Grease Traps or Interceptors {22 13 00}
  - 1. Waste water from disposers, sinks, dishwashers, floor drains and floor sinks in food facilities shall drain to a grease collection system or through a grease trap or grease interceptor serving one or more facilities. Installation shall comply with the latest edition of the Los Angeles Plumbing Code.
  - 2. Grease interceptors shall not be located in any Mechanical Rooms.
- L. Food Services {22 40 00}
  - 1. Sinks used for food service shall each have a food grinder.
- M. Sub-meter {22 11 00, 22 07 00}
  - 1. Domestic water and Gas lines serving each concession area, terminal or other buildings shall be provided with individual sub meter with option for future remote data gathering connection.

## FIRE PROTECTION SYSTEMS

- A. SUBMITTAL
  - 1. Design Phase: A complete package of design calculations and information on the plans shall be provided for review by LAWA. Calculations and plans shall be provided with whatever markings or notations that are needed to make them clearly understandable.
- B. IT Rooms {21 22 00, 21 13 16}
  - 1. Computer rooms with LAWA IT Equipment shall be protected with FM 200 system and Pre-Action system. The sequence of operation shall have the FM 200 system primary with the secondary Pre-Action system.
- NOTE: If any discrepancies are found, the manufacturers name listed in the Airport Mechanical Equipment Standards has precedence over Airport Mechanical Design Standard list of manufacturers.

## END OF SECTION

## AIRPORT MECHANICAL STANDARDS

## SECTION 23 01 30 HVAC AIR-DISTRIBUTION SYSTEM AND DUCT CLEANING

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

## 1.2 SUMMARY

A. Section includes cleaning of HVAC air-distribution components consisting supply ducts, return ducts and ductwork accessories located within the area of project scope of work.

# 1.3 DEFINITIONS

- A. ASCS: Air systems cleaning specialist.
- B. NADCA: National Air Duct Cleaners Association.

# 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For an ASCS.
- B. Strategies and procedures plan.
- C. Cleanliness verification report.

## 1.5 QUALITY ASSURANCE

- A. ASCS Qualifications: NADCA.
  - 1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
  - 2. Supervisor Qualifications: Certified as an ASCS by NADCA.
- B. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.

PART 2 - PRODUCTS

## PART 3 - EXECUTION

- 3.1 EXAMINATION
  - A. Examine HVAC air-distribution duct system to determine appropriate methods, tools, and equipment required for performance of the Work.
  - B. Perform "Project Evaluation and Recommendation" according to NADCA ACR 2006.
  - C. Prepare written report listing conditions detrimental to performance of the Work.
  - D. Proceed with work only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:
  - 1. Supervisor contact information.
  - 2. Work schedule including location, times, and impact on occupied areas.
  - 3. Methods and materials planned for HVAC ductwork.
  - 4. Required support from other trades.
  - 5. Equipment and material storage requirements.
  - 6. Exhaust equipment setup locations.
- B. Use the existing service openings, as required for proper cleaning, at various points of the HVAC duct system for physical and mechanical entry and for inspection.
- C. Comply with NADCA ACR 2006, "Guidelines for Constructing Service Openings in HVAC Systems" Section.
- 3.3 CLEANING
  - A. Comply with NADCA ACR 2006.
  - B. Remove visible surface contaminants and deposits from within the HVAC duct system.
  - C. Systems and Components to Be Cleaned:

HVAC AIR DISTRIBUTION SYSTEM AND DUCT CLEANING 23 01 30

- 1. Ductwork:
  - a. Supply-air ducts, including turning vanes.
  - b. Return-air ducts.
- D. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC duct system during the cleaning process.
- E. Particulate Collection:
  - 1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
  - 2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,
- F. Control odors and mist vapors during the cleaning and restoration process.
- G. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.
- H. Duct Systems:
  - 1. Create service openings in the HVAC duct system as necessary to accommodate cleaning.
  - 2. Mechanically clean duct systems specified to remove all visible contaminants so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
- I. Debris removed from the HVAC duct system shall be disposed of according to applicable Federal, state, and local requirements.
- J. Mechanical Cleaning Methodology:
  - 1. Source-Removal Cleaning Methods: The HVAC duct system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC duct system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC duct system or negatively alter the integrity of the system.
    - a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.

HVAC AIR DISTRIBUTION SYSTEM AND DUCT CLEANING 23 01 30

- b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC duct system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC duct system components or damage porous surface materials such as duct and duct liners.
- 2. Cleaning Mineral-Fiber Insulation Components:
  - a. Fibrous-glass thermal or acoustical insulation elements present in ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR 2006.
  - b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
  - c. Fibrous materials that become wet shall be discarded and replaced.
- K. Antimicrobial Agents and Coatings:
  - 1. Apply antimicrobial agents and coatings if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
    - a. When used, antimicrobial treatments and coatings shall be applied after the system is rendered clean.
  - 2. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.
  - 3. Sanitizing agent products shall be registered by the EPA as specifically intended for use in HVAC systems and ductwork.

# 3.4 CLEANLINESS VERIFICATION

- A. Verify cleanliness according to NADCA ACR 2006, "Verification of HVAC System Cleanliness" Section.
- B. Verify HVAC duct system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC duct system, including biocidal agents and coatings.
- C. Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC duct system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.

HVAC AIR DISTRIBUTION SYSTEM AND DUCT CLEANING 23 01 30 QTA 30% SUBMITTAL 09/23/2016 Page 4 of 5

- D. Additional Verification:
  - 1. Perform surface comparison testing or NADCA vacuum test.
  - 2. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.
- E. Prepare a written cleanliness verification report. At a minimum, include the following:
  - 1. Written documentation of the success of the cleaning.
  - 2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
  - 3. Surface comparison test results if required.
  - 4. Gravimetric analysis (nonporous surfaces only).
  - 5. System areas found to be damaged.
- F. Photographic Documentation: Provide photographs of prior to duct cleaning and after duct cleaning.

## 3.5 RESTORATION

- A. Restore and repair HVAC air-distribution components consisting supply ducts, return ducts and ductwork accessories according to NADCA ACR 2006, "Restoration and Repair of Mechanical Systems" Section.
- B. Restore service openings capable of future reopening. Comply with requirements in Section 233100" HVAC Ducts and Casing." Include location of service openings in Project closeout report.
- C. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Section 233100 "HVAC Ducts and Casing."
- D. Replace damaged insulation according to Section 230700 "HVAC Insulation."
- E. Ensure that closures do not hinder or alter airflow.
- F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.
- G. Reseal fibrous-glass ducts. Comply with requirements in Section 233100 "HVAC Ducts and Casing."

## END OF SECTION

HVAC AIR DISTRIBUTION SYSTEM AND DUCT CLEANING 23 01 30

## 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.
- B. 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 101
      - 5) NFPA 90A

- 6) NFPA 13
- 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.
  - 2. Submit the following items as hereinafter specified:
    - a. Names and qualifications of test and balance agencies.
    - b. Layout Shop Drawings showing existing conditions including all other trades.
    - c. Coordinated Drawings.
    - d. As-built Record Drawings (Submitted to Client).
    - e. Record Files (Submitted to Client).
    - f. Operating and Maintenance Manuals.
    - g. Welding certificates.

- B. Operation and Maintenance Data:
  - 1. Maintenance Manuals:
    - a. Furnish two sets of maintenance manuals, each containing items specified below:
      - 1) Furnish manuals to LAWA before final acceptance of the mechanical work.
    - b. Definitions Applicable to the Maintenance Manuals:
      - 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., "147."
    - 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.
- C. Substitutions:
  - 1. See Division 1, Substitution Procedures.
  - 2. The bid shall include products per paragraph 2.01 MANUFACTURERS. Engineer will consider formal requests for substitution of products in place of those specified only if these are submitted with the bid for evaluation and in accordance with all conditions specified hereafter.
  - 3. Requests for substitutions after award of contract shall be considered only in case of product unavailability. Product unavailability shall be verified in writing by manufacturer.
  - 4. Submit separate request for each substitution at time of bid, or at appropriate time thereafter in the event of non-availability of item included in bid. Support each request with:
    - a. Complete data substantiating compliance of proposed substitution with requirements stated in Contract documents.
    - b. Data relating to changes in construction schedule.

- c. Any effect of substitution on other work in this and other Divisions, and any other related contracts, and changes required in other work or products.
- 5. Contractor shall be responsible at no extra cost to Owner for any changes resulting from proposed substitutions which affect work of other Sections or Divisions, or related contracts.
- 6. Claims for additional costs caused by substitution which may subsequently become apparent shall be met by the Contractor.
- 7. Substitutions will not be considered for acceptance when acceptance will require revision of Contract Documents, unless Contractor bears cost of re-design.
- 8. Where any re-design of electrical, mechanical or other work is required due to substitution, arrangement or equipment layout other than herein specified or shown:
  - a. Arrange for required redesign by Engineer.
  - b. Pay all costs for such redesign.
  - c. Contractor shall perform such redesign.
  - d. Produce detailed plans at no extra cost to Owner.
  - e. All subject to Architect's approval.
- 9. Substitute products shall not be ordered or installed without prior written approval/acceptance by Architect.
- 10. Engineer will have sole discretion to determine acceptability of proposed substitutions and reserves the right to reject any such substitution.
- 11. Approval of substitutions shall not relieve Contractor from full compliance with requirements of Contract documents.
  - a. Contractor shall assure that each mechanical and electrical trade has coordinated work with other trades. Stamp each layout submittal and sign to certify that these layouts have been coordinated.
- D. Layout (Shop) Drawings:
  - 1. Submit layout drawings indicating work within mechanical rooms areas containing boilers, chillers, cooling towers, air handlers or pumps, areas containing acoustically lined ductwork, food service areas and for any areas. See Division 1 specification sections for additional requirements on layout drawings.
  - 2. Layout drawings for mechanical rooms shall be at a scale of 1/4"=1'-0".

23 05 00

- 3. Prepare layout shop drawings for all areas.
- 4. From the layout drawings, prepare and submit coordinated drawings as herein specified below.
- E. Coordinated Drawings:
  - 1. This Contractor shall prepare coordinated shop drawings which shall show work of all trades including, but not limited to:
    - a. Items noted in the Supplemental General conditions.
    - b. Coordinated Ductwork with penetrations at floors, walls, ceiling and roof.
    - c. Piping, including:
      - 1) HVAC, plumbing and fire protection.
      - 2) Minor Piping, such as drains, air vents, condensate piping, etc.
      - 3) Sleeves and penetrations.
      - 4) Expansion devices, anchors, guides and hangers.
    - d. Mechanical Equipment.
    - e. Supports and suspension devices.
    - f. Ductwork/Piping high points and low points.
    - g. Electrical Equipment.
    - h. Main electrical conduits and bus ducts.
    - i. Equipment support and suspension devices including hangers, supports and bracing.
    - j. Structural and Architectural constraints including:
      - 1) Beams, braces, trusses, flanges, constraints, walls, openings ratings, doors, wall types, glazing.
    - k. Show location of:
      - 1) Valves.
      - 2) Chemical Treatment.

- 3) Piping specialties.
- 4) Dampers.
- 5) Access doors.
- 6) Control and electrical panels.
- 7) Disconnect switches
- 8) Others as required.
- 2. Drawings shall indicate coordination with work in other Divisions which must be incorporated in mechanical spaces, including, but not limited to:
  - a. Irrigation equipment and piping.
  - b. Elevator equipment.
  - c. Cable trays not furnished under Division 26.
  - d. Computer equipment.
  - e. Others, as required.
- 3. Provide sections and elevations for all mechanical rooms, mechanical areas, areas with routed duct mains, areas with routed piping mains, and areas adjacent to the existing structure.
- 4. Preparation of drawings:
  - a. Prepare reproducible CADD drawings.
  - b. Submit to other trades for review of space allocated to all trades.
  - c. Revise drawings to compensate for requirements of existing conditions and conditions created by other trades.
- 5. Final prepared drawings shall show that other trades affected have made reviews and signed, by each trade, at completion of coordination.
- 6. Coordinated shop drawings shall be for all areas.
- 7. Contractor is to assure that each trade has coordinated work with other trades, prior to submittal.
- F. As-built (Record) Drawings:

- 1. Provide after installation is complete. Final sign-off and Owner acceptance will not occur prior to submission of as-built drawings to Owner.
- 2. Indicate as-built conditions and all revisions that occurred subsequent to "Coordinated Drawings" submittal, fully illustrating all revisions made by all trades in the course of work.
- 3. Dimension physical locations of ductwork, and piping with reference elevations and distances above finished floors, below beams, from wall faces, underground (invert elevations) and from column lines.
- 4. Exact location, type and function of concealed valves, dampers, controllers, piping, air vents, piping drains and isolators.
- 5. Indicate all equipment sizes and capacities and tag numbers.
- 6. Provide drawing on reproducible CADD mylar.
- 7. These drawings shall be for as-built record purposes for the Owner's use and are not considered shop drawings.
- G. Record Files:
  - 1. Provide 5 (five) electronic file copies of the As-built CADD drawings in the media (CDROM, Disks, Tape, etc.) of Owner's choice.
  - 2. Include hard copy and electronic copy of file naming convention, layering standards, drawing index and file descriptions.
  - 3. Electronic files shall be modifiable and shall include all associated referenced background files.
- H. Operating Instructions, Maintenance Manuals and Parts Lists:
  - 1. Before requesting acceptance of work, submit one set for review by Architect.
  - 2. After review, furnish five printed and bound sets.
  - 3. Include:
    - a. Manufacturer's name, model number, service manual, spare-parts list, and descriptive literature for all components, cross referenced and numbered on record drawings and in accordance with Title 24, as required.
    - b. Maintenance instructions.
    - c. Listing of possible breakdown and repairs.

- d. Instruction for starting, operation and programming.
- e. Detailed and simplified one line, color coded flow and wiring diagram.
- f. Field test report, including:
  - 1) Instrument set points.
  - 2) Normal operating valves.
- g. Name, address and phone number of contractors equipment suppliers and service agencies.
- h. Assemble manufacturer's equipment manuals in chronological order, following the specification alpha-numeric system, in heavy duty 3-ring binders clearly titled on the spine and front cover with appropriate index dividers.
- I. Quantity of Submittals Required:
  - 1. Layout (Shop) Drawings and Coordinated Drawings:
    - a. Submit two prints and one electronic copy. Coordinate with project manager.
    - b. Upon review, prints will be annotated and returned and retained by the Engineer.
    - c. Copies of these prints and electronic copy will serve as record copies for Architect.
  - 2. Product Data (brochures):
    - a. Submit two copies of product data in electronic format.
    - b. Upon review, electronic copy will be returned.
    - c. Five (5) copies will be returned.
    - d. If comments are required, they will be returned with each copy.
    - e. One (1) copy will be retained by the Engineer.

## 1.4 RELATED WORK AND REQUIREMENTS

A. Carefully check the documents of each section with those of other sections and Divisions. Ascertain the requirements of any interfacing materials or equipment being furnished and/or installed by those sections and Divisions, and provide the proper installation and/or required interface.

COMMON WORK RESULTS FOR HVAC

23 05 00

- B. As a minimum requirement and condition, the Contractor shall provide CADD generated drawings (for the purpose of Layout Drawings, Coordinated Drawings, As-built Drawings and Record Drawings) with a proven layering standard. Deviation from this requirement shall be:
  - 1. At the sole discretion of the Engineer.
  - 2. Submitted as a substitution within the specified time frame.
- C. Related work specified elsewhere:
  - 1. Providing temporary heat.
  - 2. Providing finish painting, including pipe stenciling.
  - 3. Access doors.
  - 4. Trench covers and frames.
  - 5. Providing chimney cleanout door and thimble.
  - 6. Excavating and backfilling under building.
  - 7. Excavating and backfilling.
  - 8. Louvers in doors.
  - 9. Undercut doors.
  - 10. Wall louvers and screens.
  - 11. Plenums other than sheet metal.
  - 12. Flashing.
  - 13. Shaft gratings.
  - 14. Equipment platforms.

# 1.5 QUALITY ASSURANCE

- A. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.
- B. Supply all equipment and accessories new and free from defects.
- C. Supply all equipment and accessories in compliance with the applicable standards and with all applicable national, state and local codes.

- D. All items of a given type shall be the products of the same manufacturer.
- E. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- F. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 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.

#### 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.
- 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.

<b>GUARANTEED MINIMUM FULL LOAD EFFICIENCY</b>		
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

a. All fan and pump motors shall be of the premium efficiency type, NEMA Design A or B, continuous rated:

## 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.

#### COMMON WORK RESULTS FOR HVAC

QTA 30% SUBMITTAL 09/23/2016 Page 13 of 19

- 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 1/2 inch (13 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. Design working pressures.
- g. Motor horsepower and/or current rating; equipment current rating; voltage characteristics.
- h. Wiring diagrams for all equipment and control systems under this section requiring electrical connections.
- i. 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.
    - 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.
    - 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

#### COMMON WORK RESULTS FOR HVAC

QTA 30% SUBMITTAL 09/23/2016 Page 16 of 19 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.

## COMMON WORK RESULTS FOR HVAC

QTA 30% SUBMITTAL 09/23/2016 Page 17 of 19

- 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

## SECTION 23 05 16 EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

# PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, Division 23 Specification Sections, and Common Work Requirements for HVAC apply to the work specified in this Section.
- B. Refer to commissioning specification sections for requirements that are applicable to Division 23.

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Metal-bellows expansion joints.
  - 2. Expansion compensators.
  - 3. Rubber expansion joints.
  - 4. Flexible-hose expansion joints.
  - 5. Packed slip expansion joints.
  - 6. Pipe bends and loops.
  - 7. Alignment guides and anchors.
  - 8. Seismic joints.
- B. This is a performance based specification and Contractor shall "Design-Built" the expansion and contraction for the piping systems. Provide shop drawings and calculations to comply with this section. Provide seismic joints for HVAC system (piping, ductwork, etc.) at all building seismic joints.

#### 1.3 DEFINITIONS

- A. BR: Butyl rubber.
- B. Buna-N: Nitrile rubber.
- C. CR: Chlorosulfonated polyethylene synthetic rubber.
- D. CSM: Chlorosulfonyl-polyethylene rubber

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING 23 05 16 QTA 30% SUBMITTAL 09/23/2016 Page 1 of 11

- E. EPDM: Ethylene-propylene-diene terpolymer rubber.
- F. NR: Natural rubber.
- G. PTFE: Polytetrafluoroethylene plastic.
- 1.4 PERFORMANCE REQUIREMENTS
  - A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.
  - B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.
  - C. Expansion Calculations:
    - 1. Chilled water temperature: 42-50 deg F (10 deg C).
    - 2. Hot water heating: 210 deg F (100 deg C).
    - 3. Use above data unless otherwise noted.

# 1.5 DELIVERY, STORAGE AND HANDLING

A. Accept expansion fittings and connectors on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

# 1.6 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Delegated-Design Submittal: For each anchor and alignment guide 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. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
  - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
  - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
  - 4. Schedule: Indicate type, manufacturer's number, size, material, temperature and pressure rating, end connections, and location for each expansion joint.
- C. Welding certificates.

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING 23 05 16 QTA 30% SUBMITTAL 09/23/2016 Page 2 of 11

- D. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.
- E. Maintenance Data: For pipe expansion joints to include in maintenance manuals. Include adjustment instructions.
- 1.7 QUALITY ASSURANCE
  - A. Design expansion compensation system under direct supervision of a professional engineer experience in design of this work and license in the State of California.
  - B. Welding Qualifications: Qualify procedures and personnel according to the following:
    - 1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code Steel."
    - 2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

## PART 2 - PRODUCTS

### 2.1 EXPANSION JOINTS

- A. Metal-Bellows Expansion Joints: ASTM F 1120, circular-corrugated-bellows type with external tie rods.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Adsco Manufacturing, LLC.
    - b. Anamet, Inc.
    - c. Badger Industries.
    - d. Expansion Joint Systems, Inc.
    - e. Flex-Hose Co., Inc.
    - f. Flexicraft Industries.
    - g. Flex-Pression, Ltd.
    - h. Flex-Weld, Inc.
    - i. Hyspan Precision Products, Inc.
    - j. Metraflex, Inc.

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING 23 05 16

- k. Piping Technology & Products, Inc.
- 1. Proco Products, Inc.
- m. Senior Flexonics, Inc.; Pathway Division.
- n. Tozen America Corp.
- o. Unaflex Inc.
- p. WahlcoMetroflex.
- 2. Metal-Bellows Expansion Joints for Copper Piping: Multiple-ply phosphor-bronze bellows, copper pipe solder end connections, and brass shrouds.
- 3. Metal-Bellows Expansion Joints for Stainless-Steel Waterway: Single-ply stainless-steel bellows, stainless-steel-pipe end connections, and steel shroud.
- 4. Metal-Bellows Expansion Joints for Steel Piping: Multiple-ply stainless-steel bellows, self- equalizing with reinforcing rings, internal sleeve, steel pipe end connections, and carbon-steel shroud.
- 5. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
- 6. Configuration: Double-bellows type with base, unless otherwise indicated.
- 7. End Connections: Flanged or weld.
- B. Expansion Compensators: Double-ply corrugated steel, stainless-steel, or copper-alloy bellows in a housing with internal guides, anti-torque device, and removable end clip for positioning.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Adsco Manufacturing, LLC.
    - b. Flexicraft Industries.
    - c. Flex-Pression, Ltd.
    - d. Flex-Weld, Inc.
    - e. Hyspan Precision Products, Inc.
    - f. Metraflex, Inc.
    - g. Senior Flexonics, Inc.; Pathway Division.
h. Unaflex Inc.

- 2. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
- 3. Configuration for Copper Piping: Two-ply phosphor-bronze or stainless-steel bellows and bronze or stainless-steel shroud.
- 4. Configuration for Steel Piping: Two-ply stainless-steel bellows and carbon-steel shroud.
- 5. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
- 6. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint or threaded.
- 7. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
- 8. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged or threaded.
- C. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Flex-Hose Co., Inc.
    - b. Flexicraft Industries.
    - c. Flex-Pression, Ltd.
    - d. Metraflex, Inc.
  - 2. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solderjoint end connections.
    - a. NPS 2 and Smaller: Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
    - b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
  - 3. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged end connections for NPS 2-1/2 and larger.
    - a. NPS 2 and Smaller: Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
    - b. NPS 2-1/2 to NPS 6: Stainless-steel hoses and single-braid, stainless-steel

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING 23 05 16 QTA 30% SUBMITTAL 09/23/2016 Page 5 of 11 sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.

- c. NPS 8 to NPS 12: Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.
- D. Packed Slip Expansion Joints: ASTM F 1007, carbon-steel, packing type designed for repacking under pressure and pressure rated for 250 psig at 400 deg F minimum. Include asbestos-free PTFE packing, compound limit stops, and drip connection.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Advanced Thermal Systems, Inc. Thermal Pak-Type TP2 or comparable product by one of the following:
    - a. Adsco Manufacturing, LLC.
    - b. Advanced Thermal Systems, Inc.
    - c. Hyspan Precision Products, Inc.
  - 2. Configuration: Double-joint class with base, unless otherwise indicated.
  - 3. End Connections: Flanged or weld ends to match piping system.
  - 4. Slip: ASTM A53 Grade "B" seamless pipe. Schedule 80 for NPS 1 1/2 to NPS 14 (DN 40 to DN 350) and Schedule 60 for NPS 16 to NPS 24 (DN 400 to DN 600).
    - a. Wall thickness after machining not reduced by more than 1/3 inch (3.1 mm).
    - b. Double layer of chrome plating, with minimum thickness of 0.001 inch (0.03 mm) after each buffing. First layer crack-free hard chrome and second layer standard hard chrome.
  - 5. Packing Cylinder: Welded steel with internal acme thread and male threaded plunger. Cylinder welded directly to stuffing box.

# 2.2 SEISMIC JOINTS

- A. Provide V-loop flexible type seismic joint by Hyspan, Mason or Metraflex.
- B. Angular motion of plus and minus 7.5 degrees minimum and torsional motion of 360 degrees.
- C. Movement shall be +/- 12-inch in each direction unless otherwise approved by the structural engineer.
- D. Contractor shall be fully responsible of reviewing the architectural and structural documents and provide seismic joints in piping and ductwork crossing a building seismic joint. All joints shall be listed for their intended use.

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING 23 05 16 QTA 30% SUBMITTAL 09/23/2016 Page 6 of 11

## 2.3 ALIGNMENT GUIDES

- A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe. Guides to be capable of serving as seismic braces if required. See Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Adsco Manufacturing, LLC.
    - b. Advanced Thermal Systems, Inc.
    - c. Flex-Hose Co., Inc.
    - d. Flexicraft Industries.
    - e. Flex-Weld, Inc.
    - f. Hyspan Precision Products, Inc.
    - g. Metraflex, Inc.
    - h. Piping Technology & Products, Inc.
    - i. Senior Flexonics, Inc.; Pathway Division.

# 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. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, and tension and shear capacities appropriate for application.
  - 1. Stud: Threaded, zinc-coated carbon steel.
  - 2. Expansion Plug: Zinc-coated steel.
  - 3. Washer and Nut: Zinc-coated steel.
- E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened Portland cement concrete, and tension and shear capacities appropriate for application.

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING 23 05 16 QTA 30% SUBMITTAL 09/23/2016 Page 7 of 11

- 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. Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.
- G. Grout: ASTM C 1107, factory-mixed and packaged, dry, hydraulic-cement, non-shrink, non-metallic grout; suitable for interior and exterior applications.
  - 1. Properties: Non-staining, non-corrosive, and non-gaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

- 3.1 PROVISIONS FOR EXPANSION
  - A. Install piping to permit free expansion and contraction without damaging piping or construction.
  - B. Provide offsets, expansion loops, anchors, guides and supports to permit expansion, within stress limits of ANSI B31.1 "Power Piping for temperature ranges specified.
  - C. Where pipe loops or changes in direction of piping cannot be employed to absorb expansion and contraction, provide mechanical expansion joints.
  - D. Flexible pipe connections and expansion joints suitable to connect the adjoining piping:
    - 1. As specified for pipe units.
    - 2. Use line sized units.
  - E. Rigidly anchor pipe to building structure.
  - F. Provide pipe guides so that movement takes place along axis of pipe only.
  - G. Use swing or swivel joints for connections as specified in other Sections for piping.
  - H. Branch connections to terminal heat transfer units shall have strain on when cold, off when hot.
  - I. Make riser offsets in manner to avoid pocket forming due to expansion.
  - J. Loops, bends, offsets:

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING 23 05 16 QTA 30% SUBMITTAL 09/23/2016 Page 8 of 11

- 1. As indicated.
- 2. If additional required, because of job required relocation of piping and equipment, design as follows.
  - a. Use spring type loop, U-bend, offset U-bend, L-bend, or Z-bend.
  - b. Join bends only by welding.
  - c. Submit design details for approval before fabrication.
- 3. Loops with ball type joints may be used in lieu of rigid elbows.
  - a. Submit design details for approval before fabrication.
  - b. Base expansion calculations on temperatures listed under performance requirements. Submit calculations with details before fabrication.

## 3.2 EXPANSION-JOINT INSTALLATION

- A. Install manufactured, non-metallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors" and the manufacturer's published installation instructions.
- 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. Where expansion joints are in concealed locations, provide access doors of size to permit inspection, servicing and replacement, as approved.

## 3.3 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.

## 3.4 SWING CONNECTIONS

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING 23 05 16

- 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.

#### 3.5 ALIGNMENT-GUIDE INSTALLATION

- A. Install guides on piping adjoining pipe expansion fittings and loops.
- B. Attach guides to pipe and secure to building structure.
- C. Locate and secure guides to maintain alignment with center line of pipe and preclude binding of spider in guide housing.
- 3.6 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 or compensators are indicated.
  - E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.
  - F. Submit details of anchoring methods for approval before installation.
- 3.7 FLEXIBLE CONNECTORS
  - A. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation.
  - B. Install flexible connectors at right angles to displacement.
  - C. Install one end immediately adjacent to isolated equipment and anchor other end.
  - D. Construct spool pieces to exact size for future insertion of flexible connectors.

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING 23 05 16 QTA 30% SUBMITTAL 09/23/2016 Page 10 of 11

- E. Seismic and other building separations which allow differential movement.
  - 1. Packless Type Expansion Joints as specified hereinbefore.
    - a. Suitable for pressure and service.
    - b. Single or dual unit as required.
    - c. Limit stops.
    - d. Not to exceed lateral limits of joints.
  - 2. Factory Assembled Seismic Joints.
    - a. Two flexible metal hoses at right angles to each other:
      - 1) Inner corrugated hose: Stainless steel or bronze.
      - 2) Outer stainless steel or bronze braid.
      - 3) Suitable for service temperature and pressure.
      - 4) End connections to suit piping system.
    - b. Movement permitted in three planes.
    - c. Minimum movement required is +/- 12-inch for each plane unless otherwise approved by the structural engineer.
  - 3. Ball joints as specified hereinbefore. Arranged to provide seismic movement without exceeding angular limits.
- F. Supports and Guides:
  - 1. As indicated on drawings and as required for a complete installation.
  - 2. Describe method of supports and guides.

## END OF SECTION

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING 23 05 16

# SECTION 23 05 23 GENERAL-DUTY VALVES FOR HVAC PIPING

# PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, Division 23 Specification Sections, and Common Work Requirements for HVAC apply to the work specified in this Section.
- B. Refer to commissioning specification sections for requirements that are applicable to Division 23.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Ball valves.
  - 2. Butterfly valves.
  - 3. Check valves.
  - 4. Check valves with closure control.
  - 5. Gate valves.
  - 6. Globe valves.
  - 7. Plug valves.
  - 8. Safety and relief valves.
  - 9. Motorized operators.
- B. All valves shall be listed for their intended use and duty.
- C. Related Sections:
  - 1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
  - 2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

#### 1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Non-rising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated. Manufacturer's data indicating body material, valve design, design pressure and temperature ratings and classification, end connection details, seat materials, trim materials, dimensions, required clearances, and installation instructions.
- B. Valve Schedule: Schedule listing type, make, and model number, size, and service for valves and motorized valve operators.

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. Codes and Standards: Provide valves conforming to the requirements of the following:
  - 1. Published Specifications' standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this Section.
  - 2. Comply with all applicable national, state, and local codes.
- C. ASME Compliance:
  - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  - 2. ASME B31.1 for power piping valves.
  - 3. ASME B31.9 for building services piping valves.
- D. In addition, comply with all standards or associations as specified herein, including, but not limited to, the following:

- 1. American National Standards Institute (ANSI).
- 2. American Society for Testing and Materials (ASTM).
- 3. Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS).

# 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, grooves, and weld ends.
  - 3. Set angle, gate, and globe valves closed to prevent rattling.
  - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
  - 5. Set butterfly valves closed or slightly open.
  - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection: Install temporary end caps and closures and maintain in place until installation.
  - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.

## PART 2 - PRODUCTS

## 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC equipment schedules and distribution piping for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures. All valves shall be selected and listed for their intended use. Contractor shall provide required pressure and temperature rating based on application and system distribution. All valves located at levels 1 through 4 shall be rated for 225 psi working pressure.

- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
  - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
  - 2. Hand wheel: For valves other than quarter-turn types.
  - 3. Hand lever: For quarter-turn valves NPS 6 and smaller.
  - 4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
  - 5. Chain wheel: Device for attachment to valve hand wheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
  - 6. Motorized Operator: Electric motor assembly for installation on valve to open and close valve from a remote location or control center.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
  - 1. Gate Valves: With rising stem.
  - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
  - 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
  - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
  - 2. Grooved: With grooves according to AWWA C606.
  - 3. Solder Joint: With sockets according to ASME B16.18.
  - 4. Threaded: With threads according to ASME B1.20.1.
  - 5. Socket Weld: With socket ends according to ASME B16.11.
  - 6. Butt Weld: With butt weld ends according to ASME B16.25.
- G. Valve Bypass and Drain Connections: MSS SP-45.
  - 1. Bypass Globe Valves: NPS <sup>3</sup>/<sub>4</sub> for NPS 8 gate valves, and NPS 1 for NPS 10 and larger gate valves.

2. Bypass Valves shall be of the same pressure rating as the gate valves.

## 2.2 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Milwaukee Valve Company.
    - b. NIBCO INC.
    - c. Crane Inc.
  - 2. Description:
    - a. Standard: MSS SP-110.
    - b. SWP Rating: 225 psig.
    - c. CWP Rating: 600 psig.
    - d. Body Design: Two piece.
    - e. Body Material: Bronze.
    - f. Ends: Threaded or solder to match connecting piping.
    - g. Seats: PTFE or TFE.
    - h. Stem: Stainless steel, blow-out proof.
    - i. Ball: Stainless steel, vented.
    - j. Port: Full.

## 2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Jenkins Valves.

#### GENERAL-DUTY VALVES FOR HVAC PIPING

- b. Crane Co.; Crane Valve Group; Stockham Division.
- c. Milwaukee Valve Company.
- d. NIBCO INC.
- 2. Description:
  - a. Standard: MSS SP-67, Type I.
  - b. CWP Rating: 225 psig.
  - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
  - d. Body Material: ASTM A 126, cast iron.
  - e. Seat: EPDM, field replaceable.
  - f. Stem: Two-piece 416 stainless steel, blowout proof.
  - g. Stem Bearing: Teflon or hylatron.
  - h. Disc: Aluminum bronze.

## 2.4 IRON, GROOVED-END BUTTERFLY VALVES

- A. 175 CWP, Iron, Grooved-End Butterfly Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Kennedy Valve; a division of McWane, Inc.
    - b. Shurjoint Piping Products.
    - c. Tyco Fire Products LP; Grinnell Mechanical Products.
    - d. Victaulic Company.
  - 2. Description:
    - a. Standard: MSS SP-67, Type I.
    - b. CWP Rating: 225 psig.

- c. Body Material: Coated, ductile iron.
- d. Stem: Two-piece stainless steel, blowout proof.
- e. Disc: Coated, ductile iron.
- f. Stem Bearing: Teflon or Nylatron.
- g. Seal: EPDM.

# 2.5 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
    - d. Milwaukee Valve Company.
    - e. NIBCO INC.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 3.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Horizontal flow with screw-in cap.
    - d. Body Material: ASTM B 62, bronze.
    - e. Ends: Threaded.
    - f. Disc: Bronze with stainless steel hinge pin.

## 2.6 IRON SWING CHECK VALVES

- A. Class 125, Iron Swing Check Valves with Metal Seats:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the

#### following:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Division.
- d. Hammond Valve.
- e. Milwaukee Valve Company.
- f. NIBCO INC.
- g. Powell Valves.

## 2. Description:

- a. Standard: MSS SP-71, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Design: Clear or full waterway.
- e. Body Material: ASTM A 126, gray iron with bolted bonnet.
- f. Ends: Flanged.
- g. Trim: Bronze.
- h. Gasket: Asbestos free.

# 2.7 IRON, GROOVED-END SWING CHECK VALVES

- A. 300 CWP, Iron, Grooved-End Swing Check Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International, Inc.
    - b. Shurjoint Piping Products.
    - c. Tyco Fire Products LP; Grinnell Mechanical Products.

- d. Victaulic Company.
- 2. Description:
  - a. CWP Rating: 300 psig.
  - b. Body Material: ASTM A 536, ductile iron.
  - c. Seal: EPDM.
  - d. Disc: Spring operated, ductile iron or stainless steel.

## 2.8 IRON, CENTER-GUIDED SILENT CHECK VALVES

- A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Milwaukee Valve Company.
    - b. NIBCO INC.
  - 2. Description:
    - a. Standard: MSS SP-125.
    - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
    - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
    - d. Body Material: ASTM A 126, gray iron.
    - e. Style: Compact wafer.
    - f. Seat: Bronze.

# 2.9 BRONZE GATE VALVES

- A. Class 125, RS Bronze Gate Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.

## GENERAL-DUTY VALVES FOR HVAC PIPING

- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Division.
- d. Milwaukee Valve Company.
- e. NIBCO INC.
- 2. Description:
  - a. Standard: MSS SP-80, Type 2.
  - b. CWP Rating: 200 psig.
  - c. Description: Inside screw, rising stem.
  - d. Body Material: ASTM B 62, bronze with integral seat and union bonnet.
  - e. Ends: Threaded or solder joint.
  - f. Stem: Bronze.
  - g. Disc: Solid wedge; bronze.
  - h. Packing: Asbestos free.
  - i. Hand wheel: Malleable iron.

## 2.10 IRON GATE VALVES

- A. Class 125, NRS, Iron Gate Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
    - d. Milwaukee Valve Company.
    - e. NIBCO INC.
  - 2. Description:

- a. Standard: MSS SP-70, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Disc: Solid wedge.
- h. Packing and Gasket: Asbestos free.
- B. Class 125, OS&Y, Iron Gate Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
    - d. Milwaukee Valve Company.
    - e. NIBCO INC.
  - 2. Description:
    - a. Standard: MSS SP-70, Type I.
    - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
    - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
    - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
    - e. Ends: Flanged.
    - f. Trim: Bronze.
    - g. Disc: Solid wedge.

h. Packing and Gasket: Asbestos free.

## 2.11 BRONZE GLOBE VALVES

- A. Class 125, Bronze Globe Valves with Bronze Disc:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Stockham Division.
    - c. Milwaukee Valve Company.
    - d. NIBCO INC.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 1.
    - b. CWP Rating: 200 psig.
    - c. Body Material: ASTM B 62, bronze with integral seat and union bonnet.
    - d. Ends: Threaded or solder joint.
    - e. Stem and Disc: Bronze.
    - f. Packing: Asbestos free.
    - g. Hand wheel: Malleable iron.

## 2.12 IRON GLOBE VALVES

- A. Class 125, OS&Y, Iron Globe Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.

- d. Milwaukee Valve Company.
- e. NIBCO INC.
- 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. Disc and Seat: Bronze.
  - g. Packing and Gasket: Asbestos free.

#### 2.13 LUBRICATED PLUG VALVES

- A. Class 250, Regular, Screwed-Gland, Lubricated Plug Valves with Threaded Ends:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Nordstrom Valves, Inc.
  - 2. Description:
    - a. Standard: MSS SP-78, Type II.
    - b. CWP Rating: 400 psig.
    - c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubricationsealing system.
    - d. Pattern: Regular.
    - e. Tapered Plug: Cast iron or bronze with sealant groove.
    - f. Suitable for 400 degrees F.
- B. Class 250, Regular, Bolted Cover-Gland, Lubricated Plug Valves with Flanged Ends:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Nordstrom Valves, Inc.
- 2. Description:
  - a. Standard: MSS SP-78, Type II.
  - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
  - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
  - d. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubricationsealing system.
  - e. Pattern: Regular.
  - f. Tapered Plug: Cast iron or bronze with sealant groove.
  - g. Suitable for 400 degrees F.

#### 2.14 MOTORIZED VALVE OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Belimo.
  - 2. EIM Company.
  - 3. Limitorgue Corporation.
  - 4. Rotork Controls, Inc.
- B. Description:
  - 1. Operators:
    - a. Mounted on side or top of valve; at factory or at site under manufacturers supervision. Provide gear operated single or double reduction. For 90 degree application provide adjustable mechanical straps to prevent travel of more than 90 degrees.
    - b. Grease or oil lubricated.

- c. 120 volt, 1 phase, 60 hertz.
- d. Control Circuit: 120 volt, provide transformer, as required.
- 2. Assembly:
  - a. Motor: High speed, high torque, totally enclosed, non-ventilated, pre-lubricated, anti- friction, type, with Class B or F insulation and thermal overload protection; operational at up to 10 percent above or below nominal voltage.
  - b. Limit Switches: Integral to unit. Bronze or stainless steel gearing. Switches shall be heavy duty, open contact type with rotary wiping action, and fully adjustable to trip anywhere between full open and full closed, as required. Provide at least two normally open and two normally closed spare contacts.
  - c. Torque Switch: Provide torque protection in either direction, fully adjustable. To shut-off motor when a predetermined amount of torque is reached.
  - d. Stem Nut: High tensile bronze or other material compatible with valve steam material. Constructed for easy removal without disassembling gear case.
  - e. Hand wheel: For manual operation, arranged to de-clutch automatically when motor is energized. Rim pull shall not exceed 80 pounds, maximum.
- 3. Open/Closed Operation:
  - a. Integral control package for each valve shall include control transformer, indicating lights, motor reversing contractor mechanically interlocked, limit switch compartment heater and terminal strip.
  - b. Indicating lights shall be:
    - 1) Red light on when valve is closed.
    - 2) Green light on when valve is open.
    - 3) Intermediate position indication.
  - c. Push Button Station: Provide selector switch, if required, and momentary or maintenance contracts, as required.
- 4. Modulating Service: Controlled by analog signal 4-20ma DC, with momentary push buttons.
  - a. Controls shall be mounted inside actuator.
  - b. Provide three-phase power supply:

- 1) Solid state reversing controller.
- 2) Comparator circuit module.
- 3) Transformer.
- 4) Two position selector switch (auto/manual).
- 5) Limit switch compartment heater.
- 6) Mechanical dial position indicator with 1,000 ohm potentiometer.
- 7) Class F insulation motor.
- 8) Mounted and wired.
- c. Provide Single-Phase Power Supply:
  - 1) Comparator circuit module.
  - 2) Mechanical dial position indicator with 1,000 ohm potentiometer feedback.
  - 3) Tow position (auto/manual) selector switch.
  - 4) Limit switch compartment heater.
  - 5) Motor: 2100 rmp DC in lieu of A.C.; Class F insulation; 20 percent run valve duty.
  - 6) Mounted and wired.
- 5. Closing Time:
  - a. Gate Valves: 12 inches per minute, minimum of 1 minute.
  - b. Globe Valves: 4 inches per minute, minimum of 1 minute.
  - c. Butterfly Valves: 1/4 turn per minute.
- 6. Provide remote open-close buttons and open-close indicating lights for installation on control board in Section 230910.
- 7. Final field adjustment of valve operation shall be made by manufacturer's representative.

# 2.15 CHAINWHEELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of 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 butterfly and plug valve stems.
  - 3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
  - 4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

#### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Test operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Test operate temperature and pressure relief valves at least three times.
- F. Do not attempt to repair defective valves; replace with new valves.

## 3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

#### GENERAL-DUTY VALVES FOR HVAC PIPING

- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem upright or horizontal, not inverted.
- D. Install valves in position to allow full stem movement and locate wheel handles to clear obstructions with hand.
- E. Install chain wheels on operators for ball butterfly gate globe and plug valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install check valves for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level.
  - 2. Center-Guided Silent Check Valves: In horizontal or vertical position, between flanges.
- G. Install valves with cast directional arrows in direction of flow.
- H. Install globe valves to close against pressure.
- I. Install valves to be removable without separating or lifting piping in which installed.
- J. Where valves abut flanged strainers or similar devices, position valve with respect to device so as to permit removal of bolts.
- K. Provide center guided silent check valves at discharge of all pumps.
- L. Install motorized operators for valves as noted.
- M. Locate equipment shut-off valves to be accessible without climbing over equipment.
- N. Piping adjacent to lugged valves shall be flanged and removable while valve is in use.
- O. Install shut-off valves at inlets and outlets of equipment, on branch connections to mains, at the base of each riser, and elsewhere as noted.
- P. Install drain valves at main shut-off valves, at low points of piping, at bases of vertical risers, and at equipment.
- Q. Pressure class for valves for pressure reducing valve stations shall be based on steam pressure at inlet to station.
- R. Install gate valves or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- S. Install globe or ball valves for throttling, by-pass, or manual flow control service.

## GENERAL-DUTY VALVES FOR HVAC PIPING

## 3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

#### 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. 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.
- B. 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 as shown; not to exceed pressure rating of protected equipment.

# GENERAL-DUTY VALVES FOR HVAC PIPING

- 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 even though only one valve may be shown.
- C. 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.
- D. Select valves, with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valveend 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.

#### 3.5 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.

#### 3.6 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.

#### GENERAL-DUTY VALVES FOR HVAC PIPING

- 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.

## 3.7 HIGH TEMPERATURE HOT WATER VALVE SCHEDULE

A. Lubricated plug valves.

# END OF SECTION

# 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.

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT 23 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 1 of 11

- 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:
  - 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.

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT 23 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 2 of 11 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

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT 23 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 3 of 11

- 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.

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT 23 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 4 of 11

- 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.

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT 23 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 5 of 11

- 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 stainlesssteel, 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.

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT 23 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 6 of 11
- 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structuralsteel 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

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT 23 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 7 of 11

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:

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT 23 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 8 of 11

- 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.

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT 23 05 29

QTA 30% SUBMITTAL 09/23/2016 Page 9 of 11

- 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.

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT 23 05 29 QTA 30% SUBMITTAL 09/23/2016 Page 10 of 11

- 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

## 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. 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

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT 01 10 00 QTA 30% SUBMITTAL 09/23/2016 Page 1 of 9 Performance of Duct Liner Materials.

- 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 REQUIREMENTS

- A. Seismic-Restraint Details:
  - 1. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
  - 2. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
  - 3. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors.
  - 4. Pre-approval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- B. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- C. Welding certificates.

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT 01 10 00 QTA 30% SUBMITTAL 09/23/2016 Page 2 of 9

- D. Qualification Data: For professional engineer and testing agency.
- E. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For air-moving systems to include in operation and maintenance manuals.
- H. All anchor bolts and tie-ins to structure shall be designed for a 1.5 importance factor.

## 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage pre-approval OPA number from pre-approval by ICC-ES, or pre-approval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If pre-approved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

## 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:

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT 01 10 00 QTA 30% SUBMITTAL 09/23/2016 Page 3 of 9

- 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.

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT 01 10 00 QTA 30% SUBMITTAL 09/23/2016 Page 4 of 9

- 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.

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT 01 10 00 QTA 30% SUBMITTAL 09/23/2016 Page 5 of 9

- 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 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.

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT 01 10 00 QTA 30% SUBMITTAL 09/23/2016 Page 6 of 9

## 3.3 INSTALLATION

- A. Lag ductwork by wrapping with insulation and covering. Apply covering to be airtight. Do not attach covering rigidly to ductwork.
- B. Install isolation for motor driven equipment.
- 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.

### 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

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT 01 10 00 QTA 30% SUBMITTAL 09/23/2016 Page 7 of 9 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 pre-stressed 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

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT 01 10 00

applications.

END OF SECTION

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT 01 10 00 QTA 30% SUBMITTAL 09/23/2016 Page 9 of 9

## 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.

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT 23 05 53 QTA 30% SUBMITTAL 09/23/2016 Page 1 of 7

## 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:
  - 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: 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:

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT 23 05 53 QTA 30% SUBMITTAL 09/23/2016 Page 3 of 7

- 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

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT 23 05 53

- 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: Pre-printed, color-coded, with lettering indicating service, and showing flow direction.
  - 2. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid 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.

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT 23 05 53

- 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  $7-1/4 \ge 3$  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

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT 23 05 53

## 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

## 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 – PRODUCT (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 PROCEDURE7

- A. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- B. Measure air quantities at air inlets and outlets.
- C. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- D. 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.

- E. 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.
- F. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- G. 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.
- H. Adjust outside air automatic dampers, outside air, return air and exhaust dampers for design conditions.
- I. Measure temperature conditions across outside air return air and exhaust dampers to check leakage.
- J. 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.
- K. 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.
- L. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
- M. 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.
- N. 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
  - 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
  - 1. 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
  - 1. 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
- 1. 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
  - 1. 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
- 1. 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
  - 1. 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
  - 1. 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

## 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 manmade 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, non-halogen, closed cell elastomeric insulation, tubular.
  - 1. Thermal Conductivity: 0.27 at 75 degrees F.

# HVAC INSULATION

QTA 30% SUBMITTAL 09/23/2016 Page 4 of 21

23 07 00

- 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.

# HVAC INSULATION

QTA 30% SUBMITTAL 09/23/2016 Page 5 of 21

23 07 00

- 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 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: A STM 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.

## HVAC INSULATION

QTA 30% SUBMITTAL 09/23/2016 Page 8 of 21

23 07 00

- 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.

#### HVAC INSULATION

 $23\ 07\ 00$ 

- 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.

#### HVAC INSULATION

QTA 30% SUBMITTAL 09/23/2016 Page 12 of 21

 $23\ 07\ 00$ 

- 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.

## HVAC INSULATION

QTA 30% SUBMITTAL 09/23/2016 Page 13 of 21

 $23\ 07\ 00$ 

- 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.

### HVAC INSULATION

QTA 30% SUBMITTAL 09/23/2016 Page 15 of 21

 $23\ 07\ 00$ 

- 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.

### HVAC INSULATION

QTA 30% SUBMITTAL 09/23/2016 Page 17 of 21

 $23\ 07\ 00$ 

- 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

			INSULATION
	INSULATION		THICKNESS
PIPING SYSTEM	TYPE	PIPE SIZE	INCHES
Chilled water supply and	P-1	1 inch and smaller	1.5
return 40 to 60 degrees F		1-1/2 inches to 4	1.5
		inches	3
		5 inches and larger	
Chilled water supply and	P-1	3/4 inch and smaller	1.5
return less than 40 degrees F		1 inch to 6 inches	2
		8 inches and larger	3
Condensate piping from	P-5	All sizes	0.5
cooling coils			
Refrigerant Suction	P-5	All sizes	1
Refrigerant Hot Gas	P-5	All sizes	1

A. Cooling Services Piping Insulation Schedule:

B. Heating Services Piping Insulation Schedule:

			INSULATION
	INSULATION		THICKNESS
PIPING SYSTEM	TYPE	PIPE SIZE	INCHES
Heating water supply and	P-1	2 inches and smaller	1.0
return 105 to 140 degrees F		2-1/2 inches and larger	1.5
Heating water supply and	P-1	2 inches and smaller	1.0
return 141 to 200 degrees F		2-1/2 inches and larger	1.5
Over 200 degrees F	P-1	2 inches and smaller	1.5
		2-1/2 inches and larger	3
Humidifier supply piping	P-1	2 inches and smaller	1.5
		2-1/2 inches and larger	2
Humidifier drain piping	P-1	All sizes	1

C. Ductwork Insulation Schedule:

		INSULATIO
DUCTWORK SYSTEM	INSULATI ON TYPE	N THICKNES
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

HVAC INSULATION

QTA 30% SUBMITTAL 09/23/2016 Page 20 of 21

23 07 00

# 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	Cellular Glass (E-5) Mineral-Fiber Board (E-2, 3,4) Mineral-Fiber Pipe and Tank (E-9)	2 1 1
Heat-exchanger (water-to-water for cooling service) insulation	Cellular Glass (E-5) Mineral-Fiber Board (E-2, 3) Mineral-Fiber Pipe and Tank (E-9)	2 1 1
Heat-exchanger (water-to-water for heating service) insulation	Calcium Silicate (E-7) Cellular Glass (E-5) Mineral-Fiber Board (E-2,3) Mineral-Fiber Pipe and Tank (E-9)	3 3 2 2
Chilled-water pump insulation	Cellular Glass (E-5) Mineral-Fiber Board (E-2,3)	3 2
Condenser-water pump insulation	Cellular Glass (E-5) Mineral-Fiber Board (E-2, 3)	3 2
Heating-hot-water pump insulation	Calcium Silicate (E-7) Cellular Glass (E-5) Mineral-Fiber Board (E-2) Mineral-Fiber Pipe and Tank (E-9)	3 3 2 2
Chilled-water expansion/compression tank insulation	Cellular Glass (E-5) Mineral-Fiber Board (E-2) Mineral-Fiber Pipe and Tank (E-9)	2 1 1
Heating-hot-water expansion/compression tank insulation	Cellular Glass (E-5) Mineral-Fiber Board (E-2)	3 2
Chilled-water air-separator insulation	Cellular Glass (E-5) Mineral-Fiber Board (E-2) Mineral-Fiber Pipe and Tank (E-9)	2 1 1
Condenser-water air-separator insulation	Cellular Glass (E-5) Mineral-Fiber Board (E-2) Mineral-Fiber Pipe and Tank (E-9)	2 1 1
Heating-hot-water air-separator	Cellular Glass (E-5) Mineral-Fiber Board (E-2)	3 2
Thermal storage tank (ice insulation)	Calcium Silicate (E-7)	3

# END OF SECTION

## 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. Piping systems.
  - 2. Ductwork.
  - 3. Variable frequency drives.
  - 4. Humidifiers.
  - 5. Air handling units.
  - 6. Fan Coil Units.
  - 7. Variable volume terminal units.
  - 8. Fans.
  - 9. Fire dampers.
  - 10. Smoke dampers.
  - 11. Indoor air quality.
  - 12. Equipment sound control if noted on drawings.
  - 13. Equipment vibration control if noted on drawings.
  - 14. Automatic temperature control system.
  - 15. 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.
- C. LAWA E-Forms: Contractor to request for commissioning E-forms from LAWA. Contractor shall complete E-forms and submit to LAWA after approved equipment installation.

#### 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 pointto-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 fullload 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 submitted 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
# SECTION 23 21 13 HYDRONIC PIPING

# PART 1 - GENERAL

# 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 23 Specification Sections, and Common Work Requirements for HVAC apply to the work specified in this Section.

# 1.2 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
  - 1. Hot-water heating piping.
  - 2. Chilled-water piping.
  - 3. Equipment drain and overflow piping.
  - 4. Condensate-drain piping.
  - 5. Air-vent piping.
  - 6. Safety-valve-inlet and -outlet piping.
- B. Specialties for above systems:
  - 1. Automatic and manual air vents.
  - 2. Strainers.
  - 3. Flow control devices.
  - 4. Tap-ins for temperature and pressure.

# 1.3 DEFINITIONS

- A. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
- B. RTRP: Reinforced thermosetting resin (fiberglass) pipe.
- 1.4 PERFORMANCE REQUIREMENTS

# HYDRONIC PIPING

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
  - 1. Hot-Water Heating Piping: 225 psig at 200 deg F.
  - 2. Chilled-Water Piping: 225 psig at 200 deg F.
  - 3. Condensate-Drain Piping: 150 deg F.
  - 4. Air-Vent Piping: 200 deg F.
  - 5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

# 1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's standard technical product data indicating conformance to the stipulated reference specifications, construction materials, dimensions, construction details, and test and operating pressures. Submit manufacturer's product data on the following:
  - 1. Pipe materials.
  - 2. Unions and flanges, including gaskets, nuts, and bolts.
  - 3. Welding fittings.
  - 4. Sleeves and packings.
  - 5. RTRP and RTRF with adhesive.
  - 6. Pressure-seal fittings.
  - 7. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated- orifice balancing valves and automatic flow-control valves.
  - 8. Air control devices.
  - 9. Chemical treatment.
  - 10. Hydronic Specialties: Submit schedule listing type, make and model number, size and service for all hydronic specialties.
- B. Shop Drawings: Provide piping layout drawings, drawn to a scale of not less than 1/4 inch to 1 ft. showing the proposed layout of piping system including valves, fittings, equipment, pumps, hangers, grading, high points, low points, drain points, guides, anchors, ball joints, and expansion devices. Piping below 3 inches show single line, all 3 inches and above show double line.

# HYDRONIC PIPING

QTA 30% SUBMITTAL 09/23/2016 Page 2 of 28

Coordination Drawings: Show double line at 3/8 inch to 1 ft. Calculations required for stressed piping at anchors. Provide shop drawings for the following locations:

- 1. Equipment rooms.
- 2. Air handling equipment rooms.
- 3. Pipe shafts.
- 4. Cooling coils.
- 5. Heating coils.
- 6. Heat exchangers.
- 7. All floor plans and roof plans.
- C. Schedules:
  - 1. Submit schedule of pipe type and rating for each system.
  - 2. Submit schedule listing type make and model number, size and service for valves, motorized valve operators, strainers, flanges, fittings, and equipment.
- D. Welding certificates.
- E. Qualification Data: For Installer.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

#### 1.6 QUALITY ASSURANCE

- A. Codes and Standards: Provide piping conforming to the requirements of the following:
  - 1. American Society of Mechanical Engineers (ASME):
    - a. B16.1: Cast iron pipe flanges and flanged fittings Class 25, 125, 250, and 800.
    - b. B16.4: Cast iron threaded fittings Classes 125 and 250.
    - c. B16.3: Malleable iron threaded fittings.
    - d. B16.5: Pipe flanges and flanged fittings.

- e. B16.9: Factory-made wrought steel buttwelding fittings.
- f. B16.1: Forged steel fittings, socket-welding and threaded.
- g. B16.18: Cast copper alloy solder joint pressure fittings.
- h. B16.22: Wrought copper and copper alloy solder joint pressure fittings.
- i. B16.39: Malleable iron threaded pipe unions Classes 150, 250, and 300.
- j. B31: Code for pressure piping.
- k. B31.1: Power piping.
- 2. Installation of piping shall conform to the requirements of ASME B31.1 "Power Piping."
- 3. American Society for Testing and Materials (ASTM):
  - a. A 53: Standard specification for pipe, steel, black and hot-dipped, zinc-coated welded seamless.
  - b. A 106: Standard specification for seamless carbon steel pipe for high-temperature service.
  - c. A126: Standard specification for gray iron castings for valves, flanges, and pipe fittings.
  - d. A 193/A 193M: Standard specification for alloy-steel and stainless steel bolting materials for high-temperature service.
  - e. A 194/ A 194M: Standard specification for carbon and alloy steel nuts for bolts for high- pressure and high-temperature service.
  - f. A 216/ A 216M: Standard specification for steel castings, carbon, suitable for fusion welding for high-temperature service.
  - g. A 276: Standard specification for stainless and heat-resisting steel bars and shapes.
  - h. A 307: Standard specification for carbon steel bolts and studs, 60,000 psi tensile strength.
  - i. B 88: Standard specification for seamless copper water tube.
- B. Codes and Standards: Provide hydronic specialties conforming to the requirements of the following:
  - 1. Published specifications' standards, tests or recommended methods of trade, industry

or governmental organizations apply to work in this section.

- 2. Comply with all applicable national, state, and local codes and refer to Section "General Provisions" for mechanical for additional Reference Standards.
- 3. In addition, comply with all standards or associations as specified herein including, but not limited to, the following, as applicable:
  - a. American Society for Mechanical Engineers (ASME).
  - b. American Society for Testing and Materials (ASTM).
  - c. American National Standards Institute (ANSI).
  - d. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS).
- C. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code Steel."
- D. 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.

- E. 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.
- F. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.
- G. LAWA may perform random inspection and supplemental non-destructive testing throughout the project. Contractor shall be responsible for all connection and repair as well as re-examination of defective welds at no cost to LAWA.

#### 1.7 EXTRA MATERIALS

- A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion. Chemical treatment must match existing.
- B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

# PART 2 - PRODUCTS

- 2.1 COPPER TUBE AND FITTINGS
  - A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
  - B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
  - C. DWV Copper Tubing: ASTM B 306, Type DWV.
  - D. Wrought-Copper Fittings: ASME B16.22.
    - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      - a. Anvil International, Inc.

# HYDRONIC PIPING

- b. S. P. Fittings; a division of Star Pipe Products.
- c. Victaulic Company of America.
- 3. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
- 4. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, pre-lubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.

#### 2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
  - 1. Material Group: 1.1.
  - 2. End Connections: Butt welding.
  - 3. Facings: Raised face.
- H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

#### 2.3 BRASS PIPE AND FITTINGS

- A. Brass Pipe: ASTM B43, seamless, annealed, 85% copper, 1ps.
- B. Bronze Fittings: Standard cast bronze, threaded in accordance with ANSI B16.15.

# HYDRONIC PIPING

QTA 30% SUBMITTAL 09/23/2016 Page 7 of 28

C. Brass Unions: All bronze, 150 lb. wsp, ground joint seat.

# 2.4 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts:
  - 1. Bolts shall be chrome-molybdenum bolt stud in accordance with ASTM A 193 Grade B7 with full length threads in accordance with ANSI B1.1. Threaded length shall be sufficient to project beyond nuts one complete thread when joint is made.
  - 2. Nuts shall be carbon steel in accordance with ASTM A 194, Grade 2. Nuts shall be hexagon heavy series type. Threads shall be the same as for bolts.
- 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, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.
- G. Cast iron drainage fittings shall be in accordance with ANSI B16.12.
- H. Galvanized fittings for galvanized piping.
- I. Ductile iron shall be in accordance with ASTM A 445. Contractor has option to furnish 300 lb ductile iron in lieu of 250 lb. cast iron or 300 lb. malleable iron.

# 2.5 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

# HYDRONIC PIPING

- 1. Manufacturers:
  - a. Advance Products & Systems, Inc.
  - b. Calpico, Inc.
  - c. Metraflex Co.
  - d. Pipeline Seal and Insulator, Inc.
- 2. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- 3. Pressure Plates: Carbon steel or Stainless steel. Include two for each sealing element.
- 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

#### 2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

#### 2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

- C. One-Piece, Cast-Brass Type: With set screw.
  - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
  - 1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chromeplated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.
- 2.8 VALVES
  - A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."
  - B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Building Automation System."
  - C. Bronze, Calibrated-Orifice, Balancing Valves:
    - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      - a. Armstrong Pumps, Inc.
      - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
      - c. Flow Design Inc.
      - d. Gerand Engineering Co.
      - e. Griswold Controls.
      - f. Taco.
    - 3. Body: Bronze, ball or plug type with calibrated orifice or venturi.

# HYDRONIC PIPING

QTA 30% SUBMITTAL 09/23/2016 Page 10 of 28

- 4. Ball: Brass or stainless steel.
- 5. Plug: Resin.
- 6. Seat: PTFE.
- 7. End Connections: Threaded or socket.
- 8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
- 9. Handle Style: Lever, with memory stop to retain set position.
- 10. CWP Rating: Minimum 125 psig.
- 11. Maximum Operating Temperature: 250 deg F.
- D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armstrong Pumps, Inc.
    - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    - c. Flow Design Inc.
    - d. Gerand Engineering Co.
    - e. Griswold Controls.
    - f. Taco.
    - g. Tour & Andersson; available through Victaulic Company of America.
  - 2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
  - 3. Ball: Brass or stainless steel.
  - 4. Stem Seals: EPDM O-rings.
  - 5. Disc: Glass and carbon-filled PTFE.
  - 6. Seat: PTFE.
  - 7. End Connections: Flanged or grooved.

- 8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
- 9. Handle Style: Lever, with memory stop to retain set position.
- 10. CWP Rating: Minimum 125 psig.
- 11. Maximum Operating Temperature: 250 deg F.
- E. Diaphragm-Operated Safety Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Amtrol, Inc.
    - b. Armstrong Pumps, Inc.
    - c. Bell & Gossett Domestic Pump; a division of ITT Industries.
    - d. Conbraco Industries, Inc.
    - e. Spence Engineering Company, Inc.
    - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Body: Bronze or brass.
  - 3. Disc: Glass and carbon-filled PTFE.
  - 4. Seat: Brass.
  - 5. Stem Seals: EPDM O-rings.
  - 6. Diaphragm: EPT.
  - 7. Wetted, Internal Work Parts: Brass and rubber.
  - 8. Inlet Strainer: removable without system shutdown.
  - 9. Valve Seat and Stem: Noncorrosive.
  - 10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- F. Automatic Flow-Control Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Flow Design Inc.
  - b. Griswold Controls.
- 3. Body: Brass or ferrous metal.
- 4. Piston and Spring Assembly: Stainless steel Corrosion resistant, tamper proof, selfcleaning, and removable.
- 5. Combination Assemblies: Include bonze or brass-alloy ball valve.
- 6. Identification Tag: Marked with zone identification, valve number, and flow rate.
- 7. Size: Same as pipe in which installed.
- 8. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
- 9. Minimum CWP Rating: 175 psig.
- 10. Maximum Operating Temperature: 250 deg F.
- G. Combination Balancing and Shut-off valve:
  - 1. Manufacturers:
    - a. Tour & Anderson.
    - b. Armstrong Pumps, Inc.
    - c. Bell & Gossett Domestic Pump; A Division of ITT Industries.
  - 2. Body: "Y" pattern, modified, equal percentage globe style. Brass up to 2 inch; ductile iron for 2-1/2 and larger.
  - 3. Bronze trim.
  - 4. Precision flow measurement.
  - 5. Precision flow balancing.

- 6. Positive drip tight shut-off.
- 7. Two (2) 1/2 inch NPT metering ports with nordel check valves and gasketed caps located on both sides of the valve seat.
- 8. Two (2) additional 1/4 inch NPT connections with brass plugs on opposite side of the metering ports for use as drain connections.
- 9. Drain connections and metering ports are to be interchangeable.
- 10. Handwheel with hidden memory feature.
- 11. Minimum CWP Rating: 175 psig (1207 kPa).
- 12. Maximum Operating Temperature: 250 deg F (121 deg C)

# 2.9 AIR CONTROL DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Amtrol, Inc.
  - 2. Armstrong Pumps, Inc.
  - 3. Bell & Gossett Domestic Pump; a division of ITT Industries.
  - 4. Taco.
- B. Manual Air Vents:
  - 1. Body: Bronze.
  - 2. Internal Parts: Nonferrous.
  - 3. Operator: Screwdriver or thumbscrew.
  - 4. Inlet Connection: NPS 1/2.
  - 5. Discharge Connection: NPS 1/8.
  - 6. CWP Rating: 150 psig.
  - 7. Maximum Operating Temperature: 225 deg F.
- C. Automatic Air Vents:

# HYDRONIC PIPING

QTA 30% SUBMITTAL 09/23/2016 Page 14 of 28

- 1. Body: Bronze or cast iron.
- 2. Internal Parts: Nonferrous.
- 3. Operator: Noncorrosive metal float.
- 4. Non-opening on negative pressure.
- 5. Inlet Connection: NPS 1/2.
- 6. Discharge Connection: NPS 1/4.
- 7. CWP Rating: 150 psig.
- 8. Maximum Operating Temperature: 240 deg F.

#### 2.10 HYDRONIC PIPING SPECIALTIES

- A. Y-Pattern Strainers:
  - 1. Body: Brass or ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
  - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  - 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
  - 4. CWP Rating: 125 psig.
- B. Basket Strainers:
  - 1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
  - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  - 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
  - 4. CWP Rating: 125 psig.
- C. Flow Control Devices:

- 1. Manufacturer: Griswold Controls, or equal.
- 2. Body: Brass or iron, with tappings for dual pressure/temperature test valves for verifying accuracy of flow performance.
- 3. Internal Parts: Passivated stainless steel.
- 4. Accuracy: Devices factory set to limit flow to within 5% accuracy over an operating pressure differential of not less than 14 times the minimum required for control. Maximum operating differential between body tappings, required for control shall be between 1 psi and 4 psi.
- 5. Pressure Drop: Pressure drop though devices shall not exceed 4 psi.
- 6. CWP Rating: 250 psig (1725 kPa).
- 7. Valve Tag: Provide for each device, identification number, model, and flow rate.
- 8. Portable Meter Kit: Griswold Model 3429, or equal. Provide one (1) for delivery to Owner.
- D. Stainless-Steel Bellow, Flexible Connectors:
  - 1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
  - 2. End Connections: Threaded or flanged to match equipment connected.
  - 3. Performance: Capable of 3/4-inch misalignment.
  - 4. CWP Rating: 150 psig.
  - 5. Maximum Operating Temperature: 250 deg F.
- E. Spherical, Rubber, Flexible Connectors:
  - 1. Body: Fiber-reinforced rubber body.
  - 2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
  - 3. Performance: Capable of misalignment.
  - 4. CWP Rating: 150 psig.
  - 5. Maximum Operating Temperature: 250 deg F.
- F. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

### HYDRONIC PIPING

QTA 30% SUBMITTAL 09/23/2016 Page 16 of 28

# 2.11 HANGERS, SUPPORTS, GUIDES, AND ANCHORS

- A. See Section 230516 "Expansion Fittings and Loops for HVAC Piping."
- B. See Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

# PART 3 - EXECUTION

# 3.1 PIPING APPLICATIONS

- A. Hot Water Heating System, 100 deg F to 220 deg F supply temperature, shall be all welded system, steel in accordance with ASTM A106 or A53, seamless with wall thickness as follows:
  - 1. To 2 Inches: Schedule 40, socket weld ends.
  - 2. 2-1/2 Inches to 10 Inches: 0.375 inch wall thickness, grade butt weld ends.
- B. Low-Temperature Water System, not in excess of 100 psig, 2- deg F to 100 deg F supply temperature (hot water, heating, condenser water, and chilled water, for primary and secondary systems):
  - 1. Material: Steel in accordance with ASTM A53 or A120 and copper, hard drawn, in accordance with ASTM B88.
    - a. To 2 Inches: Type L copper tubing, or Schedule 40 steel with screwed fittings at contractor option.
    - b. 2-1/2 Inches to 10 Inches: Schedule 40 with mechanical coupling.
- C. Water Treatment Chemical Feed Piping and Sampling Piping:
  - 1. As specified for system piping to which connected.
  - 2. Red brass, ASTM B 43, standard weight.
- D. Atmospheric air vents shall be galvanized steel in accordance with ASTM A 120 or A 53, Schedule 40.
- E. Fan Coil Units Runouts System shall be copper Type L in accordance with ASTM B 88.
- F. Condensate Drain, Miscellaneous Drains, and Overflow:
  - 1. To 2 Inches: Copper, Type L in accordance with ASTM B 88.
  - 2. 2-1/2 Inches and Larger: Galvanized steel, Schedule 40 in accordance with ASTM A 120

# HYDRONIC PIPING

QTA 30% SUBMITTAL 09/23/2016 Page 17 of 28

#### or A 53.

- G. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
- H. All other piping shall be galvanized steel, Schedule 40 in accordance with ASTM A 53, Grades A or B.
- 3.2 FITTINGS APPLICATIONS
  - A. For Steel Pipe:
    - 1. To 2 inches:
      - a. Hot Water Heating Systems: Steel fittings with socket weld ends in accordance with ANSI B 16.11.
      - b. All Other Piping Systems: Cast iron threaded fittings in accordance with ANSI B 16.4.
      - c. Malleable iron fittings shall be in accordance with ANSI B 16.3, 150 lb. wsp. Provide 300 lb. wsp, where noted.
      - d. Cast iron drainage fittings shall be in accordance with ANSI B 16.12. Provide for all drain piping.
      - e. Galvanized fittings for all galvanized piping.
      - f. Pressure Ratings: 125 lb. wsp or 250 lb. wsp to suit system operating pressure.
    - 2. For 2-1/2 Inch and Larger Welded:
      - a. Butt weld fittings same weight as piping and in accordance with ANSI B 16.9.
      - b. Branch Connections:
        - 1) Equal to main and to two pipe sizes smaller: Use weld tees.
        - Three or more pipe sizes smaller than main, but 2-1/2 inches and larger: Use Weld- o-lets.
        - 3) To 2 inches: Weld-o-lets, Thread-o-lets, threaded Nip-o-lets, or steel couplings.

- B. For Copper Tubing:
  - 1. Solder joint shall be wrought copper in accordance with ANSI B16.22.
    - a. Solder shall be 95-5 in accordance with ASTM B 32.
    - b. For refrigerant piping and where noted, solder shall be silver brazing alloy similar to Handy and Harman Easy-Flow.
- C. For Lightweight Copper Pipe:
  - 1. Fittings shall be standard cast bronze, banded, brazing joint in accordance with MIL-f-1183.
  - 2. Silver brazing alloys shall be similar to Handy and Harman Sil-Fos.
- D. For Red Brass Pipe:
  - 1. Fittings shall be standard cast bronze, banded, threaded in accordance with ANSI B16.15.
- E. Flanges:
  - 1. For steel, pipe flanges shall be of matching quality, grade, and thickness.
    - a. Welded: Welding neck, slip-on, socket welded in accordance with ANSI B16.5, slip-on flanges shall be back welded.
      - 1) 150 lb. wsp.
      - 2) 300 lb. wsp.
      - 3) 300 lb. ring-groove for high pressure service.
  - 2. Screwed flanges shall be standard cast or extra heavy cast iron in accordance with ANSI B16.4.
  - 3. Match Connecting Flange:
    - a. Class.
    - b. Facing.
- F. Flange gaskets shall be one-piece ring type 1/16 inch thick (minimum), except as noted, suitable for temperature, pressure (operating and test) and service of system.
  - 1. Non-asbestos elastometer for 250 deg F and under.

### HYDRONIC PIPING

QTA 30% SUBMITTAL 09/23/2016 Page 19 of 28

- 2. Non-asbestos spiral wound 304 stainless steel for 250 deg F, similar to Flexitallic.
- G. Unions:
  - 1. For Steel Pipe:
    - a. Malleable iron 300 lb. wsp.
      - 1) Ground Jacket Seat: Brass-to-iron, black or galvanized to match piping.
    - b. A.A.R. malleable iron 300 lb. wsp.
    - c. Forged steel, 2000, 3000 lb. wog class, bronze-to-steel or steel-to-steel seats, where noted or required for service.
    - d. For Red Brass Pipe:
      - 1) All bronze, 150 lb. wsp, ground joint seat.
      - 2) Not to be used on medium or high temperature water systems or oil systems.

#### 3.3 FLASHINGS AND SLEEVES

- A. Flashings for Pipes Through Roofs:
  - 1. M.D. Products No. 65 or equal and M.D. Products No. 67 or equal for vents.
  - 2. Provide counter-flashing sleeves.
  - 3. Other flashings shall be galvanized sheet steel.
- B. Sleeves:
  - 1. Membrane Waterproofed Walls and Floors: Cast iron flashing type, adjustable to construction with galvanized pipe nipples.
  - 2. Integral Waterproofed Walls and Floors: Galvanized steel pipe with welded center flange, buried. Caulked watertight.
  - 3. Concrete Floors and Masonry Walls: Galvanized steel pipe.
  - 4. All Other Floor and Wall Penetrations: Galvanized sheet metal.
  - 5. Piping Run in Floor Fill: Provide 22 USSG galvanized sheet metal, U-shaped covers with clearance for expansion.

6. Sleeves flush with walls and ceilings and extend 2 inches above finished floors, except in mechanical rooms extend 4 inches above floor.

# C. Caulking:

- 1. Seal openings between sleeves and pipe or pipe insulation for full depth of sleeve.
- 2. Material:
  - a. For Fire Barrier: Mineral wool or equivalent non-asbestos, non-combustible material.
  - b. Through Waterproofed Construction, Interior: Non-asbestos ceramic fiber packing and hot poured mastic.
  - c. Through Waterproofed Construction, Exterior: Non-asbestos ceramic fiber packing and caulking lead.

# 3.4 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch and/or riser connection to supply mains, and at supply connection to each piece of equipment.
- B. Install throttling-duty or calibrated-orifice, balancing valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

# 3.5 PIPING INSTALLATIONS

- A. Install piping approximately as indicated and modify to suit building conditions, to avoid interference with other trades, to maintain access and clearance and to maintain pitch. Where modifications are required provide necessary offsets, drains, vents, values, and required pipe and fittings.
- B. Maintain maximum headroom and ceiling height; offset as necessary and coordinate with work of other trades.

# HYDRONIC PIPING

QTA 30% SUBMITTAL 09/23/2016 Page 21 of 28

- C. Install drains, consisting of a tee fitting, valve, and short threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage. Valve: Up to 6 inches pipe use <sup>3</sup>/<sub>4</sub> inch ball valve and 8 inches and larger pipe use 1-1/2 inch gate valve.
- D. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- E. Reduce pipe sizes using eccentric reducer fitting installed with level side up. Use of bushings will not be acceptable.
- F. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- G. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
- H. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- I. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- J. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- K. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."
- L. Install no piping in elevator machine rooms, electric rooms and closets, and telephone rooms and closets.
- M. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

## 3.6 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.
- B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Provide for expansion and contraction and to prevent vibration or swaying.

- D. Support piping independently, so that equipment is not stressed by piping weight or expansion.
- E. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
  - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
  - 6. Supports of wire, rope, wood, chain, strap, perforated bar or any other makeshift device will not be permitted.
- F. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
  - 2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
  - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 4. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
  - 5. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  - 6. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
  - 7. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
  - 8. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
  - 9. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
  - 10. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.
- G. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.

- 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
- 3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
- 4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
- 5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
- 6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- H. Uncoated hangers, rods, and supports shall be dipped in zinc chromate primer before installation.
- I. Support vertical runs at base, at roof, at each floor, and at 10-foot intervals between floors.
  - 1. Base Elbow Support: Provide bearing plate on structural support, similar to F&S Manufacturing Corp. Fig. 720 or 720.
  - 2. Provide guides at every third floor but not to exceed:
    - a. 25 ft. for piping to 2 inches.
    - b. 36 ft. for piping 2-1/2 inches to 12 inches.
    - c. 50 ft. for piping 14 inches and larger.
  - 3. Top Support: Provide special hanger or saddle in horizontal connection and make provisions for expansion.
  - 4. Intermediate Supports: Steel pipe clamp at floor. Bolt and weld to pipe with extension ends bearing on structural steel or bearing plates.
  - 5. For multiple pipes, coordinate guides bearing plates and accessory steel.

### 3.7 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape thread sealant or thread compound to external pipe threads unless dry seal threading is specified. Use no lamp wick in joints.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

# 3.8 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.
- D. Install flow control devices at each heat exchanger, coil, filter backwash, and elsewhere as indicated.

#### 3.9 TERMINAL EQUIPMENT CONNECTIONS

- A. Connect equipment in accordance with manufacturer's standard details and recommendations as approved, except as noted, with accessory piping, vents, drains, reliefs and by passes.
- B. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- C. Install control valves in accessible locations close to connected equipment.
- D. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

# HYDRONIC PIPING

QTA 30% SUBMITTAL 09/23/2016 Page 25 of 28

E. Install ports for pressure gages and thermometers at coil inlet and outlet connections, and elsewhere as indicated, according to Division 23 Section "Meters and Gages for HVAC Piping." When permanent gauges or thermometers are not indicated or specified herein, provide temperature pressure tap-ins at inlet and outlet of each coil, heat exchangers, chiller and condenser.

# 3.10 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
  - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
  - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
  - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
  - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
  - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. 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

### HYDRONIC PIPING

QTA 30% SUBMITTAL 09/23/2016 Page 26 of 28

replacing components, and repeat hydrostatic test until there are no leaks.

- 7. Prepare written report of testing.
- C. Perform the following before operating the system:
  - 1. Open manual valves fully.
  - 2. Inspect pumps for proper rotation.
  - 3. Set makeup pressure-reducing valves for required system pressure.
  - 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
  - 5. Set temperature controls so all coils are calling for full flow.
  - 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
  - 7. Verify lubrication of motors and bearings.

#### 3.11 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.
- j. For piping that may not be activated immediately, provide piping protection including corrosion inhibitor after testing by filling the piping with nitrogen or other chemical sealant that can be easily flushed prior to final fill and activation.
- 4. Do not circulate water to the CUP until the CUP water treatment contractor has certified the water quality on both sides.
- B. Balancing and Adjusting Water Systems: Refer to Section 230595, "Testing, Adjusting and Balancing for HVAC."

END OF SECTION

# 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. Thermometer 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 copper 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
# 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.

# HYDRONIC PUMPS

23 21 23

- 2. Armstrong.
- 3. Taco.
- B. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for inline 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.
- 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.

# 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.

#### HYDRONIC PUMPS

- 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

# HYDRONIC PUMPS

# 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 STEM 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

# REFRIGERANT PIPING

23 23 00

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.

#### **REFRIGERANT PIPING**

23 23 00

# 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:
  - 1. Comply with LA city code for installation of pipes at egress area, corridors.
- 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

# 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 low 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 8.8 to 9.5.
  - 2. Turbidity: Maintain a value less than 15 NTU.
  - 3. Boron: Maintain a value within 100 to 200 ppm. (Glycol system) and less than 10 ppm for the closed hydronic system.

- 4. Soluble Copper: Maintain a maximum value of 0.20 ppm.
- 5. TDS: Maintain a maximum value of 3000 ppm.
- 6. Ammonia: Maintain a maximum value of 5 ppm.
- 7. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
- 8. 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.
- 9. Treatment:
  - a. Low temperature hot water, closed cooling and chilled water Mixture of sodium nitrite, borax and molybdate with other copper alloy inhibitor. For the chilled water a non-nitrite program of phosphate, polymer borate and copper alloy inhibitors: 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. Soluble Copper: Maintain a maximum value of 0.20 ppm.
  - 4. Conductivity: Maintain a minimum value of 2400 uhmos. The goal of the plant is to run the highest conductivity possible for water conservation.
  - 5. Ammonia: Maintain a maximum value of 20 ppm.
  - 6. Free "OH" Alkalinity: Maintain a maximum value of 0 ppm

- 7. Silica: Maintain a maximum value of 125 ppm
- 8. 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.
- 9. Polymer Testable: Maintain a minimum value within 10 to 40.
- 10. 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.
- 11. Bleed off:
  - a. Automatic control by condenser water conductivity and water meter signals.
  - b. To maintain maximum chloride concentration at the maximum level possible based on the incoming water quality up 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 watertreatment 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

## HVAC WATER TREATMENT

23 25 00

Completion, and shall include the following:

- 1. Initial makeup and (and subsequent analysis of water quality changes) 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. Weekly 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. Nalco Company / An Ecolab 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 28day 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 or higher quality stainless steel, with minimum 110 percent containment vessel.
  - 2. Molded cover with recess for mounting pump.
  - 3. Capacity: Maintain inventory sufficient to meet the system demands.
- 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 bleedoff 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 current system capacity 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; oxygen

scavenger 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. Two 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.

HVAC WATER TREATMENT

23 25 00

#### 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 for the heating and chilled water loops only. Pumps for the cooling towers and steam boilers shall operate base on the actual chemistry of the water.
  - 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 Oxidation-Reduction Potential (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 6 inch long brass nipple for the pipes 1 ½ inch and smaller and dielectric flange for the pipes 2 inch and larger. Dielectric flanges are allowed in the pump and fan rooms only.
- 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

HVAC WATER TREATMENT

QTA 30% SUBMITTAL 09/23/2016 Page 10 of 12

# $23\ 25\ 00$

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 TRAINING

- A. Engage a factory-authorized service representative to train LAWA's Maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.
- B. Provide a minimum of 12 hours (3 shifts) of classroom and hands on training to LAWA Maintenance personnel on handling and testing of treatment chemicals with "how-to-use" 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

# 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

- 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 indicating refrences from the bottom of ducts , other 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, Indicate insulation thickness around ducts, indicate duct elevation with insulation thickness included, indicate bottom of supported elevation.
- 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. Show all access openings and clearances for all equipment and panels etc.
- 4. Show all seismic supports, bracing, and cableing of equipment
- 5. Structural members to which duct will be attached.
- 6. Size and location of initial access modules for acoustical tile.
- 7. Penetrations of smoke barriers and fire-rated construction.
- 8. 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 buttwelded 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, ductsupport 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 cadmiumplated 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 twopart 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. Prepare and submit shop drawing
  - 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. Prepare and submit shop drawing.
    - 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. Prepare and Submit test procedures
- 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."
  - 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

# 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. Combination 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.
- 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, 0.050inch- (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.

#### AIR DUCT ACCESSORIES

23 33 00

# 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

#### AIR DUCT ACCESSORIES

23 33 00

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. 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. Show all access doors sizes and locations on shop drwaings:
  - 2. 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.
    - 1. Inlet side of each single width centrifugal fan.
    - m. Install at locations for cleaning kitchen exhaust ductwork in accordance with

#### NFPA 96.

- 3. Install access doors with swing against duct static pressure.
- 4. 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.
- 5. Label access doors according to Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- 6. 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. Wire mesh screen grilles shall be made with minimum 14 gage of material thickness.
- 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 nonaccessible 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 INSTALLATION - 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
## 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.

### 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 midposition; 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 midposition; 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 midposition; 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. Safety screen shall be made with minimum 14 gage of material thickness

### 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

## SECTION 23 36 00 AIR TERMINAL UNITS

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Variable volume terminal units.

## 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

### AIR TERMINAL UNITS

- 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 openable sheet metal enclosure.
    - 2. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings; maximum damper leakage: 2 percent of design air

#### AIR TERMINAL UNITS

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.
  - 3. All VAV boxes with reheat coil shall be provided with factory supplied minimum of 3-feet in length sound attenuator.
  - 4. All VAV boxes with reheat coil shall be provided with minimum 24-inch clear space for heating coil removal and maintenance on service and maintenance side of the box.

## 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

## SECTION 23 37 00 AIR OUTLETS AND INLETS

### PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes:
  - 1. Diffusers.
  - 2. Registers
  - 3. Grilles.

## 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  $1/2 \ge 1/2 \ge 1$  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,  $1/8 \ge 3/4$  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.

### 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

## SECTION 23 37 23 HVAC GRAVITY VENTILATORS

#### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Louvered-penthouse ventilators.
  - 2. Roof hoods.
  - 3. Goosenecks.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
  - 1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
  - 2. Wind Loads: Determine loads based on a uniform pressure of 20 lbf/sq. ft. (960 Pa), acting inward or outward.
- B. Seismic Performance: Ventilators, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 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."
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.
  - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

## 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. LEED Submittals:
  - 1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 "Systems and Equipment."
- C. Shop Drawings: For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
  - 1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
- D. Samples: For each exposed product and for each color and texture specified.
- E. Samples for Initial Selection: For units with factory-applied color finishes.
- F. Samples for Verification: For each type of louvered-penthouse ventilator indicated, in manufacturer's standard size.

### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof framing plans and other details, 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. Structural members to which roof curbs and ventilators will be attached.
  - 2. Sizes and locations of roof openings.
- B. Seismic Qualification Certificates: For ventilators, 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.
- C. Welding certificates.

#### 1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.2/D1.2M, "Structural Welding Code Aluminum."
  - 2. AWS D1.3, "Structural Welding Code Sheet Steel."

#### 1.7 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.
- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) zinc coating, mill phosphatized.
- D. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. 4 finish.
- E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
  - 1. Use types and sizes to suit unit installation conditions.
  - 2. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
- F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

### 2.2 FABRICATION, GENERAL

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

- B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
- D. Fabricate supports, anchorages, and accessories required for complete assembly.
- E. Perform shop welding by AWS-certified procedures and personnel.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.
- B. Install goosenecks on curb base where throat size exceeds 9 by 9 inches (230 by 230 mm).
- C. Install gravity ventilators with clearances for service and maintenance.
- D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Division 07 Section "Joint Sealants" for sealants applied during installation.
- F. Label gravity ventilators according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

### 3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.

### 3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

## END OF SECTION

## 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  $24 \times 24 \times 5/8$  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.
- 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 facilities.
  - 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

### 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/cm2).
- 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

ULTRA-VIOLET GERMICIDAL IRRADIATION (UVGI) SYSTEM 23 42 00

- 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. 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

ULTRA-VIOLET GERMICIDAL IRRADIATION (UVGI) SYSTEM 23 42 00

A. Install per manufacturer's recommendation.

END OF SECTION

ULTRA-VIOLET GERMICIDAL IRRADIATION (UVGI) SYSTEM 23 42 00 QTA 30% SUBMITTAL 09/23/2016 Page 4 of 4

### SECTION 23 52 00 HOT WATER BOILERS

### PART 1 - GENERAL

### 1.1 DESCRIPTION

- A. General: Provide packaged hydronic boilers, complete, as shown, specified or required per Contract Documents.
  - 1. Other Applicable Sections: Applicable portions of Division 01 and Sections 230500 "COMMON WORK RESULTS FOR HVAC", apply to work of this Section.

#### 1.2 RELATED DOCUMENTS

- A. Section includes gas-fired, copper finned-tube hydronic heating boilers
- B. Related Sections
  - 1. Facility Natural Gas Piping Division 23, Section 23 11 23.
  - 2. Instrumentation and Controls of HVAC Division 23, Section 23 09 00
  - 3. Electrical Division 26, Section 26 09 33

#### 1.3 STANDARDS

- A. Materials, equipment, and installation shall comply with all applicable building laws and with published standards of:
  - 1. ASME Boiler and Pressure Vessel Code, Section IV, Title "Heating Boilers".
  - 2. UL Listing and Label.
  - 3. State of California Electrical Safety Orders.
  - 4. California State Fire Marshal.
  - 5. State of California, Division of Industrial Safety Orders.
  - 6. NEC.
  - 7. SCAQMD Low Nox approved boilers.
  - 8. ANSI 221.13/CSA 4.9.

### HOT WATER BOILERS

- 9. I = B = R.
- 10. 2006 ASME CSD-1.
- 11. NFPA 54/ANSI Z223.1.

### 1.4 SUBMITTAL REQUIREMENTS

- A. Refer to Division 01 and Division 23 Section 230500 "COMMON WORK RESULTS FOR HVAC".
- B. Submittal material shall include, but not be limited to, the following:
  - 1. Descriptive Data:
    - a. Complete descriptive and capacity data.
    - b. Technical information and details of construction.
    - c. Installation and operating instructions.
    - d. Operating weights.
    - e. Provide and complete SCAQMD application forms for Permit to Construct/Operate Boiler.
    - f. Wiring diagram.
    - g. Warranty information.
  - 2. Shop Drawings:
    - a. Installation details.
    - b. Certified dimensions.
    - c. Control and wiring diagrams.
    - d. Schematic piping drawings.

### HOT WATER BOILERS

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. The complete packaged boiler shall be approved as a unit by Underwriters' Laboratories and shall bear the U.L. label. The complete boiler shall be designed for the seismic zone in which it is installed.
- B. Each boiler shall be completely preassembled and fire tested at the factory. Some items will be shipped loose for field mounting. The units shall be mounted on a concrete pad and ready for attachment of water, fuel, electrical and vent connections.
- C. The boiler shall be designed for 140 psi hot water operation with temperatures not exceeding 250°F.
- D. Boiler to be capable of operating down to 105°F without condensation.

### 2.2 PACKAGED BOILER

- A. General
  - 1. The boiler(s) shall be fired with natural gas with valves as specified on plans.
  - 2. The boiler(s) shall be CSA tested and certified with a minimum thermal efficiency of 87 percent at full fire (88.4% at part load).
  - 3. The boiler(s) shall be ASME inspected and stamped and National Board registered for 160 PSIG working pressure, complete with a Manufacturer's Data Report.
  - 4. The boiler(s) shall have a floor loading of -185 lbs. /square foot or less.
- B. Heat Exchanger
  - 1. The heat exchanger shall be of a single-bank, horizontal-grid design with eight integral copper- finned tubes, each end of which is rolled into an ASME boiler-quality steel tube sheet.
  - 2. The heat exchanger shall be sealed to 160 PSIG rated bronze headers with high temperature silicone "O" rings rating over 500°F.
  - 3. The low water volume heat exchanger shall be explosion-proof on the water side and shall carry a twenty-year warranty against thermal shock.
  - 4. The headers shall be secured to the tube sheet by stud bolts with flange nuts to permit inspection and maintenance without removal of external piping connections.

- 5. The boiler(s) shall be capable of operating at inlet water temperatures as low as 105°F without condensation.
- 6. The boiler(s) shall be designed to accommodate field changes of either left or right hand plumbing and electrical while leaving the tube bundle in place.
- 7. The boiler(s) flue connection, combustion air opening, gas connection, water connections and electrical connections shall be located on the rear.
- 8. The primary heat exchanger shall have accessible boiler drain valves with hose bibs to drain the water section of the primary heat exchanger.

### C. Burners

- 1. The combustion chamber shall be of the sealed combustion type employing high temperature FeCrAloy woven mesh burner, mounted in a vertical orientation.
- 2. The burner must be capable of firing at both a complete blue flame with maximum gas and air input as well as firing infrared when gas and air are reduced. The burner must be capable of firing at 100% of rated input when supplied with 4.0"WC of inlet gas pressure, so as to maintain service under heavy demand conditions; no exceptions.
- 3. The burner shall use a combustion air blower to precisely control the fuel/air mixture for maximum efficiency throughout the entire range of modulation. The combustion air blower shall operate for a pre-purge period before burner ignition and a post-purge period after burner operation to clear the combustion chamber.
- 4. The blower shall infinitely vary its output in response to a 4-20 mA signal supplied directly from the PID modulating temperature controller, thereby electronically and precisely adjusting the volume of air and gas supplied for combustion. Minimum fire shall be 25 percent of rated input.
- D. Ignition Control System
  - 1. The boiler(s) shall be equipped with a 100 percent safety shutdown system.
  - 2. The ignition shall be Hot Surface Ignition type with full flame rectification by remote sensing separate from the ignition source, with a three-try-for-ignition sequence, to ensure consistent operation.
  - 3. The igniter will be located away from the water inlet to protect the device from condensation during startup.
  - 4. The ignition control module shall include an LED that indicates six (6) individual diagnostic flash codes.
- 5. Two external viewing ports shall be provided, permitting visual observation of burner operation.
- E. Gas Train
  - 1. The boiler(s) shall have a firing/leak test valve and pressure test valve as required by CSD-1.
  - 2. The boiler(s) shall have dual-seated main gas valve(s).
  - 3. Gas control trains shall have a redundant safety shut-off feature, main gas regulator, shutoff cock and plugged pressure tapping to meet the requirements of ANSI Z21.13/CSA 4.9.
- F. Boiler Control
  - 1. The following safety controls shall be provided:
    - a. High limit control
    - b. Flow switch, mounted and wired
    - c. 45 PSIG ASME pressure relief valve, piped by the installer to an approved drain
    - d. Temperature and pressure gauge
  - 2. The boiler(s) shall be equipped with an energy-saving pump relay, mounted and wired, which automatically shuts off the boiler pump at a set period after boiler shut-down (adjustable for five or ten minutes) to avoid standby losses associated with constant pump operation.
- G. Firing Mode
  - 1. Provide on/off control of the gas input to the boiler.
- H. Boiler Diagnostics
  - 1. Provide external LED panel displaying the following boiler status/faults:
    - a. Power on Blue
    - b. Call for heat Amber
    - c. Flow Green
    - d. Stages 1 and 2 Green
    - e. Fan 1 proven Green

- f. Ignition fault Red
- g. Safety fault Red
- 2. Provide internal circuit board indicating the following safety faults by a 2-line, 20-character LCD display:
  - a. System status
  - b. Manual reset high limit
  - c. Blocked vent
  - d. Flow switch
  - e. Air pressure
  - f. Factory option
  - g. External interlock
  - h. Ignition lock-out
  - i. Auto reset high limit (optional)
  - j. Low water cut-off (optional)
  - k. Low gas pressure switch (optional)
  - 1. High gas pressure switch (optional)
  - m. Controller alarm (optional)
  - n. Cold Water Start/Cold Water Run (optional)
- 3. A Central Point Wiring board with diagnostic LED's indicating the status of each relay.
- 4. Provide ignition module indicating the following flash codes by LED signal and displayed on LCD display:
  - a. 1 flash low air pressure
  - b. 2 flashes flame in the combustion chamber w/o CFH
  - c. 3 flashes ignition lock-out (flame failure)
  - d. 4 flashes low hot surface igniter current

- e. 5 flashes low 24VAC
- f. 6 flashes internal fault (replace module)
- I. Combustion Chamber: The lightweight, high-temperature, multi-piece, interlocking ceramic fiber combustion chamber liner shall be sealed to reduce standby radiation losses, reducing jacket losses and increasing unit efficiency.
- J. Venting
  - 1. Boiler shall meet safety standards for venting as noted in UMC 2003 code 802.2.5 and 1107.6, ASHRAE 15-1994-, 8.13.6.

#### K. Cabinet

- 1. The corrosion-resistant galvanized steel jackets shall be finished with a baked-on epoxy powder coat which is suitable for outdoor installation, applied prior to assembly for complete coverage, and shall incorporate louvers in the outer panels to divert air past heated surfaces.
- 2. The boiler(s), if located on a combustible floor, shall not require a separate combustible floor base.
- 3. The boiler(s) shall have the option of venting the flue products either through the top or the back of the unit.
- 4. Combustion air intake shall be on the rearside of the cabinet.
- L. Operating Controls
  - 1. The boiler(s) shall be provided with two-stage digital controller with adjustable outdoor reset, mounted and wired.
  - 2. Water and air temperature sensors shall be shipped loose for field installation by installing contractor.
- M. Boiler Pump Refer to Equipment Schedule
- N. Cold Water Start System
  - 1. The boiler(s) shall be configured with a cold water start automatic proportional bypass system that ensures the boiler will experience inlet temperatures in excess of 105°F in less than 7 minutes to avoid damaging condensation. The unit will automatically shut down if the inlet temperature is not achieved within the 7 minute time frame. Provide bypass valve and install unit by manufacturer contractor.

- 2. The cold water start system shall be configured with a modulating three-way valve that is controlled by a system-matched PID controller. The PID controller temperature sensor shall be located in the inlet header of the boiler. The three way valve shall be factory furnished and installed by contractor.
- 3. The control shall have a temperature setting dial located on the face of the board. The temperature range of the dial shall be 105°F to 120°F. The PID Logic shall be capable of limiting system overshoot to a maximum of 10°F on initial start-up or call-for-heat.
- 4. The cold water start system shall be completely wired and mounted at the factory.
- 5. The control shall have the following diagnostic LED's:
  - a. Call for heat
  - b. Start-up mode
  - c. Inlet temperature error
  - d. Sensor out of range
- 6. The controller shall have alarm contacts.
- O. Cold Water Run System
  - 1. The boiler(s) shall be configured with a cold water run automatic proportional bypass system that ensures the boiler will experience inlet temperatures in excess of 105°F in less than 7 minutes to avoid damaging condensation. The unit will automatically shut down if the inlet temperature is not achieved within the 7 minute time frame.
  - 2. The cold water run system shall be configured with a variable-speed pump that is controlled by a system-matched PID control that injects the correct amount of cold water directly into the boiler loop to maintain a minimum inlet temperature. The PID controller temperature sensor shall be located in the inlet header of the boiler.
  - 3. The control shall have a temperature setting dial located on the face of the board. The temperature range of the dial shall be 105°F to 120°F. The PID Logic shall be capable of limiting system overshoot to a maximum of 10°F on initial start-up or call-for-heat.
  - 4. The cold water start system shall be completely wired and mounted at the factory.
  - 5. The control shall have the following diagnostic LED's:
    - a. Call for heat
    - b. Start-up mode

- c. Inlet temperature error
- d. Sensor out of range
- 6. The controller shall have alarm contacts.

#### 2.3 SOURCE QUALITY CONTROL

- A. The boiler(s) shall be completely assembled, wired, and fire-tested prior to shipment from the factory.
- B. The boiler(s) shall be furnished with the sales order, ASME Manufacturer's Data Report, inspection sheet, wiring diagram, rating plate and Installation and Operating Manual.

#### 2.4 WARRANTY

- A. Limited one-year warranty from date of installation
- B. Limited twenty-year thermal shock warranty
- C. Limited ten-year closed-system heat exchanger warranty

#### 2.5 MANUFACTURER

- A. Raypak or approved equal to Laars, PK.
- 2.6 INSURANCE UNDERWRITER APPROVAL
  - A. Furnish all controls, flame safety equipment and fuel trains to conform to the requirements of the Owner's Insurance Underwriter.

## PART 3 - EXECUTION

#### 3.1 EFFICIENCY GUARANTEE

A. The completed unit shall be guaranteed to operate at an efficiency of 80% or greater over the operating range.

#### 3.2 SHOP TESTS

A. Each complete packaged boiler shall receive factory tests to check construction, operation and function of all controls.

## 3.3 INSTALLATION

- A. Must comply with:
  - 1. Local, state, provincial, and national codes, laws, regulations and ordinances
  - 2. National Fuel Gas Code, ANSI Z223.1/NFPA 54 latest edition
  - 3. National Electrical Code, ANSI/NFPA 70 latest edition
  - 4. Standard for Controls and Safety Devices for Automatically Fired Boilers, ANSI/ASME CSD-1, when required
  - 5. Manufacturer's installation instructions, including required service clearances and venting guidelines
- B. Manufacturer's representative to verify proper and complete installation.
- C. VIBRATION ISOLATION AND SEISMIC RESTRAINTS
  - 1. Conform to Division 23, Section 230548, VIBRATION AND SEISMIC CONTROL FOR HVAC PIPING AND EQUIPMENT.

#### 3.4 START-UP

- A. Shall be performed by Raypak factory-trained personnel.
- B. Test during operation and adjust if necessary:
  - 1. Safeties (2.2 F)
  - 2. Operating Controls (2.3)
  - 3. Static and full load gas supply pressure
  - 4. Gas manifold and blower air pressure
  - 5. AMP draw blower
- C. Submit copy of start-up report to Architect and Engineer.

#### 3.5 TRAINING

A. Provide factory-authorized service representative to train maintenance personnel on procedures and schedules related to start-up, shut-down, trouble shooting, servicing, and preventive maintenance.

B. Schedule training at least seven days in advance.

END OF SECTION

HOT WATER BOILERS

QTA 30% SUBMITTAL 09/23/2016 Page 11 of 11

## 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.
- B. 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:
  - 1. The operational weight of the new equipment.
  - 2. The location of the center of gravity.
  - 3. Points of anchorage to the existing structure.
- C. 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.
  - 1. Factory assembled galvanized steel mounting curb designed and manufactured by unit manufacturer.
  - 2. Perimeter type with support of air handling sections.
  - 3. Minimum of 12 inches high.
  - 4. 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.

- C. Outside Casing Finish: outs
  - 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 SS 304 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: Plug fans or fan wall technology.
- 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.
- H. 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.
- B. 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.
  - 3. Motor shall be equipped with a maintenance free, circumferential, conductive micro fiber shaft grounding rings. Motor shaft grounding shall be factory provided and factory tested by Air handler unit manufacturer and cordinate with VFD design analysis.

## 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 1-1/2 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. Corrdinate with plumbing and position the condensate outlet to provide the shortest pipe run.
- 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

## 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. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
  - 1. ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings.

## 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.

PACKAGED ROOFTOP AIR CONDITIONING UNITS NON-CUSTOM 23 81 03 QTA 30% SUBMITTAL 09/23/2016 Page 1 of 6

- 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 WARRANTY

A. Furnish five year manufacturer's warranty for compressors, heat exchangers and condenser coils.

#### 1.5 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:

PACKAGED ROOFTOP AIR CONDITIONING UNITS NON-CUSTOM 23 81 03 QTA 30% SUBMITTAL 09/23/2016 Page 2 of 6

- 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:

PACKAGED ROOFTOP AIR CONDITIONING UNITS NON-CUSTOM 23 81 03 QTA 30% SUBMITTAL 09/23/2016 Page 3 of 6

- 1. Economizer:
  - a. Factory installed fully modulating motorized outside air and return air dampers controlled by dry bulb controller with minimum position setting.
  - b. Outside air damper normally closed and return air damper normally open.
  - c. Furnish barometric relief damper capable of closing by gravity.
  - d. Furnish rain hood with screen.
  - e. 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.

PACKAGED ROOFTOP AIR CONDITIONING UNITS NON-CUSTOM 23 81 03 QTA 30% SUBMITTAL 09/23/2016 Page 4 of 6

- 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 components furnished loose for field mounting.
- D. Install electrical devices furnished loose for field mounting.
- E. Install control wiring between unit and field installed accessories.

### 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.

PACKAGED ROOFTOP AIR CONDITIONING UNITS
NON-CUSTOM
23 81 03

QTA 30% SUBMITTAL 09/23/2016 Page 5 of 6

- 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 TRAINING

- A. Train LAWA Maintenance personnel to adjust, operate and maintain the packaged rooftop air conditioning unit non custom.
- B. Provide a minimum of 12 hours (3 hours) of classroom and hands on training to LAWA Maintenance personnel.

## END OF SECTION

## 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.
- 1. 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<sup>2</sup>t 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.
- 1. 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.
- 1. 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

## SECTION 23 81 19 PRE-CONDITIONED AIR

## PART 1 - DESCRIPTION

## 1.1 SCOPE OF WORK

- A. The scope of work for the Pre-Conditioned Air units includes but is not necessarily limited to engineering design, calculation, preparation of all installation drawings, co-ordination, manufacture, delivery to site, erection/installation, quality control, field testing, commissioning, training, operation and maintenance manuals, and hand-over of the following items:
  - 1. Apron mounted, air-cooled, direct expansion "Point of Use" packaged preconditioned air units.
  - 2. 14" flexible, heavy duty, high abrasion resistant vinyl coated fabric (flat, reinforced) air delivery hose of sufficient length to effectively service the farthest aircraft on each parking position, complete with couplings and connections to suit the various designated aircraft mix at each parking position requiring preconditioned air.
  - 3. PCA manual hose reels with built in chock storage.
  - 4. Electrical wiring, NEMA 4 disconnects and junction boxes, controls, and associated equipment including cabling to the detachable temperature sensor.
  - 5. Acoustic and vibration isolation facilities.
  - 6. Miscellaneous metalwork including fixing facilities to suit apron mounting.
  - 7. Supports and bases required for all equipment, pipe-work, condensate hose, conduits, panels, racks, and similar.
  - 8. Connection and termination of all power, control cabling, drainage, condensate hose and the like, at designated interface points including provision of terminal strips, panel openings, gland plates, bushes, flanges, and similar.

# 1.2 WARRANTY

A. This contractor shall provide a one-year written warranty against defects in material and workmanship furnished under this contract. The costs of such warranty shall be part of the purchase price. The warranty commences when the Los Angeles Building and Safety Department, and LAWA accepts the total installation.

- B. The warranty shall include all necessary material, travel, labor and parts to replace defective components or materials at the job site. This contractor shall comment repair of any, "in warranty" defects within 18 hours of notification of such defects.
- C. The warranty shall include all necessary factory and field items required to perform the specified tasks.

## 1.3 PREVENTIVE MAINTENANCE

- A. This contractor shall provide a one-year written preventive maintenance to maintain the equipment in working conditions. The one-year written preventive maintenance commences when the Los Angeles Building and Safety Department and LAWA accept the total installation.
- B. The one-year written preventive maintenance shall include all necessary material, travel, labor and parts to maintain all components of the installation in working conditions.

# PART 2 - EQUIPMENT AND MATERIALS

# 2.1 EQUIPMENT AND MATERIALS

- A. Each designated aircraft parking stand shall have an air cooled, Jet Bridge mounted packaged Pre-Conditioned Air unit (PCA) on the apron. The capacity of the PCA's shall be 75 ton and 90 ton depending on aircraft size.
- B. Key features shall include the following:
  - 1. The PCA's shall utilize 100% outside air which shall be cooled to near 30°F using multistage compressors. A high-pressure fan shall be used to overcome system resistance within the delivery hose and the aircraft distribution system. Pleated filters shall be provided at the PCA air intake.
  - 2. Variable electric heating shall be provided.
  - 3. The air delivery hose that connects the PCA to the aircraft shall be stored on a manual pull out hose reel parked adjacent to the PCA unit when not in use. A range of couplings and adapters shall be provided to suit the various types of aircraft using the stand as well as facilities for extending, joining or splitting an air supply as required. For units with dual hoses, provide labels and markings on both the PCA unit outlets and hose nozzles that read "Jumbo/NLA" and "CRJ/NB/WB" accordingly. Ensure that only one hose is pressurized when selector switch is on CRJ, NB or WB. Refer to plans for details of aircraft types
  - 4. Cooling coil condensate shall be pumped from each PCA unit to the designated area drain at close proximity to the unit, to drip onto the apron with pump operating correctly at various settings. Condensate hose shall run along the underside of the PCA unit to a raceway support and terminate at the designated area drain.

- 5. The PCA's shall be designed to operate automatically once initiated. Compressors shall be staged in response to either a 'supply air temperature' sensor or a 'cabin temperature' sensor. The supply air temperature sensor shall be located in the PCA supply air discharge plenum. The cabin temperature sensor shall be mounted and shall be attached to a 100 feet length of cable to allow it to be positioned within the aircraft cabin after the aircraft has parked. Provide manual cable reel for the sensor cable, which shall be attached on the frame of the PCA hose reel.
- 6. A rigid, NEMA 4X metal type local control panel for each PCA shall be mounted on a designated control panel mounting pole along the immediate area of the PCA unit at apron level by operators who shall be able to initiate and shutdown the PCA. The control panel shall have a LED pushbutton type selection panel with the types of aircraft listed (CRJ, Narrow Body, Wide Body and Jumbo/NLA). The airflow selection based on aircraft type will be manually selected by the operator using the push button control. A programmed control unit shall automatically set the following parameters to suit the aircraft:
  - a. Select either high or low airflow operation for different types of aircraft.
  - b. Select either 'cooling', 'ventilation' or 'heating'
  - c. Select temperature control set-points.
- 7. Fault indicators and mute facilities shall be provided on the exterior side of the PCA unit, easily accessible to the operator and maintenance personnel.
- C. The PCA shall operate in conjunction with other ramp facilities and a typical sequence of events shall be:
  - 1. Aircraft arrives.
  - 2. PCA flexible hoses are run out and connected to the aircraft.
  - 3. PCA aircraft type is entered, fan speed is automatically selected and the PCA is initiated at the local operator's control panel.
  - 4. PCA continues to run until shutdown by local operators.
- D. Design Criteria
  - 1. Performance Requirements:
    - a. General: Provide efficient and effective facilities in line with good commercial value.
    - b. Energy usage and running costs: Give due regard to equipment selections and system design to minimize energy usage and operating and maintenance costs.

- c. Flexibility: Provide PCA units, which are sufficiently flexible to enable a reasonable change of use in all areas without extensive modifications.
- d. Isolation facilities: Provide suitable isolation facilities for operation and maintenance, i.e. all take-offs from piping or cable risers, long horizontal runs and the like.
- 2. Space Requirements:
  - a. Check space requirements of equipment and services, which are, indicated diagrammatically in the contract documents. Select equipment with dimensions to suit the available space.
  - b. Coordinate and lay out equipment and services to be accessible for operation, maintenance and replacement and so as not to interfere with access to other installations. Make offsets as necessary.
  - c. Design with prime consideration to safety of crew, airport personnel, aircraft and equipment with good engineering practices and meeting all applicable standards, codes and regulations.
  - d. Design for easy maintenance, providing access to all components.
  - e. Design controls that are ergonomic, user friendly, and durable.
  - f. Design individual mechanical and electrical assemblies such that they can be easily accessed, maintained, and replaced quickly.
  - g. Design moving and fixed components to prevent catching, tripping or trapping of persons, articles or litter.
  - h. Use lubricants and design operating mechanisms, to be operative in local Los Angeles weather conditions.
  - i. Locate operating mechanisms and control hardware to protect against malfunction due to weather conditions or otherwise.
  - j. Give particular attention to keeping components simple, rugged and easily accessible for routine maintenance (including lubrication) and component exchange. Ease of adjustment and ability to retain adjustment are of equal importance. Access panels, if required, shall be sized to accommodate component being changed, together with equipment and personnel necessary to accomplish change. When possible, use package type components for ease of changing rather than necessitating repair in place. Utilities supply to components, electrical, hydraulic and pneumatic, shall be quick-disconnect type.
  - k. Provide suitable lugs (or similar cleats) where units can be anchored for the purposes of lifting and towering during maintenance and repairs.

- 1. Provide airflow rate per passenger to meet ASHRAE and aircraft manufacturers' standards for both heating and cooling.
- m. Airflow for static pressure, as shown on the table below, in relation to Aircraft Manufacturers' heating and cooling curves for the largest designated aircraft type.

Pre-Conditioned Air – Point of Use Equipment					
Unit Reference	<b>Type 2 (90 Ton)</b>				
Cooling					
High Speed Nominal Air flow (lb/min)					
at end of nozzle	240	440			
Required static pressure at end of					
nozzle for high speed nominal air flow					
(inch H <sub>2</sub> O)	25	35			
Nominal Cooling Capacity (ton)	75	90			
Number of Cooling Stages (min./max.)	3/4	3/4			
Entering Air (°Fdb/°Fwb)	98.0/70.0	98.0/70.0			
Leaving Air (°Fdb/°Fwb)	28/30	28/30			
Ambient (°Fdb/°Fwb)	98.0/70.0	98.0/70.0			
Heating					
High Speed Nominal Air flow					
(lbs/min) at end of nozzle	240	440			
Nominal Heating Capacity (kw)	50	100			
Number of Heating Stages (min./max.)	PWM	PWM			
Entering Air (°Fdb)	30.0	30.0			
Leaving Air (°Fdb) @end of nozzle	95.0	98.0			
Winter °Fdb	30.0	30.0			
General					
Discharge duct diameter (inch)	14	2x 14			
Electrical Supply /V/PH/Hz)	460V/3/60	460V/3/60			
Maximum allowance free field sound					
pressure level at 9 feet (all sides)					
(dBA)	85	85			
Condensate pump (gal/h/psi)	20.6/21.8	138.0/21.8			
	Panel Fabric, 25-30%	Panel Fabric, 25-30%			
	ASHRAE Standard 52	ASHRAE Standard 50			
Filter Type	Eff.	Eff.			
Nominal Dimensions –	As per Manufacturer's	As per Manufacturer's			
L(in) x W(in) x H(m)	Standard	Standard			
	As per Manufacturer's	As per Manufacturer's			
Nominal Weight (lbs)	Standard	Standard			

E. Shop Drawings and Submittals:

- 1. Submit within eight (8) weeks after contract award, a construction planning schedule showing production and shipping dates, initial prototype factory testing, delivery, installation, on-site testing and commissioning, and Final Acceptance.
- 2. Submit within eight (8) weeks of contract award, the following information:
  - a. Equipment starting and running currents, and recommended fuse ratings.
  - b. Confirmation of electrical power characteristic.
  - c. Heating/Cooling Load calculations for each PCA unit types on the largest designated aircraft type to be served.
  - d. Blower performance curves indicating operating condition points.
  - e. Blower motor ratings and electrical characteristics.
  - f. Condenser fan performance curves indicating operating points.
  - g. Condenser motor ratings and electrical characteristics.
  - h. Compressor operating characteristics, performance points.
  - i. Type and Quantity of Refrigerants.
  - j. Compressor motor ratings and electrical characteristics.
  - k. Overload protection devices for all motors.
  - 1. Strip heater characteristics.
  - m. Starter and contractor catalog cuts and other performance data.
  - n. Materials, gauges and finishes.
- 3. Submit within twelve (12) weeks after contract award for approval, dimensioned drawings, diagrams showing details of the fabrication, layout and installation of all PCA's, including relationship to structure and other services, all materials being supplied, connections, attachments, anchorage, including sequence of erection and supporting structures, electrical connections to building feed. The Trade Contractor shall submit detailed design analysis, showing loads and stresses in structural members, deflecting surface and bolted joints. Drawing shall use Imperial system of weights and measures.
- 4. Submit necessary templates and instructions where fastenings or anchor brackets have to be built in by other trades.
- 5. Submit within twelve (12) weeks after contract award for approval, samples of operator control panel, finished housing panels, control console graphics/text. Samples for

approval shall be visible in final finish. Samples for all operating buttons signage plaques shall be full size.

- 6. Provide drawings and details of associated work and details of interfaces, with standard imperial scale and dimensioned scale line to facilitate drawing reduction, in sufficient time to allow incorporation in the work by the other Trade Contractors in the most economical manner. Confirm dimensions by site measurement.
- 7. Submit drawings stamped and signed by qualified professional engineer registered or licensed in the State of California.
- 8. Eight (8) weeks prior to the application for Final Acceptance, provide:
  - a. Accurate, detailed AS-Built Record Drawings in "AutoCAD" CAD format, ensuring ease of reference for proper operation and maintenance of the equipment.
  - b. Label all As-built Record Drawings "As-Built" dated and signed by the engineer or consultant as appropriate.
- 9. Sustainability Requirements:
  - a. Product Data for PD14-MR-11: For sealants, adhesives, paints and coatings, including printed statement of VOC content.
  - b. Product Data for PD14-MR-11: Specify VOC emission requirements for the shop finished materials, including where applicable primed steel, finished metals, including aluminum and finished steels.
  - c. Laboratory Test Reports for PD14-MR-11: For sealants, adhesives, paints and coatings, documentation indicating that products comply with the VOC level limits outlined in the SCAQMD Rule 1168 (9 Adhesives and Sealants) and Rule 1113 (Paints and Coatings) and applicable source specific SCAQMD standards.
- 10. Shop drawings shall include without limitation the following:
  - a. Plant layout plans with sections and details.
  - b. Equipment layout with detailed sections.
  - c. Schematic and layout drawings of piping, ducting, tray and conduits, electrical and controls.
  - d. Schedule of electrical loadings.
  - e. Switchboard and control panel layouts and schematics with terminal numbering.
  - f. Cable type, size and marking details.

- g. Location and identifier for all equipment.
- h. Detail of all interfaces with other services and utilities.
- i. Services co-ordination drawings for spatial co-ordination with building structure and other services with details for restricted locations.
- j. Control logic diagrams with settings.
- k. Protection relay and circuit breaker settings.
- 1. Layout and details of services cast in concrete.
- m. Construction loadings.
- n. Label schedules.
- o. Lifting point loads.
- p. Comprehensive cooling and heating load calculations.
- q. Factory Performance Testing Protocols
- r. Site Performance and Functional Tests
- s. Standard Sequence of Operations for each PCA unit type.
- t. Technical information on cooling coils, electric motors, fans, electric heaters, refrigerant circuit components, filters, condensate pumps, compressors, etc.
- u. Copy of previously completed performance test for each type by an independent testing entity.
- 11. Identification
  - a. Identify the project, contract number, contract title, Trade Contractor, Trade Subcontractor or supplier, manufacturer, applicable product, model number and options, as appropriate and include pertinent contract document or equipment identifier references. Include service connection requirements and product certification. Identify non-compliances with project requirements, and characteristics, which may be detrimental to successful performance of the completed work.
- 12. Amendments
  - a. Submit amended documents as appropriate, highlighting changes since the previous submission.

## 13. Deviations

- a. Where selected equipment or systems do not fully comply with the contract, submit in a timely manner, giving reasonable time for review, details of proposed deviations for approval.
- 14. Alternatives
  - a. If alternatives are proposed, submit proposed alternatives and include cost, samples where specified, technical information, advantages and disadvantages of proposed substitutions including life, operating costs and effect on program. State if use of proposed alternatives will necessitate alteration to other parts of the works and include consequent costs.
- 15. Design
  - a. Submit documents showing the layout and details of the installation and the details of the design.
- 16. Maintenance Data and Manuals
  - a. Provide operating and maintenance data for incorporation into maintenance manuals.
  - b. Prior to application for Final Acceptance, provide the manufacturers Maintenance & Operating Manuals which shall have as a minimum, the following information:
    - 1) Description of Operation and Control including, but not restricted to, control system and special or non-standard features.
    - 2) Trouble Shooting.
    - 3) Servicing.
    - 4) Adjusting/Testing.
    - 5) Inspection/Checking.
    - 6) Approved Parts/Parts Lists.
    - 7) Recommended local maintenance/repair service providers.
    - 8) As Built Drawings.
    - 9) Mechanical and Electrical.
    - 10) Software/hardware passwords, if applicable.

- c. Information on each piece of equipment shall be assembled in following order:
  - 1) Equipment details such as: approved shop drawings, model, part and serial numbers.
  - 2) Maintenance details such as: lubrication, trouble-shooting procedures, adjustments techniques, and operations checks.
- d. All documents other than circuit diagrams larger than standard letter size paper shall be neatly folded and inserted in labeled envelope. All photocopies shall be totally legible.
- e. Maintenance and Operating manuals/binders shall be approved by the Consultant before certification of Substantial Performance.
- f. Provide three (3) copies of maintenance video (DVD format) for self-teaching of maintenance personnel. Videos shall be model specific.
- g. Submit operation and maintenance manuals for installations to provide a detailed understanding of the plant and its operation, an aid for training of operators, a reference for fault diagnosis and a framework for preventive and breakdown maintenance.
- F. Contractor to provide a 12-month warranty period for all components, free against any defects from the date of Final Acceptance.
- G. Assign the Owner all warranties for materials and equipment received from suppliers. Provide technical support, as required by the contract documents, and as agreed upon by the Owner. This support shall be by personnel qualified to advise the owner on training, provisioning, start-up and maintenance of the equipment.
- H. Provide a parts warranty which states material and equipment furnished and installed is new and free from faults and defects in material, workmanship, detail or incorrect component selection; conforms to the functional and technical requirements of this section and contract drawings; complies with all laws, statutes, ordinances and codes applicable at the installation site; and are suitable for the intended purposes.
- I. Provide a design warranty which states that the system, materials and equipment furnished and installed are free from faults and defects in design; conform to the functional and technical requirements of this section and contract drawings; comply with all laws, statutes, ordinances and codes applicable at the installation site; and are suitable for the intended purpose.
- J. The Trade Contractor shall supply and install factory fabricated Point of Use, air-cooled packaged Pre-Conditioned Air units (PCA's) in the locations indicated on the Drawings. The units shall include but not be limited to:
  - 1. Metal base stands for apron mounting.

- 2. Aluminum or Galvanized Sheet metal housings.
- 3. Fan motors, complete with variable frequency drives.
- 4. Cooling and condenser coils.
- 5. Filters.
- 6. Drain pans, pipe work, and condensate hose.
- 7. Thermal and acoustic insulation.
- 8. Vibration isolation and flexible connections.
- 9. Compressors.
- 10. PLC type controls including RSMS and Pressurization Fan interface facilities.
- 11. Flexible insulated lay-flat type hose; complete with nozzle and adaptors.
- 12. Flexible hose reels (manual).
- 13. Operator control panel.
- 14. Hose storage baskets and reels.
  - a. Each PCA installation shall meet scheduled capacity requirements for each parking position as a minimum, based on the aircraft mix for each position. Notwithstanding this requirement, the Trade Contractor shall submit to the Consultant for review, comprehensive cooling and heating load calculations generally in accordance with the principles and procedures detailed in most recent ASHRAE standards.
  - b. PCA units shall meet or exceed the performance criteria identified in the Pre-Conditioned Air – Point of Use Equipment table on Page 4 of this section for;
    - 1) Airflow (at design conditions).
    - 2) Static Pressure (at design airflow).
    - 3) Air Temperature (dry bulb and wet bulb).
- K. Fan performance shall meet total system requirements, including but not necessarily limited to, pressure drops across wet cooling coils, dirty filters, sound attenuators, dampers, plenums, ductwork, couplings, and similar.

- 1. Scheduled external fan static pressures are approximate. The Trade Contractor shall submit static pressure calculations to the Consultant for review before final selection and procurement of fans, motors, dampers and associated equipment.
  - a. Units shall be factory type tested as witnessed by Owner's representatives and rated in accordance with ASHRAE 37 or equivalent acceptable to the Consultant.
  - b. PCA unit construction including the following:
    - 1) The unit housing shall be fabricated from heavy gauge (min. gauge 16) galvanized, structural members and heavy gauge galvanized, folded sheet steel panels. Panels shall be fixed to structural members by welding, bolting or metal thread screws. Joints between sections shall be fitted with gaskets or shall be caulked to prevent air leakage. The complete unit shall be stiffened as necessary to ensure structural rigidity. Provide rubber bumper guard on each corner of the unit housing, including reflective yellow/black caution tape around lower portion of each PCA units.
    - 2) All equipment including fans, compressors, coils, valves, dampers, filters, motors, and similar, shall be accessible for inspection, adjustment, maintenance and removal from the one side of the PCA wherever possible.
    - 3) A structural steel channel or rolled steel hot dipped galvanized joist base shall be provided.
    - 4) The unit shall be provided with rigid, gasketed, non-leaking access doors and panels to provide access to items that may require adjustment, maintenance and/or removal.
    - 5) The access doors or panels shall be located in positions that are easily accessible after the unit is installed and shall be held in place by non-screwed clamps or handles such as tension fasteners.
    - 6) At least one cooling coil shall be downstream of the fan.

# 2.2 COOLING COILS

- A. Coils shall be type tested in accordance with ASHRAE 33 and rated in accordance with ARI 410.
- B. All coils shall be of the extended surface staggered tube type.
- C. The cooling medium shall be designed to enter the coil on the air leaving side.
- D. Coils shall be copper tubes and aluminum fins with a 19 gauge minimum thickness. The 1st stage cooling coil shall be selected at 300 fpm to prevent blocking.
- E. Coil support frames shall be constructed from brass or steel hot dip galvanized after fabrication. Provide protection to ensure coils do not touch any metal conduits.

PRE-CONDITIONED AIR

QTA 30% SUBMITTAL 09/23/2016 Page 12 of 25

- F. Coils shall be selected to totally avoid moisture carryover without the use of an eliminator.
- G. Coils shall be designed and installed to shed condensate without "water clogging' or causing an uneven air distribution across the face of the coil.
- H. Access for inspection shall be provided to all cooling coils.
- I. Condensate drains pans shall be located beneath each coil and shall be constructed of copper, stainless steel or epoxy coated heavy gauge galvanized sheet steel.
- J. Drain pans shall be configured to eliminate the effects of "cold bridging" to the unit casing.
- K. Drain pans shall be integral with cooling coils or designed and installed to allow removal of the cooling coil without the need to dismantle or damage the drain pan. The drain pans shall be of sufficient dimensions to collect all condensate.
- L. Drain pipe-work shall connect into the bottom of the drain pan and shall be extended through a sealed trap to the exterior of the unit housing. The trap shall be configured and sized to maintain a seal under full load, dirty filter and wet coil conditions.

#### 2.3 ELECTRIC MOTORS.

- A. General
  - 1. Motors shall be of the squirrel cage induction type.
  - 2. Motors rated 0.37 kW and above shall be arranged for 3-phase operation.
  - 3. Motors less than 1 1.0 kW shall be started direct on line.
  - 4. Motors and ancillary facilities shall be installed so that they are accessible for inspection, testing and maintenance without undue restriction.
- B. Construction
  - 1. Motors shall be totally enclosed fan cooled.
  - 2. Semi-hermetically sealed compressor motors are permissible.
  - 3. Motor enclosures shall be NEMA 3. Motor enclosures for condenser fans shall be NEMA 4x.
  - 4. Eyehooks shall be provided for all motors over 22lb.
  - 5. Motors driving equipment through belts shall comply with ISO 9608. Unless the driven unit is supplied with a suitable belt-tensioning device, the motor shall be supplied with slide rails.

- 6. All motors shall be insulated throughout with minimum IEC 85: Class F: Vacuum Impregnated Insulation and a maximum temperature rise under rated conditions not exceeding that allowed for Class B insulation. Insulation resistance between phases and to earth shall be a minimum 1 Mega-ohm.
- 7. Single-phase motors shall be capacitor start/induction run or repulsion start induction run.
- 8. All motors rated above 15 kW and all variable speed motors rated above 2.2 kW shall be fitted with thermistors.
- 9. Motors rated above 30 kW shall include anti-condensation heaters.

## C. Performance

1. Motors shall be designed to maintain the highest possible efficiency and power factor under all conditions of loading. Minimum motor efficiency shall be as follows:

Motor Size	Motor Efficiency	
5.5 kW – 1 1.0 kW	85%	
1 1.0 kW – 22.0 kW	88%	
22.0 kW and above	91%	

2. Operating noise of motors shall not exceed the sound power levels given below for all conditions of loading:

Overall Sound Power Levels (Ref 10 p W)							
Rating (kW)	0.75	4.0	7.5	15.0	37.0	75.0	
Sound Power (dBA)	64	69	74	79	86	91	

- 3. The continuous rating of motors shall exceed the specified full load duty by a minimum of 5% for compressors and 15% for fans.
- 4. Maximum motor speed shall be 1750 rpm.
- D. Motor Bearings
  - 1. Under design conditions, bearings shall have a minimum L10 life of 100,000 hours.
  - 2. Bearings shall be located in suitable housings with suitable shaft seals to prevent the entry of impurities and the escape of grease. All housings shall be fitted with accessible, capped grease nipples and relief plugs to enable bearings to be lubricated without the removal of end caps and without the risk of pressure build up. Motors shall be delivered with

bearings lubricated using a lithium-based grease suitable for minimum bearing temperatures of 300°F.

3. Alternatively, sealed for life housings may be fitted subject to review without objection by the Consultant.

## 2.4 FILTERS

- A. Filters shall be tested and rated in accordance with ASHRAE Standard 52.
- B. Filters shall be selected with a maximum face velocity of 500 ft/min with no moisture carry-over.
- C. Provide access to filters for inspection, removal and replacement.
- D. Filter media shall be made of synthetic or glass fibers and shall be disposable.
- E. Filter media shall be fixed within a system of enclosing and holding frames in a manner that prevents the bypass of air.
- F. Frames and media shall be capable of remaining in place without distortion or bypass at differential pressures up to twice the fan operating pressure.
- G. Filter media shall be secured within removable enclosing frames.
- H. Enclosing frames shall be supported within holding frames secured to and forming part of the associated PCA unit.
- I. Enclosing frames shall be secured in position to holding frames using fasteners that do not require the use of tools for fixing or removal. Provide sliding rails or similar to facilitate ease of removal and replacement of enclosing frames as required.
- J. Enclosing and holding frames shall be robust, non-corrosive and factory fabricated.
- K. Cartridge filters may have non-metallic enclosing frames where these are securely bonded to the filter media to form a rigid and stable assembly. All other frames shall be constructed of galvanized steel.
- L. When rated in accordance with ASHRAE 52, filters shall conform to the following:

'Maximum Initial Resistance'	0.3 In WC		
'Minimum Average Arrestance'	80%		
'Minimum Average Efficiency'	30%		
'Minimum Dust Holding Capacity'	939 g/sf		
At design air quantity and design final resistance	0.5 In WC.		

M. Filters shall have a pleated extended surface arrangement.

## 2.5 FANS

- A. Fans shall be tested in accordance with:
  - 1. ASHRAE 51/AMCA 210 Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
  - 2. ASHRAE 68 Laboratory Methods of Testing to Determine Sound Power in a Duct.
  - 3. ARI Standard 670.
- B. Fans shall be of welded mild steel construction. Axial condenser fans may be of marine grade aluminum or similar construction subject to review without objection by the Consultant.
- C. Under all operating conditions, fan performance characteristics shall exhibit increasing pressure development with reduction in air quantity and a unique operating point for each pressure.
- D. Belt driven fans shall use a v-belt drive rated at not less than 150% of actual full load and shall have a minimum of two belts. Provision shall be made for belt adjustment.
- E. Belt guards to protect belts and pulleys shall be provided including provision for insertion of a tachometer.
- F. Bearings shall be ball type or roller type. Under design conditions bearings shall have a minimum life of 100,000 hours.
- G. Bearings shall be located in dust tight housings with suitable shaft seals to prevent the entry of impurities and the escape of grease. All housings shall be fitted with accessible grease nipples and relief plugs to enable bearings to be lubricated without the removal of end caps and without the risk of pressure build up. Fans shall be delivered with bearings lubricated using a lithium-based grease suitable for minimum bearing temperatures of 302°F.
- H. Alternatively, sealed for life housings may be fitted for smaller fans, subject to review without objection by the Consultant.

#### 2.6 ELECTRIC HEATERS

- A. Electric heaters mounted in PCA's shall incorporate the following design features:
  - 1. Electric heater components, controls and installation shall comply with Relevant Authority requirements.
  - 2. Unless otherwise reviewed without objection by the Consultant, heating elements shall be designed to operate at "black heat" with a maximum flux of approximately 3.25W per Sq Ft; maximum sheath temperature shall not exceed 752°F at 68°F ambient conditions.

- 3. Notwithstanding the above, sheath materials and sheath operating temperatures shall be selected so that adjacent materials, equipment and components are unaffected if all heating elements are fully energized at the time the air handling unit fan is shut down.
- 4. Element clearance from the edge of the unit shall not exceed 10% of the total unit or duct width when the heater is energized.
- 5. Heating elements shall be mounted horizontally from the one side of the unit.
- 6. Internal element supports shall be provided. Adequate provision shall be made for thermal expansion.

# 2.7 REFRIGERANT CIRCUIT, CONDENSING SECTIONS AND CONTROLS

- A. The refrigerant used shall be R134A or a refrigerant with a lower ozone depletion potential (ODP) and lower global warming potential (GWP). Design PCA system including blowers, condenser coils/fans and evaporator coil for optimum performance with R410A refrigerant.
- B. The Trade Contractor shall provide hermetic or accessible hermetic compressors and motors. The refrigeration compressor shall contain inherent manual reset high, and low-pressure cutouts, in addition to an automatic reset suction pressure cutout. Provide defrost facilities as applicable.
- C. Provide discharge and liquid shutoff valves, filter dryers and refrigerant sight glasses.
- D. Provide refrigerant capacity control down to 33% of the total capacity. Use variable electric reheat capacity control below 33%.
- E. Condenser coils shall be copper tube with aluminum fins 14 gauge minimum thickness and constructed generally in accordance with the requirements for cooling coils.

## 2.8 AIRCRAFT COUPLINGS AND ADAPTERS

- A. The Contractor shall provide a wide range of couplings and adapters for all aircraft scheduled on each stands as shown on Plans. Features shall include but shall not necessarily be limited to the following:
  - 1. Couplings shall be robust, lightweight and corrosion resistant.
  - 2. All couplings shall incorporate facilities for quick fixing and release.
  - 3. Provide extended throats, levers, handles and the like on all aircraft couplings to enable attachment and release with the operator hands positioned no higher than 6 feet above the apron.
  - 4. At each stand, provide coupling facilities for joining at least two hoses without tools, tape, sealant or similar; and where applicable, couplings shall comply with 'C10 British Standard for Coupling Dimensions for Aircraft Ground Air Conditioning Connections.

B. Couplings and adapters shall be designed to operate satisfactorily at design flow rates and pressure.

# 2.9 MANUAL PUSH-OUT HOSE REELS

- A. Provide flat hose reel carts for storage of the hose in accordance to the size of the PCA unit with one cart for each 75 ton unit and two carts for each 90 ton unit. The carrier shall be:
  - 1. Constructed from sturdy steel construction and hot dipped galvanized sheet steel. Paint Color to be specified by the Owner.
  - 2. Robust construction designed to accommodate the weight of all hoses, fittings, couplings, adapters, chocks storage, cable reel for the cabin sensor and similar, plus 970 lbs.
  - 3. Large enough to house the hose and designed to secure hoses, couplings and other fittings and accessories under storm conditions, including the provision of a flexible lid or strap that will secure the flexible hose under storm conditions.
  - 4. These storage facilities shall be positioned and where applicable move in a manner that minimizes disruption to ramp operations and minimizes the required length of hose.
  - 5. Designed and manufactured with no protrusions, burrs, edges and similar features likely to 'catch' and/or damage hoses and associated fittings.
  - 6. Designed and arranged to facilitate ease of removal, run-out, and repacking of hoses and accessories.

# 2.10 AUTOMATIC CONTROLS – GENERAL

- A. Controls shall be factory wired with site cabling limited to connection of field devices.
  - 1. The Contractor shall provide all factory and on-site testing and commissioning equipment.
  - 2. All sensors, controllers, relays and operating mechanisms shall be readily accessible for maintenance.
  - 3. Provide appropriate smoke sensor to automatically shut down PCA during a fuel spill fire.
- B. Equipment shall be provided with identifying nameplates or stencils on the front of the service door of the unit, including laminated phenolic plastic nameplate.
- C. All electrical components associated with the automatic control system shall have the approval of the Consultant and all Relevant Authorities.
- D. Control facilities shall include but shall not necessarily be limited to:

- 1. Capacity and local operator controls.
- 2. Airside 'no flow' and 'over pressure" protection;
- 3. Refrigerant head pressure control;
- 4. High and low refrigerant pressure protection;
- 5. Motor over-current and over-temperature protection; and
- 6. Oil pressure failure protection.
- E. Each fault-monitoring device shall be manual reset. Separate indication shall be provided for each fault condition either at the relevant device or on the motor control centre.

## 2.11 LOCAL OPERATOR'S CONTROL PANELS

- A. All packaged preconditioned air units (PCA units) shall be started and shutdown from the local operator's control panel located at apron level or at the unit, using momentary contact lighted push buttons complete with self holding relays.
- B. Local operator's control panel (push button station) shall be on NEMA 4X box and enable automatic selection of:
  - 1. Either "cooling", "ventilation" or "heating";
  - 2. Aircraft type category
- C. The airflow selection operation based on aircraft type will be manually selected by the operator using the push button control.
- D. PCA equipment shall be sufficiently robust to enable a change in ventilating and temperature control modes, and fan speed while the unit is operating.
- E. Local operators shall be able to independently select 'supply air' and 'cabin' temperature set points.
- F. The Contractor shall provide the following monitoring facilities at the exterior face of the PCA units by a LCD display.
  - 1. Status indication of all operating and control mode;
  - 2. Common fault indication with electronic sounder with mute facilities or fault lamps, which includes, but not limited to, compressor fault, heater fault, over-pressure fault, ambient probe, discharge probe, cabin probe fault, interlock fault.
- G. The Contractor shall provide a lamp and electronic sounder test pushbutton at the local operator's control panel.

# 2.12 PCA CONTROL FACILITIES

- A. Compressors shall cycle in response to the relevant temperature sensor selected as the control mode.
- B. Condenser fans shall cycle in response to head pressure.
- C. Provide automatic coil defrost facilities arranged and controlled to minimize the effect on overall PCA cooling capacity.
- D. When low fan speed is selected, the final stage of cooling shall be locked out.
- E. An on-site emergency stop pushbutton shall be integrated with the power supply.

# PART 3 - CONSTRUCTION METHODS

# 3.1 CONSTRUCTION METHODS

- A. The Contractor shall coordinate the installation with other ramp services and associated utility connections, and verify conditions in the field prior to start of work. If unanticipated mechanical, electrical or other elements that conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict. Submit written report to the Consultant in accurate detail. Pending receipt of directive from the Consultant, rearrange work schedule as necessary to continue overall job progress without undue delay.
- B. Cover and protect systems equipment from damage and soiling during installation.
- C. Perform installation work as shown, with due care, including support, bracing, etc. Trade Contractor is responsible for damage, which may be caused by such work, to any part of existing system. Perform work in accordance with applicable technical sections of the specifications. Where cutting and new work involve the exterior building envelope, including the new apron pavement, consult the Consultant to ascertain if existing guarantees, warranties or bonds are in force and execute the work so as not to invalidate such agreements.
- D. Execute the work in a careful and orderly manner, with the least possible disturbance or conflict to operations, other construction work and occupants if affected area is designated as being occupied during installation.
  - 1. Take necessary precautions to keep noise producing operations to a minimum. Select equipment which is of a quieter nature than others and enclose areas of operations with acoustical screens, if necessary.
  - 2. Locate installation and alteration equipment safely so that no part endangers normal airport operations; including runways, terminals, taxiways, apron, approach ways, power utility, lighting, and communication lines.
  - 3. Promptly remove debris to avoid interference with system operations.

- E. Ensure that the standard of work and materials throughout the project shall be of first-class quality and workmanship in every respect. Workmanship which for any reason is otherwise will not be accepted by the consultant.
- F. Fabrication and installation of the PCA shall be in strict compliance with the specifications, applicable standards and codes, construction drawings and shop drawings to be prepared in compliance with the contract documents.
- G. Provide all supports, brackets, anchors, bollards, and any other items necessary to facilitate the complete installation and safe operation of all equipment and components. Mounting of this equipment to the apron pavement shall be by lead expansion anchor, cast-in-place anchor bolts, or a method approved by the Engineer. Mounting of this equipment to the apron shall be by lead expansion anchor, cast-in-place anchor bolts or a method approved by the Engineer.

# 3.2 ELECTRICAL INSTALLATION – OPERATING SUPPLIES

- A. All nominal mains power supply will be 480 V, 3 ph and N 60 Hz.
- B. The Contractor shall ensure that the voltage drop is less than 0.5% within all circuits fed from switchgear and power panel assemblies installed as part of the Work.
- C. The control supply shall be 24 V, 1 ph and N, 60 Hz. Control voltages less than 24 V will be permitted where such voltages are a design feature of factory wired mechanical equipment forming part of the installation.
- D. Interlocking between motor control centers and local control panels shall be carried out at 24 V, 1 ph and N, 60 Hz through interposing relays. The Contractor shall provide additional voltage transformers as applicable.

# 3.3 INSTRUMENTS

- A. Instruments, gauges, sensors and the like shall be calibrated and shall indicate in imperial units in accordance with ISO 1000.
- B. Indicating instruments shall be appropriate and selected so that all normal operating conditions are in the mid range of the scale. Scale ranges shall be selected so that system conditions are shown when equipment is running and when it is stopped. Graduation shall be appropriate for the operating range and application to which the instrument is to be put. Graduation shall be at a maximum of 10% intervals over the operating range of the instrument.

# 3.4 WIRING SYSTEMS AND CABLE MANAGEMENT

A. All wiring from the main distribution panel within the RON area to the junction box for the PCA units shall be provided by others and shall be carried out using PVC insulated cables enclosed in conduits or wiring ducts. PCA Trade contractor shall be responsible from input cables from the designated junction box to PCA unit in accordance with the specifications of this contract and shall meet local, state and federal code requirements.

- B. All cables or wires from PCA unit to power junction box/disconnect switch shall be properly secured with appropriate rigid supports and installed without damage to insulation and without kinking. Cables or wires with damaged insulation shall be replaced.
- C. Cables shall be terminated only in terminals of equipment or accessories.
- D. All cable and wire ends shall be prepared for termination without damaging strands. Lugs or clips shall be fitted to prevent strands from spreading then terminals are tightened.

## 3.5 MCC CABLING

A. All incoming and outgoing cables whether power or control, shall be terminated in the fixed portions of units. All necessary cable end boxes, gland plates, cable glands, cable trays, cable lugs, and conduit entries shall be provided between terminations and equipment. Cable entries shall correspond to the protective NEMA standard specified.

## 3.6 WORKMANSHIP

- A. Perform installation work as shown, with due care, including support, bracing, etc. Contractor is responsible for damage, which may be caused by such work, to any part of existing system. Perform work in accordance with applicable technical sections of the specifications. Where cutting and new work involve the exterior building envelope, including the new apron pavement, consult the Engineer to ascertain if existing guarantees, warranties or bonds are in force and execute the work so as not to invalidate such agreements.
- B. Execute the work in a careful and orderly manner, with the least possible disturbance or conflict to operations, other construction work and occupants if affected area is designated as being occupied during installation.
  - 1. Take necessary precautions to keep noise producing operations to a minimum. Select equipment which is of a quieter nature than others and enclose areas of operations with acoustical screens, if necessary.
  - 2. Locate installation and alteration equipment safely so that no part endangers normal airport operations; including runways, terminals, taxiways, apron, approach ways, power utility, lighting, and communication lines.
  - 3. Promptly remove debris to avoid interference with system operations.
- C. Ensure that the standard of work and materials throughout the project shall be of first-class quality and workmanship in every respect. Workmanship which for any reason is otherwise will not be accepted by the Engineer.
- D. Ensure that all equipment, components and materials are free from defects.

# 3.7 METAL SURFACES

- A. Protect all metal surfaces from corrosion using one or more of the following methods;
  - 1. Protect all unpainted surfaces with a suitable rust inhibitor during shipping and installation.
  - 2. Apply an industrial quality primer and enamel to all surfaces to be painted in accordance with the manufacturer's directions. All paint shall be of the same make, type and color (as approved by Architects).
  - 3. Finish paint (gray) electrical enclosures normally purchased primed prior to assembly and delivery to the work site.
  - 4. Prepare surface to be painted in accordance with paint manufacturer's requirements.
  - 5. Touch up painted surfaces scratched or damaged during installation.

# 3.8 TESTING

- A. Do not commence production of equipment, materials or components, until required submission, including performance testing plan, have been reviewed with no exceptions taken and prototype testing and inspection have been completed as witnessed by Owner's representatives. Extent of submissions will comprise; technical specifications and drawings, size, arrangement, operating and maintenance clearances, capacity, energy consumption and power factor, motor power requirements (full and starting load), control details, evidence of compliance with product certification (i.e. NFPA). This part of the specification outlines the responsibilities, procedures and tagging system to be used during testing and commissioning of the Pre-Conditioned Air. It provides the procedures for inspection, testing and trials of the PCA and all of its associated components, including all aspects of commissioning for mechanical, piping, electrical, instrumentation and over-all equipment installation. The usefulness of inspections, testing and commissioning is in most cases lost if the results are not immediately and properly recorded. For this reason, the Contractor shall develop and submit for the Engineer's review and approval a testing and commissioning form as a convenient means of recording and transmitting installation checks and test data. Test acceptance criteria shall be prepared by the Trade Contractor in accordance with the Technical Specifications and included as part of each Test Results Form as approved by the Engineer. Acceptance criteria may not be changed by the Trade Contractor except with the consent of the Engineer in writing.
- B. Stage 1 Commissioning of Individual Equipment
  - 1. This stage of commissioning consists of factory testing, including complete inspection, functional and performance testing of each piece of equipment individually, checking that electrical control and power wiring has been connected to the equipment correctly and checking the calibration of each instrumentation loop as related to the scope of work of the contract. It is the Contractor's responsibility to direct, furnish all necessary equipment and appliances for the conduct of and carrying completely this Stage 1 commissioning. The Engineer will provide technical assistance where necessary. The Engineer will approve the inspections and witness the tests.

# C. Stage 2 – Commissioning of Systems

1. This stage of commissioning consists of successfully conducting field functional and performance tests and operating the equipment grouped together into a module or system. Stage 2 will be directed by the Engineer; and related work will be done by the Contractor/Manufacturer, supplying all required testing equipment and appliances. At the end of Stage 2 commissioning, the Contractor will have corrected any deficiencies, which the Engineer deems necessary to proceed with Stage 3 commissioning (start-up). The Engineer will prepare a list of the Contractor's remaining work deficiencies, to which the Contractor will agree in writing to remedy. The Contractor shall correct these and any other deficiencies covered under the responsibilities and warranties as defined by the contract. All testing and commissioning shall be undertaken by the Contractor's appropriate testing and commissioning specialist or by a competent independent commissioning specialist nominated by, paid by and acting for the Contractor whose nomination has been reviewed without objection by the Engineer. The Contractor shall provide all necessary skilled labor and assistance for testing, operating, adjusting, commissioning and verifying the performance of all PCA units. The Contractor's testing and commissioning staff shall have had previous experience with testing and commissioning similar equipment/installation of comparable duty. The Contractor's relevant specialist testing and commissioning staff including supervisors shall be available on Site at all times during testing and commissioning of the PCA units. The Contractor shall provide all portable and supplementary instrumentation, recording facilities, consumables and the like required for all factory tests and testing and commissioning on site. Testing and commissioning instrumentation shall be designed for field use and to minimize field measurement errors through the use of electronic sensors, digital displays and similar devices. The calibration of instruments shall be demonstrated immediately prior to, and after completion of testing and commissioning, and current calibration certification submitted to the Engineer for record purposes.

# PART 4 - MATERIAL REQUIREMENTS

# 4.1 MATERIAL REQUIREMENTS

- A. NEC National Electrical Code
- B. NEMA National Electrical Manufacturer's Association
- C. ANSI American National Standards Institute
- D. ASME American Society of Mechanical Engineers
- E. ARI Air Conditioning and Refrigeration Institute:
  - 1. 410: Standard for Forced-Circulation Air Cooling and Air Heating Coils
  - 2. 850: Commercial and Industrial Filter Equipment
- F. ASHRAE American Society of Heating, Refrigeration and Air conditioning Engineers:

- 1. 15: Safety Code for Mechanical Refrigeration
- 2. 52: Method of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter
- 3. AFBMA Anti-Friction Bearing Manufacturer's Association
- 4. MIL-S-23586C Sealing Compound, Electrical, Silicone Rubber
- 5. Building Industry Consulting Service International (BICSI)
- 6. ANSI/IEEE STD 81 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

# PART 5 - MEASUREMENT AND PAYMENT

# 5.1 METHOD OF MEASUREMENT

A. Supply and Installation of Pre Conditioned Air units shall be measured per each complete unit assembly which will include the PCA equipment unit itself and all appurtenances such as hoses, operator control unit, hose reels, unit stand, cabling, cabin sensors and cable reel, wirings, panel boxes, all bollards associated with the ramp services enclosures at the RON apron, conduit, power connections, and safety switches, measured as installed, operational and accepted as compliant to the requirements of the contract.

#### 5.2 BASIS OF PAYMENT

- A. Payment will be made under:
  - 238119.1 Pre-Conditioned Air Unit, 75 Ton with Appurtenances per each
  - 238119.2 Pre-Conditioned Air Unit, 120 Ton with Appurtenances per each

#### END OF SECTION

# SECTION 23 81 23.16 HVAC FOR TELECOM ROOMS

# PART 1 - GENERAL

## 1.1 SUMMARY

- A. These Specifications describe requirements for an environmental control system. The system shall be designed to control temperature within the telecom rooms.
- 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

# HVAC FOR TELECOM ROOMS

- 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:

## 1.2 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. 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.

#### 1.4 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.

# HVAC FOR TELECOM ROOMS
## 1.5 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.

# 1.6 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.

# 1.7 FIELD/SITE CONDITIONS

A. A Contractor shall coordinate the existing field conditions with new HVAC unit and refrigerant lines.

#### 1.8 WARRANTY

A. Furnish five (5) year manufacturer's warranty.

# 1.9 MAINTENANCE SERVICE

- A. Furnish service and maintenance of units for one (1) 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.

# PART 2 - PRODUCTS

## 2.1 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. Refer to mechanical schedule drawing for HVAC Liebert Unit Model Number 5 sizing.
- G. Manufacturers:
  - 1. Liebert.
  - 2. Approved equal.
- H. Product Description: Packaged, water or air cooled, factory assembled, pre-wired and prepiped unit, consisting of cabinet, fans filters, humidifier and controls, reheat and reheating coils. Refrigerant shall be R407C or R410A, for mounting above ceilings.
- I. Cabinet and Frame:

- 1. Cabinet: 14 gage welded steel with baked enamel finish, and lined with ½ inch think acoustic duct liner.
- 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.

# 2.2 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  $1-9.9^{\circ}F(1-5^{\circ}C)$
  - 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  $^{\circ}$ F or  $^{\circ}$ 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 Water Alarm Lockout Unit Operation
    - 4) High Head Pressure #1 and #2
    - 5) Loss of Power
    - 6) Compressor Short Cycle
- 2. Custom Alarms (2x)
  - a. User-customized text can be entered for the two (2) custom alarms.
    - 1) Filter Clog
    - 2) Water Detected
    - 3) 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.

# 2.3 FACTORY-INSTALLED OPTIONS

- A. 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.
- B. 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.
- C. 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.

# 2.4 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.

### 2.5 SPECIFICATIONS, WIRING SPECIFICATION, ORDERING INFORMATION

- A. Power:  $24VAC \pm 10\%$ , 50 to 60 HZ,  $24VA or 26VDC \pm 10\%$ , 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 3<sup>rd</sup> –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

## 3.1 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.

### 3.2 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.

# 3.3 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

### 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:

SPLIT-SYSTEM AIR-CONDITIONERS (DUCTED)

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.

# SPLIT-SYSTEM AIR-CONDITIONERS (DUCTED)

- 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

SPLIT-SYSTEM AIR-CONDITIONERS (DUCTED)

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.

# SPLIT-SYSTEM AIR-CONDITIONERS (DUCTED)

- 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

# SPLIT-SYSTEM AIR-CONDITIONERS (DUCTED)

# 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.

DUCTLESS SPLIT-SYSTEM AIR-CONDITIONERS

- 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.

#### DUCTLESS SPLIT-SYSTEM AIR-CONDITIONERS

- 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.
  - 2. Access Panels: Located on both sides of unit. Furnish with duct collars on inlets and outlets.
  - 3. 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.

DUCTLESS SPLIT-SYSTEM AIR-CONDITIONERS

- 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.
  - 1. 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.

# DUCTLESS SPLIT-SYSTEM AIR-CONDITIONERS

- 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.

# 3.2 TRAINING

A. Training shall include minimum of 10 LAWA personnel for 40 hours three shifts total, 16 hours shall be classroom training and 24 hours shall be hands on training.

# END OF SECTION

# DUCTLESS SPLIT-SYSTEM AIR-CONDITIONERS

# SECTION 23 82 19 FAN COIL UNITS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including general and supplementary conditions and Division 01 Specification sections, apply to this section.

### 1.2 SUMMARY

A. This section includes fan-coil units and accessories.

### 1.3 DEFINITIONS

- A. BAS: Building Automation System.
- 1.4 ACTION SUBMITTALS
  - A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
  - B. LEED Submittals:
    - 1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
    - 2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 "Systems and Equipment."
  - C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    - 1. Wiring Diagrams: Power, signal, and control wiring.
  - D. Samples for Initial Selection: For units with factory-applied color finishes.
  - E. Samples for Verification: For each type of fan-coil unit indicated.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, 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. Ceiling suspension components.
  - 2. Structural members to which fan-coil units will be attached.
  - 3. Method of attaching hangers to building structure.
  - 4. Size and location of initial access modules for acoustical tile.
  - 5. Items penetrating finished ceiling, including the following:
    - a. Lighting fixtures.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
  - 6. Perimeter moldings for exposed or partially exposed cabinets.
- B. Manufacturer Seismic Qualification Certification: Submit certification that fan-coil units, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    - a. 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."
    - b. 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."
  - 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.

FAN COIL UNITS

QTA 30% SUBMITTAL 09/23/2016 Page 2 of 15

- C. Field quality-control test reports.
- D. Warranty: Special warranty specified in this Section.

# 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

# 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fan-Coil-Unit Filters: Furnish one spare filter for each filter installed.
  - 2. Fan Belts: Furnish one spare fan belt for each unit installed.

# 1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 "Systems and Equipment" and Section 7 "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 "Heating, Ventilating, and Air-Conditioning."

# 1.9 COORDINATION

- A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate size and location of wall sleeves for outdoor-air intake.

#### 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Compressor failure.
    - b. Condenser coil leak.
  - 2. Warranty Period: Five years from date of Substantial Completion.
  - 3. Warranty Period (Compressor Only): Five years from date of Substantial Completion.
  - 4. Warranty Period (Condenser Coil Only): Five years from date of Substantial Completion.

### PART 2 - PRODUCTS

## 2.1 FAN-COIL UNITS

- A. Manufacturers:
  - 1. Carrier Corporation.
  - 2. McQuay International.
  - 3. Trane.
  - 4. USA Coil and Air.
  - 5. YORK International Corporation.
- B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
- C. Coil Section Insulation: 1-inch (25-mm) thick, matte-finish, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
  - 1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
  - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

FAN COIL UNITS

QTA 30% SUBMITTAL 09/23/2016 Page 4 of 15

- D. Main and Auxiliary Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1. Drain pans shall be removable.
- E. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling screws.
- F. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.
  - 1. Vertical Unit Front Panels: Removable, steel, with integral stamped steel discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
  - 2. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with integral stamped discharge grilles.
  - 3. Stack Unit Discharge and Return Grille: Aluminum double-deflection discharge grille, and louvered- or panel-type return grille; color as selected by Architect from manufacturer's standard custom colors. Return grille shall provide maintenance access to fan-coil unit.
  - 4. Steel recessing flanges for recessing fan-coil units into ceiling or wall.
- G. Outdoor-Air Wall Box: Minimum 0.1265-inch- (3.2-mm-) thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen.
  - 1. Louver Configuration: Horizontal, rain-resistant louver.
  - 2. Louver Material: Steel.
  - 3. Bird Screen: 1/2-inch (13-mm) mesh screen on interior side of louver.
  - 4. Decorative Grille: On outside of intake.
  - 5. Finish: Baked enamel, color as selected by Architect from manufacturer's standard colors.
- H. Outdoor-Air Damper: Galvanized-steel blades with edge and end seals and nylon bearings; with electronic modulating actuators.
- I. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
  - 1. Washable Foam: 70 percent arrestance and 3 MERV.
  - 2. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.
  - 3. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.
- J. Fan and Motor Board: Removable.

QTA 30% SUBMITTAL 09/23/2016 Page 5 of 15

- 1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
- 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- 3. Wiring Termination: Connect motor to chassis wiring with plug connection.
- K. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
- L. Cooling and Heating Coils
  - Chilled Water Coils: Chilled water coils shall be aluminum sinusoidal plate fin type with belled collars and shall be bonded to 5/8 inch OD copper tubes by mechanical expansion. Coils shall be provided with headers for MPT or Victaulic connections. Working pressure shall be 300 psig at 200 degrees F. 0.008" thick aluminum-fin coils shall be provided with a wet-table finish to minimize water blow off. Coil casings and tube supports shall be 304 stainless steel. Coils shall be drainable and shall be provided with non-trapping circuits. Copper headers shall be provided with drain and vent connections external to unit.
  - 2. Hot Water Coils: Hot water coils shall be 0.008" thick aluminum plate fin type with belled collars bonded to 5/8 inch OD Coils shall be provided with copper or red brass headers for MPT connections. Working pressures shall be 175 psig at 400 F. Headers shall be furnished with drain and vent connections external to unit.
  - 3. Coil Tubes: Tube wall thickness shall not be less than 0.02 inch. Tube diameter with 0.025" brazed return bends on water and refrigerant coils. Tubes shall be 5/8-inch OD to ensure high thermal performance with lower total flow and reduced pumping requirements. Intermediate tube support shall be provided for coils over 44" fin length with an additional support every 42".
- M. Basic Unit Controls:
  - 1. Control voltage transformer.
  - 2. Wall-mounting thermostat with the following features:
    - a. Heat-cool-off switch.
    - b. Fan on-auto switch.
    - c. Fan-speed switch.
    - d. Automatic changeover.

- e. Adjustable deadband.
- f. Exposed set point.
- g. Exposed indication.
- h. Degree F indication.
- 3. Unit-mounted temperature sensor.
- 4. Unoccupied-period-override push button.
- 5. Data entry and access port.
  - a. Input data includes room temperature, and humidity set points and occupied and unoccupied periods.
  - b. Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.
- N. DDC Terminal Controller:
  - 1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
  - 2. Unoccupied Period Override Operation: Two hours.
  - 3. Unit Supply-Air Fan Operation:
    - a. Occupied Periods: Fan runs continuously.
    - b. Unoccupied Periods: Fan cycles to maintain room setback temperature.
  - 4. `Outdoor-Air Damper Operation:
    - a. Occupied Periods: Open damper to fixed position for 15 percent outdoor air.
    - b. Unoccupied periods: Close damper.
  - 5. Outdoor-Air Damper Operation:
    - a. Occupied Periods:
      - 1) Outdoor-Air Temperature below Room Temperature: If room temperature is above thermostat set point, modulate outdoor-air damper to maintain room temperature (outdoor-air economizer). If room temperature is below thermostat set point, position damper to fixed minimum position.

FAN COIL UNITS

- 2) Outdoor-Air Temperature above Room Temperature: Position damper to fixed minimum position for 15 percent outdoor air.
- b. Unoccupied Periods: Close damper.
- 6. Controller shall have volatile-memory backup.
- O. BAS Interface Requirements:
  - 1. Interface relay for scheduled operation.
  - 2. Interface relay to provide indication of fault at the central workstation.
  - 3. Provide BACnet interface for central BAS workstation for the following functions:
    - a. Adjust set points.
    - b. Fan-coil-unit start, stop, and operating status.
    - c. Data inquiry, including outdoor-air damper position, supply- and room-air temperature and humidity.
    - d. Occupied and unoccupied schedules.
- P. Electrical Connection: Factory wire motors and controls for a single electrical connection.

#### 2.2 DUCTED FAN-COIL UNITS

- A. Manufacturers:
  - 1. Carrier Corporation.
  - 2. McQuay International.
  - 3. Trane.
  - 4. USA Coil and Air.
  - 5. YORK International Corporation.
- B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
- C. Coil Section Insulation: 1-inch (25-mm)] thick foil-faced glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

- 1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
- 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1.
- E. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.
- F. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
  - 1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis with mill-finish, aluminum, double-deflection grille.
  - 2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
  - 3. Mixing Plenum: Sheet metal plenum finished and insulated to match the chassis with outdoor- and return-air, formed-steel dampers.
  - 4. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.
- G. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
  - 1. Washable Foam: 70 percent arrestance and 3 MERV.
  - 2. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.
  - 3. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.
- H. Indoor Refrigerant Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and brazed joints at fittings. Comply with ARI 210/240, and leak test to minimum 450 psig (3105 kPa) for a minimum 300-psig (2070-kPa) working pressure. Include thermal expansion valve.
- I. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
- J. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

QTA 30% SUBMITTAL 09/23/2016 Page 9 of 15

- K. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
  - 1. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- L. Remote condensing units are specified in Division 23 Section "Packaged Compressor and Condenser Units."
- M. Remote Condensing Units: Factory assembled and tested, consisting of compressors, condenser coils, fans, motors, refrigerant receiver, and operating controls. Construct, test, and rate condensing units according to ARI 210/240 and ASHRAE 15.
  - 1. Casing: Steel with baked-enamel finish, removable panels for access to controls, weep holes for water drainage, and mounting holes in base.
  - 2. Compressor: Hermetic, scroll type; internally isolated for vibration with factory-installed safety devices as follows:
    - a. Anti-recycle timer.
    - b. High-pressure cutout.
    - c. Low-pressure cutout or loss-of-charge switch.
    - d. Internal thermal-overload protection.
    - e. Current and voltage sensitive safety devices.
  - 3. Compressor Motor: Start capacitor, relay, and contactor. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 4. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."
  - 5. Refrigerant Piping Materials: ASTM B 743 copper tube with wrought-copper fittings and brazed joints.
  - 6. Refrigerant: R-407C or R-410A.
  - 7. Low ambient controls to permit operation down to 45 deg F (7 deg C).
  - 8. Crankcase heater.
  - 9. Charging and service fittings on exterior of casing.

QTA 30% SUBMITTAL 09/23/2016 Page 10 of 15

- 10. Filter dryer.
- 11. Air-to-Air Heat Pump: Pilot-operated, sliding-type reversing valve with replaceable magnetic coil, and controls for air-to-air heat pump operation with supplemental heat operation.
- 12. Hot-gas-bypass, constant-pressure expansion valve and controls to maintain continuous refrigeration system operation at 10 percent of full load.
- 13. Condenser: Copper-tube, aluminum-fin coil, with liquid subcooler.
- 14. Condenser Fan: Direct-drive, aluminum propeller fan.
  - a. Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- 15. Accessories: Polyethylene mounting base to provide a permanent foundation.
- N. Control devices and operational sequence are specified in Division 23 Section "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
- O. Basic Unit Controls:
  - 1. Control voltage transformer.
  - 2. Wall-mounting thermostat with the following features.
    - a. Heat-cool-off switch.
    - b. Fan on-auto switch.
    - c. Fan-speed switch.
    - d. Automatic changeover.
    - e. Adjustable deadband.
    - f. Exposed set point.
    - g. Exposed indication.
    - h. Degree F indication.
  - 3. Unit-mounted temperature sensor.
  - 4. Unoccupied-period-override push button.
  - 5. Data entry and access port.

- a. Input data includes room temperature, and humidity set points and occupied and unoccupied periods.
- b. Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.
- P. DDC Terminal Controller:
  - 1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
  - 2. Unoccupied Period Override Operation: Two hours.
  - 3. Unit Supply-Air Fan Operation:
    - a. Occupied Periods: Fan runs continuously.
    - b. Unoccupied Periods: Fan cycles to maintain room setback temperature.
  - 4. Refrigerant-Coil Operation:
    - a. Occupied Periods: Start compressor to maintain room temperature or humidistat set point.
    - b. Unoccupied Periods: Stop compressor cooling and cycle compressor for heating to maintain setback temperature.
  - 5. Outdoor-Air Damper Operation:
    - a. Occupied Periods: Open damper to fixed position for 15 percent outdoor air.
    - b. Unoccupied Periods: Close damper.
    - c. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
- Q. BAS Interface Requirements:
  - 1. Interface relay for scheduled operation.
  - 2. Interface relay to provide indication of fault at the central workstation.
  - 3. Provide BACnet interface for central BAS workstation for the following functions:
    - a. Adjust set points.
    - b. Fan-coil-unit start, stop, and operating status.

- c. Data inquiry including outdoor-air damper position, supply- and room-air temperature and humidity.
- d. Occupied and unoccupied schedules.
- R. Electrical Connection: Factory wire motors and controls for a single electrical connection.

#### PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fancoil-unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

# 3.2 INSTALLATION

- A. Install fan-coil units as shown on design documents and coordinate all required opening clearances and access panels.
- B. Install fan-coil units to comply with NFPA 90A.
- C. Suspend fan-coil units from structure with elastomeric hangers. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above finished floor.
- E. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

#### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
  - 1. Install piping adjacent to machine to allow service and maintenance.
  - 2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.

- 3. Connect condensate drain to indirect waste.
  - a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.
- B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
  - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

### 3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. 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 during other than normal occupancy hours for this purpose.
#### 3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Architect maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Division 01 Section "Demonstration and Training."

#### END OF SECTION

FAN COIL UNITS

QTA 30% SUBMITTAL 09/23/2016 Page 15 of 15

### SECTION 23 83 00 VARIABLE REFRIGERANT SYSTEMS FC|CU|BC UNITS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

A. This Section includes Variable Refrigerant Volume and Variable Refrigerant Flow split-system heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and connected to ducts.

### 1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For VR system air-conditioning units to include in emergency, operation, and maintenance manuals.
- F. Warranty: Special warranty specified in this Section.

#### 1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of VR system units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2013, Section 5 "Systems and Equipment" and Section 7 "Construction and Startup."

D. ASHRAE/IESNA 90.1-2013 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2013, Section 6 - "Heating, Ventilating, and Air-Conditioning."

### 1.5 COORDINATION

- A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 07 Section "Roof Accessories."

#### 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of VR system air-conditioning units that fail in materials or workmanship within specified warranty period.
- B. The units shall have a manufacturer's warranty for a period of two (2) years from date of manufacturer's startup in the commissioning process. The units shall have a limited labor warranty for a period of two (2) year from date of manufacturer's startup in the commissioning process. The compressors shall have a warranty of six (6) years from date of manufacturer's startup in the commissioning process. During the stated period, should any part fail due to defects in material and workmanship, it shall be repaired or replaced at the discretion of Owner. All warranty service work shall be performed by a manufacturer's factory trained service professional.

# 1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: Two set of filters for each unit, one for start up and an additional set for post construction turn over to Owner. Final filter to be installed by Contractor at turn over.

### PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Mitsubishi: or equal. Two pipe system shall only be accepted, no three pipe system substitution allowed.

#### 2.2 CEILING-MOUNTING, EVAPORATOR-FAN COMPONENTS (FC-1 Thru FC-11)

- A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
  - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2013.
  - 3. Drain Pan and Drain Connection: Comply with ASHRAE 62.1-2013.
- B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
- C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
- D. Fan: Direct drive, centrifugal fan. Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add paragraphs below to suit Project.
- E. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 1. Special Motor Features: Multi-tapped, multispeed with internal thermal protection and permanent lubrication.
- F. Filters: Disposable, with ASHRAE 52.2 MERV rating of 6 or higher.

#### 2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS (HEAT PUMP CU-1, 2, 3, 4)

- A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  - 1. Compressor Type: Scroll
  - 2. Variable-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.

- 3. Refrigerant: R-410A.
- C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
- D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.
- E. Fan: Aluminum-propeller type, directly connected to motor.
- F. Motor: Permanently lubricated, with integral thermal-overload protection.
- G. Low Ambient Kit: Permits operation down to 45 deg F.
- H. Mounting Base: Polyethylene.
- I. Minimum Energy Efficiency: Comply with ASHRAE/IESNA 90.1 "Energy Standard for Buildings except Low-Rise Residential Buildings."

#### 2.4 BRANCH CIRCUIT (BC) CONTROLLERS FOR R2-SERIES SYSTEMS (BC-1, 2)

- A. General: The BC (Branch Circuit) Controllers shall be specifically used with R410A R2-Series systems. These units shall be equipped with a circuit board that interfaces to the M-NET controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish. The BC Controller shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of rated capacity.
- B. BC Unit Cabinet:
  - 1. The casing shall be fabricated of galvanized steel.
  - 2. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.
  - 3. The unit shall house two tube-in-tube heat exchangers.
- C. Refrigerant
  - 1. R410A refrigerant shall be required.
- D. Refrigerant valves:
  - 1. The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and up to three indoor units. Branches may be twinned to allow more than 54,000 BTUH.
  - 2. Each branch shall have multiple two-position valves to control refrigerant flow.
  - 3. Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.

- 4. Linear electronic expansion valves shall be used to control the variable refrigerant flow.
- E. Integral Drain Pan: An integral condensate pan and drain shall be provided.
- F. Electrical:
  - 1. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
  - 2. The unit shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253V (230V/60Hz).
  - 3. The BC Controller shall be controlled by integral microprocessors.
  - 4. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

#### 2.5 REFRIGERANT PIPING

- A. Pipe: Type L hard drawing copper tube.
- B. Fittings: Copper solder Joint fitting. Silvabrite, Bridgit or Stay-Safe 50

#### 2.6 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Division 23 Sections "Instrumentation and Control for HVAC".
- B. Thermostat: Low voltage with sub base to control compressor and evaporator fan.
- C. Thermostat: Functioning to remotely control evaporator fan, with the following features:
  - 1. Compressor time delay.
  - 2. 24-hour time control of system stop and start.
  - 3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
  - 4. Fan-speed selection, including auto setting.
- D. Automatic-reset timer to prevent rapid cycling of compressor.
- E. A condensate pump (if required) wired to unit power.
- F. Condensate overflow safety switch protection.

- G. Fresh air intake and supply air duct connections.
- H. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
  - 1. Minimum Insulation Thickness: <sup>1</sup>/<sub>2</sub> inch.

#### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install ground-mounting, compressor-condenser components on 4-inch-thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.
- D. Install roof-mounting compressor-condenser components on equipment supports specified in Division 07 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- E. Install seismic restraints.
- F. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. Refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- G. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- H. The system must be installed by a manufacturer factory trained contractor/dealer. The bidders shall be required to submit training certification proof with bid documents. The mechanical contractor's installation price shall be based on the systems installation requirements. The mechanical contractor bids with complete knowledge of the HVAC system requirements.
- I. Contractors who wish to bid this project must have an experience with installations of a minimum of three Variable Refrigerant systems and performed factory training. Documentation and references are to be provided with bid documents.
- J. Manufacturer shall have a minimum of twenty years of HVAC experience in the U.S. market.
- K. The system shall be capable of refrigerant piping up to 540 actual feet or 620 equivalent feet from the outdoor unit to the furthest indoor unit, a total combined liquid line length of 3,280 feet of

piping between the condensing and fan coil units with 295 feet maximum vertical difference, without any oil traps.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to unit to allow service and maintenance.
- C. Provide a ball valve at all refrigerant piping connections to all units and controllers to allow complete refrigerant shutoff to unit for maintenance of unit or controller.
- D. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."
- E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- F. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.
- G. Provide a separate disconnect switch, provided and installed by electrical. Disconnect switch shall be a toggle switch of proper rating in a single gang "utility box". A thermal overload switch is not necessary if built-in thermal protection is provided. A factory wired non-fused disconnect switch shall be acceptable only if easily accessible for maintenance of unit.

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-certified service representative to inspect fieldassembled components and equipment installation, including connections Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
  - 1. Leak Testing of refrigerant piping system:
    - a. The high side and low side of each completed refrigeration piping system shall be pressure tested at a pressure not less than the lower of the system design pressure or the setting of the pressure relief device protecting the high side or low side of the system.
    - b. Exception: Field installed systems with copper tubing not exceeding 0.625" O.D., shall be tested by means of refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 68°F minimum.

- c. The testing media shall be dry nitrogen. The contractor shall perform the leak test before insulating, evacuating and charging, in the presence of the CNUSD Representative.
- d. Isolate the compressor from the leak test by firmly closing the suction and discharge valves.
- e. Where pressure relief valves are installed, position the three-way dual shut-off valves so that full test pressure is applied to both relief valves.
- f. Do not attempt to repair any leak while the system is pressurized. If any leaks are found, relieve the test pressure and perform repairs.
- g. Recharge the system, as previously described, and allow it to remain under pressure for 24 hours. Maximum pressure drop shall be 5 psig in 24 hours, at constant ambient temperature. For every 10°F drop in ambient temperature, from start of test, the maximum pressure drop may increase by 3 psig.
- h. Repeat until no leaks exist.
- 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

#### 3.4 STARTUP SERVICE

- A. Engage a manufacturer's representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

### 3.5 DEMONSTRATION

A. Engage a factory-certified service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Provide eight (8) hours training period. Refer to Division 01 Section "Demonstration and Training."

## END OF SECTION

### SECTION 25 20 00 BUILDING AUTOMATION SYSTEM (BAS)

# PART 1 – GENERAL

### 1.1 INTENT

- A. The intent of this Section is to define the requirements for a terminal Building Automation System (BAS). BAS is the total integrated system of fully operational and functional elements, including, but not limited to, equipment, software, programming, and associated materials.
- B. LAWA has designated the BAS for its Central Utilities Plant (Johnson Controls Metasis BACnet BAS with Wonderware Graphical User Interface) as the Facility Management Control System (FMCS) for LAX.
- C. LAWA has designated an FMCS Systems Administrator (FMCS SA) to coordinate BACnet tiein with all Terminal BAS Contractors and to perform all final termination and programming.
- D. There are three (3) existing Network Automation Engine (NAE) panels at Terminal 2, one located in mechanical room 4521 mezzanine level, one in pump room 1037 arrival level and one in mechanical room 1584 arrival level. Tie-in new mechanical equipment controls in to these NAEs. Refer to mechanical design drawings and controls riser diagrams for details.
- E. BAS contractor shall provide all necessary mapping including custom programming and graphic updates at existing BMS work station to monitor and control the new systems. Contractor shall be responsible for complete interface between new systems and existing BMS. All data required by the application shall be mapped into the Network Controller's database, and shall be transparent to the operator work station located at existing BMS located at pump room 1037 at arrival level Terminal 2. Point inputs and outputs from the controllers shall have real-time interoperability with BAS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Dial-Up and Local Area Network Communications
- F. BAS contractor shall decommission devices, networks, controllers, etc. where required. BAS contractor shall be responsible for keeping the existing Metasys system operational during construction period; perform all database modification necessary to keep system in proper operating condition during demolition phase. BAS contractor shall modify all graphics, trend logs, binding, etc. as necessary to reflect final conditions.
- G. BAS contractor to make safe (software), inventory, and decommission (software) controllers. Upon completion inform LAWA for salvaging of equipment by LAWA representatives.

#### 1.2 SUMMARY

- A. All work of this Section shall be coordinated and provided by a single BAS Contractor who shall be the primary manufacturer, installer, commissioner and ongoing service provider for the work.
- B. The work of this Section shall be scheduled, coordinated and interfaced with the associated work of other trades.
- C. If the BAS Contractor believes there are conflicts or missing information in the project documents, s/he shall promptly request, in writing, clarification and instruction from LAWA. In all cases, where conflicts in bid documents exist, the more extensive and costly alternative shall prevail with LAWA retaining the right to request a deduct change order to provide the lower cost alternative. Regardless, a fully functional BAS system shall be provided.
- D. Work Included:
  - 1. Contractor shall furnish and install all system equipment, Intelligent Local Controllers (ILCs), software, initial database and system programming, data link communications hardware, accessories, Field Interface Panels (FIPs), field sensors, control dampers and valves, data highway, wiring, conduit, and power wiring required for a complete and functioning BAS, based on the requirements of this section. Any hardware, software, programming, or installation required but needs not specifically mentioned or addressed within this section, which are required to provide a complete and functioning system in accordance with the intent of this section, shall be considered a part of this section.
  - 2. Provide catalog data sheets, wiring and control diagrams, point lists, factory support information, and sequence of operations for BAS to FMCS for coordination of work.
  - 3. Furnish and install all wire and conduit necessary to connect the BAS to the fire alarm panel for system interface.
  - 4. The entire communication backbone for the BAS is to include, but not limited to, all router, hubs, switches, converters, and Ethernet/fiber-optic cable plant required for a fully functional system shall be the responsibility of the BAS Contractor.
- E. System shall use the BACnet protocol for communication to the FMCS operator workstation and web server, and for communication between control modules. Schedules, set points, trends, and alarms shall be BACnet objects.
- F. The BAS Contractor is responsible for integration of the BAS and FMCS systems. The BAS Contractor shall provide Point of Connection (POC) of the BAS and the FMCS. The BAS Contractor shall provide minimum of 80 hours of labor for the BAS/FMCS integration.
- G. Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BAS Contractor where filing is necessary. Provide a copy of all related correspondence and permits to LAWA.

- H. Integration and monitoring:
  - 1. The BAS contractor shall be fully responsible for reviewing all other disciplines (Mechanical, Electrical, Plumbing, Lighting, Vertical Transportation) scope of work for the LAX Terminal-2 Renovation Project.; quantifying and providing complete interface (interface module, wiring, programming, etc.) to all equipment and systems listed and specified herein.
  - 2. The BAS contractor shall be fully responsible for reviewing the design of emergency power generators and their controls on electrical drawings. The BAS contractor shall be fully responsible for providing complete interface (interface module, wiring, programming, etc.) to connect these emergency power generators with Building Automation System.

# 1.3 QUALITY REQUIREMENTS

- A. General Requirements
  - 1. The BAS Contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and long term maintenance and service of total integrated building automation systems, of a recognized national manufacturer of building automation systems for no less than 15 years.
  - 2. The BAS Contractor shall have experience providing BAS services for a large campus environment comparable to LAX and for clients / organizations with similar complexity and diversity of facilities.
  - 3. The BAS Contractor shall have a branch facility within a 50-mile radius of the LAX site.
  - 4. As evidence and assurance of the BAS Contractor's ability to support LAWA's system with service and parts, the contractor must have been in the BAS business for at least the last fifteen (15) years and have successfully completed total projects of at least 10 times the value of this contract in each of the preceding five years within a 100 mile radius of the LAX site.
  - 5. The BAS architecture shall consist of the products of a manufacturer regularly engaged in the production of building automation systems, and shall be the manufacturer's latest standard of design at the time of bid.
  - 6. The BAS Contractor shall provide a list of five comparable projects that have Building Automation Systems with the features as specified for this project. These projects must be on-line and functional.
  - 7. Cost impact matrix will be provided as a part of the final specifications and will be used as an evaluation tool in the selection process of the BAS control contractor.
- B. Safety Requirements

- 1. Work shall comply with the requirements of Occupational Safety and Health Administration (OSHA), the Health and Safety requirements for the project and with all of the daily Health and Safety instructions given by the General Contractor.
- 2. Work shall comply in accordance with LAWA safety standard and LAWA (PR) project requirement documents.
- C. Quality Management Program
  - 1. Designate a competent and experienced employee to provide BAS Project Management. The designated Project Manager shall be empowered to make technical, scheduling and related decisions on behalf of the BAS Contractor. At minimum, the Project Manager shall:
    - a. Manage the scheduling of the work to ensure that adequate materials, labor and other resources are available as needed.
    - b. Manage the financial aspects of the BAS Contract.
    - c. Coordinate as necessary with other trades.
    - d. Be responsible for the work and actions of the BAS workforce on site.
- D. Requirements of Regulatory Agencies
  - 1. All work shall meet the requirements of local codes, ordinances, except where more strict requirements are specified. Codes and Standards which govern BAS work are as follows:
    - a. National Electric Code (NEC) and applicable local Electric Code.
    - b. Underwriters Laboratories (UL) listing and labels.
    - c. UL 916 Energy Management
    - d. NFPA 70 National Electrical Code.
    - e. NFPA 90A Standard For The Installation Of Air Conditioning And Ventilating Systems.
    - f. Factory Mutual (FM).
    - g. American National Standards Institute (ANSI).
    - h. National Electric Manufacturer's Association (NEMA).
    - i. American Society of Mechanical Engineers (ASME).

- j. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
- k. Air Movement and Control Association (AMCA).
- 1. Institute of Electrical and Electronic Engineers (IEEE).
- m. American Standard Code for Information Interchange (ASCII).
- n. Electronics Industries Association (EIA).
- o. Occupational Safety and Health Administration (OSHA).
- p. American Society for Testing and Materials (ASTM).
- q. Federal Communications Commission (FCC) including Part 15, Radio Frequency Devices.
- r. Americans Disability Act (ADA)
- s. ASHRAE Standard 135 (BACnet)
- t. LAWA Design & Construction Handbook

### 1.4 DEFINITIONS

- A. Analog: A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values.
- B. Binary: A two-state system where an "ON" condition is represented by one discrete signal level and an "OFF" condition is represented by a second discrete signal level.
- C. Control Sequence: A BAS pre-programmed arrangement of software algorithms, logical computation, target values and limits as required attaining the defined operational control objectives.
- D. Direct Digital Control: The digital algorithms and pre-defined arrangements included in the BAS software to provide direct closed-loop control for the designated equipment and controlled variables. Inclusive of Proportional, Derivative and integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like.
- E. BAS Network: The total digital on-line real-time interconnected configuration of BAS digital processing units, workstations, panels, sub-panels, controllers, devices and associated elements individually known as network nodes. May exist as one or more fully interfaced and integrated sub-networks, LAN, WAN or the like.

- F. Node: A digitally programmable entity existing on the BAS network.
- G. BAS Integration: The complete functional and operational interconnection and interfacing of all BAS work elements and nodes in compliance with all applicable codes, standards and ordinances so as to provide a single coherent BAS as required by this Section.
- H. Provide: The term "Provide" and its derivatives when used in this Section shall mean to furnish, install in place, connect, calibrate, test, commission, warrant, document and supply the associated required services ready for operation.
- I. Furnish: The term "Furnish" and its derivatives when used in this Section shall mean supply at the BAS Contractor's cost to the designated third party trade contractor for installation. BAS Contractor shall connect furnished items to the BAS, calibrate, test, commission, warrant and document.
- J. Wiring: The term "Wiring" and its derivatives when used in this Section shall mean provide the BAS wiring and terminations.
- K. Install: The term "Install" and its derivatives when used in this Section shall mean receive at the jobsite and mount.
- L. Protocol: The term "protocol" and its derivatives when used in this Section shall mean a defined set of rules and standards governing the on-line exchange of data between BAS network nodes.
- M. Software: The term "software" and its derivatives when used in this Section shall mean all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in the BAS industry for real-time, on-line, integrated BAS configurations.
- N. The use of words in the singular in this Section shall not be considered as limiting when other indications in this Section denote that more than one such item is being referenced.
- O. Headings, paragraph numbers, titles, shading, bolding, underscores, clouds and other symbolic interpretation aids included in this Section are for general information only and are to assist in the reading and interpretation of this Section.
- P. The following abbreviations and acronyms may be used in describing the work of this Section:
  - 1. ADC Analog to Digital Converter
  - 2. AHU Air Handling Unit
  - 3. AI Analog Input
  - 4. AN Application Node
  - 5. ANSI American National Standards Institute

6.	AO	Analog Output
7.	ASCII	American Standard Code for Information Interchange
8.	ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
9.	AWG	American Wire Gauge
10.	CPU	Central Processing Unit
11.	CRT	Cathode Ray Tube
12.	CUP	Central Utility Plant
13.	DAC	Digital to Analog Converter
14.	DDC	Direct Digital Control
15.	DI	Digital Input
16.	DO	Digital Output
17.	EEPROM	Electronically Erasable Programmable Read Only Memory
18.	MPOE	Main Point of Entry
19.	EMI	Electromagnetic Interference
20.	FAS	Fire Alarm Detection and Annunciation System
21.	FMCS	Facility Management Control System (located at CUP)
22.	FMCS SA	Facility Management Controls System Administrator
23.	GUI	Graphical User Interface
24.	НОА	Hand-Off-Auto
25.	ID	Identification
26.	IEEE	Institute of Electrical and Electronics Engineers
27.	I/O	Input/output
28.	IT	Information Technology

29.	LAWA FMC	S SA LAWA FMCS System Administrator
30.	LAN	Local Area Network
31.	LCD	Liquid Crystal Display
32.	LED	Light Emitting Diode
33.	MCC	Motor Control Center
34.	NAE	Network Automation Engine (supervisory level device)
35.	NC	Normally Closed
36.	NO	Normally Open
37.	OWS	Operator Workstation
38.	OAT	Outdoor Air Temperature
39.	PC	Personal Computer
40.	RAM	Random Access Memory
41.	RF	Radio Frequency
42.	RFI	Radio Frequency Interference
43.	RH	Relative Humidity
44.	ROM	Read Only Memory
45.	RTD	Resistance Temperature Device
46.	SPDT	Single Pole Double Throw
47.	SPST	Single Pole Single Throw
48.	XVGA	Extended Video Graphics Adapter
49.	TBA	To Be Advised
50.	TCP/IP	Transmission Control Protocol/Internet Protocol
51.	TTD	Thermistor Temperature Device
52.	UC	Unitary Controller

UPS	Uninterruptible Power Supply
VAC	Volts, Alternating Current
VAV	Variable Air Volume
VDC	Volts, Direct Current
WAN	Wide Area Network
	UPS VAC VAV VDC WAN

# 1.5 BAS DESCRIPTION

- A. The BAS shall be a complete BACnet system designed for connection to dedicated BAS IT network at LAX. This functionality shall extend into the equipment rooms. BAS Contractor shall be responsible for coordination with LAWA's engineering staff and LAWA FMCS SA to ensure that the BAS will perform in the LAX environment without disruption to any of the other activities taking place on that LAN.
- B. All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BAS manufacturer for use as a building operations terminal.
- C. Where necessary and as dictated elsewhere in these Specifications, servers shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft SQL Server.
- D. The work of the single BAS Contractor shall be as defined individually and collectively in all Sections of this Specification together with the associated Point Schedules and Drawings and the associated interfacing work as referenced in the related documents.
- E. The BAS work shall include, but not be limited to, the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, performance bonding, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these documents which are required for the complete, fully functional and commissioned BAS.
- F. Provide a complete, neat and workmanlike installation. System shall be installed by original equipment manufacturer (OEM) of the BAS products, by direct employees of the OEM, who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided.

- G. Manage and coordinate the BAS work in a timely manner in accordance with LAWA- approved schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.
- H. The BAS as provided shall incorporate, at minimum, the following integrated features, functions and services:
  - 1. Operator information, alarm management and control functions;
  - 2. Enterprise-level information and control access back to the FMCS;
  - 3. Information management including monitoring, transmission, archiving, retrieval, and reporting functions;
  - 4. Diagnostic monitoring and reporting of BAS functions;
  - 5. Offsite monitoring and management access;
  - 6. Energy management; and
  - 7. Standard applications for terminal HVAC systems.

# 1.6 WORK BY OTHERS

A. General Contractor is responsible for the demarcation of work and responsibilities between the BAS Contractor and other related trades and for ensuring delivery of fully functional and integrated BAS.

#### 1.7 SUBMITTALS

- A. Provide submittals in accordance with LAWA (PR) project requirement documents.
- B. Provide the following:
  - 1. FMCS Integration Coordination Plan (detailing the timing in the project schedule above that the LAWA FMCS SA will be able to integrate the BAS into the FMCS and the employee of the BAS that will be made available to coordinate this critical integration).
  - 2. BAS network architecture diagrams including all nodes and interconnections.
  - 3. Systems schematics, sequences and flow diagrams.
  - 4. Points schedule for each point in the BAS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
  - 5. Samples of Graphic Display screen types and associated menus.

- 6. Detailed bill of materials list for each system or application, identifying quantities, part numbers, descriptions, and optional features.
- 7. Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.
- 8. Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address
- 9. Details of all BAS interfaces and connections to the work of other trades.
- 10. Product data sheets or marked catalog pages including part number, photo and description for all products including software.
- 11. Sample thermostat (temperature sensor).

# 1.8 RECORD DOCUMENTATION

- A. Provide Operational and Maintenance manuals in accordance with LAWA (PR) project requirement documents.
- B. Provide the following:
  - 1. Archive copy of all site-specific databases and sequences.
  - 2. BAS network diagrams, including integration to the FMCS.
  - 3. Interfaces to all third-party products and work by other trades.
- C. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.
- D. After completion of all tests and adjustments the BAS Contractor shall provide a copy of all asbuilt information and product data to be installed on a LAWA-designated computer workstation or server.

# 1.9 WARRANTIES

- A. Provide Warranties in accordance with LAWA (PR) project requirement documents.
- B. Provide the following:

- 1. Provide a five-year labor and material warranty on the BAS.
- 2. If within sixty (60) months from the date of acceptance of product, upon written notice from LAWA, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BAS Contractor at the cost of the BAS Contractor.
- 3. Maintain an adequate supply of materials within 50 miles of LAX such that replacement of key parts and labor support, including programming.
- 4. Warranty work shall be done during hours designated by LAWA.

# PART 2 – GENERAL

2.1 PRODUCTS

### 2.2 GENERAL DESCRIPTION

- A. The BAS shall use BACnet open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BAS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications.
- B. The BAS shall consist of the following:
  - 1. Field Controller(s)
  - 2. Terminal Controllers
  - 3. Input/output Module(s)
  - 4. Portable Operator's Terminal(s)
  - 5. Network processing, data storage and communications equipment
  - 6. Other components required for a complete and working BAS
- C. The BAS shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment as approved in writing by LAWA.
- D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
  - 1. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

- 2. The BAS shall maintain all settings and overrides through a system reboot.
- E. Acceptable Manufacturers:
  - 1. Johnson Controls

Note: Basis of design for this project is Johnson Controls (JCI). Contractor is responsible to tie-in new controls to nearest JCI Facilities Management and Control System (FMCS) panel. All interface/converter required to tie-in new controls shall be provided by contractor. Contractor is responsible to seamlessly integrate new controls into existing JCI FMCS.

### 2.3 BAS ARCHITECTURE

- A. Primary BAS Network
  - 1. The primary BAS network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.
  - 2. The BAS shall network multiple User Interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.
  - 3. The primary BAS network will be compatible with other enterprise-wide networks.
  - 4. Where indicated, the primary BAS network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.
- B. Secondary BAS Network
  - 1. Secondary BAS networks shall provide either "Peer-to-Peer," or Primary-Secondary communications, and shall operate at a minimum communication speed of 9600 baud.
  - 2. DDC Controllers shall reside on the either primary or on the secondary BAS network. All controllers shall be tied into the system so that they can be accessed via the LAN network.
  - 3. Secondary BAS network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.
  - 4. The main equipment controllers shall reside only on the primary BAS network.
- C. Integration
  - 1. Hardwired

- a. Analog and digital signal values shall be passed from one system to another via hardwired connections.
- b. There will be one separate physical point on each system for each point to be integrated between the systems.
- 2. BACnet Protocol Integration BACnet
  - a. The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.
  - b. The ability to command, share point object data, changes of state (COS) data and schedules between the host and BACnet systems shall be provided.

# 2.4 USER INTERFACE

- A. Dedicated User Interface:
  - 1. Where indicated on plans the BAS Contractor shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BAS to facilitate greater fault tolerance and reliability.
  - 2. Dedicated User Interface Architecture The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BAS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards.
    - a. Microsoft Office Professional for creation, modification and maintenance of reports, sequences other necessary building management functions
    - b. Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports
    - c. Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries
  - 3. Dedicated user interface workstation shall be located at Mezzanine level mechanical room at LAX Terminal 2. The locations for dedicated user interface shall be coordinated finalized with assigned LAWA Project Engineers and LAWA Facility Management Department.

- 4. PC Hardware One (1) desktop and two (2) latest laptop personal computers by major computer manufacturer (Hewlett Packard) shall be configured as follows:
  - a. Memory 16 GB Minimum,
  - b. CPU– 3.2 GHz Clock Speed minimum
  - c. Hard Drive 1 Terabytes free hard drive space minimum
  - d. Hard drive backup system CD/RW, DVD/RW or network backup software provided by IT department
  - e. CD ROM Drive
  - f. Ports -(1) Serial, (2) USB ports.
  - g. Keyboard Desktop PC 101 Keyboard and 3 Button Mouse
  - h. Monitor configuration
    - 1) Each Display 22" Flat Panel Monitor
    - 2) 32 bit or higher color resolution
    - 3) Display card with multiple monitor support
  - i. LAN communications Ethernet communications board
  - j. Built-in wireless 802.11 b/g/n LAN
  - k. Mouse: two-button optical type wireless.
- 5. Operating System Software
  - a. Windows 8 (64 bit)
  - b. Provide complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers, and peripherals.
  - c. Provide software registration cards to LAWA for all included software.
  - d. The software shall run on the Microsoft Internet Explorer (10.0 or higher) browser supporting the following functions:
    - 1) Configuration

- 2) Commissioning
- 3) Data Archiving
- 4) Monitoring
- 5) Commanding
- 6) System Diagnostics
- 6. Peripheral Hardware
  - a. Reports printer:
    - 1) Printer Make Hewlett Packard DeskJet or equal
    - 2) Print Speed Black 32 ppm, Color 20 ppm
    - 3) Print Resolution Black 600 dpi, Color 300 dpi
    - 4) Buffer 64 K Input Print Buffer
    - 5) Color Printing Include Color Kit
- B. Distributed Web Based User Interface
  - 1. All features and functions of the dedicated User Interface previously defined in this Section shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the primary BAS network and conforming to the following Minimum hardware requirements and compliance with LAWA IMTG Standards, Policies and Procedures:
    - a. 16 GB RAM
    - b. 3.2 GHz Clock Speed
    - c. 1 Terabytes Hard Drive.
    - d. 1024x768 minimum resolution display with 64K colors and 32 bit color
- C. Site Management User Interface Application Components
  - 1. Operator Interface
    - a. All Inputs, Outputs, Set points, and all other parameters as defined within Part 3 of this Section, or shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification

from the operator interface software.

- b. The User Interface software shall provide help menus and instructions for each operation and/or application.
- c. The system shall support customization of the UI configuration and a home page display for each operator.
- d. The system shall support user preferences in the following screen presentations:
  - 1) Alarm
  - 2) Trend
  - 3) Display
  - 4) Applications
- e. All controller software operating parameters shall be displayed for the operator to view/modify from the User Interface. These include: set points, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.
- f. The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
  - 1) User access for selective information retrieval and control command execution
  - 2) Monitoring and reporting
  - 3) Alarm, non-normal, and return to normal condition annunciation
  - 4) Selective operator override and other control actions
  - 5) Information archiving, manipulation, formatting, display and reporting
  - 6) BAS internal performance supervision and diagnostics
  - 7) On-line access to user Help menus On-line access to current BAS as-built records and documentation
  - 8) Means for the controlled re-programming, re-configuration of BAS operation and for the manipulation of BAS database information in compliance with the prevailing codes, approvals and regulations for individual BAS applications

- g. The system shall support a list of application programs configured by the users that are called up by the following means:
  - 1) The Tools Menu
  - 2) Hyperlinks within the graphics displays
  - 3) Key sequences
- h. The operation of the control system shall be independent of the User Interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.
- 2. Alarms
  - a. Alarms shall be routed directly from controllers to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the User Interface shall, at the minimum, provide the following functions:
    - 1) Log date and time of alarm occurrence.
    - 2) Generate a "Pop-Up" window, with audible alarm, informing a user that an alarm has been received.
    - 3) Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
    - 4) Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
    - 5) Provide select alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
  - b. The BAS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.
  - c. The BAS shall allow a minimum of 4 categories of alarm sounds customizable through user defined wav files.
  - d. The BAS shall annunciate application alarms at minimum, as required by Part 3 of this Section.

- 3. Reports and Summaries
  - a. Reports and Summaries shall be generated and directed to the User Interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
    - 1) All points in the BAS
    - 2) All points in each BAS application
    - 3) All points in a specific controller
    - 4) All points in a user-defined group of points
    - 5) All points currently in alarm
    - 6) All points locked out
    - 7) All user defined and adjustable variables, schedules, interlocks and the like.
  - b. Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
  - c. Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.
  - d. Provide a focused set of reports that includes essential information required for effective management of energy resources within the facility. Energy reports shall be configurable from a LAWA-selected and approved predefined, preconfigured templates. Requirements include, but shall not be limited to:
    - 1) Energy Overview
    - 2) Load Profile
    - 3) Simple Energy Cost
    - 4) Consumption
    - 5) Equipment Runtime
    - 6) Electrical Energy
    - 7) Energy Production

- 8) Reports shall be selectable by date, time, area and device. Each report shall include a color visual summary of essential energy information.
- 4. Schedules
  - a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
    - 1) Weekly schedules
    - 2) Exception Schedules
    - 3) Monthly calendars
  - b. Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
  - c. It shall be possible to define one or more exception schedules for each schedule including references to calendars.
  - d. Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.
  - e. Schedules and Calendars shall comply with ASHRAE SP135/ BACnet Standard.
  - f. Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.
  - g. The Controllers shall have capability to configure and implement optimal start and stop programming based on existing indoor and outdoor environmental conditions as well as equipment operating history
- 5. Password
  - a. Multiple-level password access protection shall be provided to allow the user/manager to User Interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.
  - b. Each user shall have the following: a user name (accept 24 characters minimum), a password (accept 12 characters minimum), and access levels.

- c. The system shall allow each user to change his or her password at will.
- d. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
- e. A minimum of six levels of access shall be supported individually or in any combination as follows:
  - 1) Level 1 = View Data
  - 2) Level 2 =Command
  - 3) Level 3 = Operator Overrides
  - 4) Level 4 = Database Modification
  - 5) Level 5 = Database Configuration
  - 6) Level 6 = All privileges, including Password Add/Modify
- f. A minimum of 100 unique passwords shall be supported.
- g. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
- h. Operators shall be further limited to only access, command, and modify those buildings, systems, and subsystems for which they have responsibility.
- i. The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.
- 6. Screen Manager
  - a. The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.
- 7. Dynamic Color Graphics
  - a. The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.

- b. The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed.
- c. The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
- d. Graphics runtime functions A maximum of 16 graphic applications shall be able to execute at any one time on a User Interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:
  - 1) All graphics shall be fully scalable
  - 2) The graphics shall support a maintained aspect ratio. III. Multiple fonts shall be supported.
  - 3) Unique background shall be assignable on a per graphic basis.
  - 4) The color of all animations and values on displays shall indicate the status of the object attribute.
  - 5) Graphics that represent buildings or systems shall allow natural links and transitions between related detailed tabular views of data that complement the graphic.
- e. Operation from graphics It shall be possible to change values (set points) and states in system controlled equipment directly from the graphic.
- f. Floor Plan graphics The User Interface shall provide graphic applications that summarize conditions on a floor. Floor plan graphics shall indicate thermal comfort using dynamic colors to represent zone temperature deviations from zone set point(s). Floor plan graphics shall display overall metrics for each zone in the floor.
- 8. Historical trending and data collection
  - a. Each Controller shall store trend and point history data for all analog and digital inputs and outputs, as follows:
    - 1) Any point, physical or calculated, may be designated for trending. Two methods of collection shall be allowed:
      - i. Defined time interval
      - ii. Upon a change of value

- 2) Each Controller shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.
- b. Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.
- c. The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in SQL database format.
- 9. Trend data viewing and analysis
  - a. Provide a trend viewing utility that shall have access to all database points.
  - b. It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
  - c. The trend viewing utility shall have the capability to define trend study displays to include multiple trends
  - d. Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
  - e. Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. The Display shall support the user's ability to change colors, sample sizes, and types of markers.
- 10. Database Management
  - a. Where a separate SQL database is utilized for information storage the System shall provide a Database Manager that separates the database monitoring and managing functions by supporting two separate windows.
  - b. Database secure access shall be accomplished using standard SQL authentication including the ability to access data for use outside of the Building Automation application.
  - c. The database managing function shall include summarized information on trend, alarm, event, and audit for the following database management actions:
    - 1) Backup

- 2) Purge
- 3) Restore
- d. The Database management function shall support four tabs:
  - 1) Statistics shall display Database Server information and Trend, Alarm (Event), and Audit information on the BAS Databases.
  - 2) Maintenance shall provide an easy method of purging records from the BAS Server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting the database, and allowing for the retention of a selected number of day's data.
  - 3) Backup Shall provide the means to create a database backup file and select a storage location.
  - 4) Restore shall provide a restricted means of restoring a database by requiring the user to log into an Expert Mode in order to view the Restore screen.
- e. The database monitoring functions shall be accessed through Microsoft Windows and shall continuously read database information once the user has logged in.
- f. The System shall provide user notification via taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.
- g. The Monitoring Settings window shall have the following sections:
  - 1) General Shall allow the user to set and review scan intervals and start times.
  - 2) Email Shall allow the user to create and review e-mail and phone text messages to be delivered when a Warning or Alarm is generated.
  - 3) Warning shall allow the user to define the Warning limit parameters, set the Reminder Frequency, and link the e-mail message Alarm shall allow the user to define the Alarm limit parameters, set the Reminder Frequency, and link the e-mail message.
  - 4) Database login Shall protect the system from unauthorized database manipulation by creating a Read Access and a Write Access for each of the Trend, Alarm (Event) and Audit databases as well as an Expert Mode required to restore a database.

- h. The System shall provide user notification via Taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.
- 11. Demand Limiting and Load Rolling
  - a. The BAS shall:
    - 1) Provide a Demand Limiting and Load Rolling program for the purpose of limiting peak energy usage and reducing overall energy consumption.
    - 2) Support both Sliding Window and Fixed Window methods of predicting demand.
    - 3) Support three levels of sensitivity in the Sliding Window demand calculations for fine tuning the system.
- 12. Low Setting Sheds loads later and over the shortest amount of time. Maximizes the time the equipment is on.
- 13. Medium Setting Sheds loads earlier over a longer amount of time than the Low Setting. Increases the time the equipment is on and decreases the probability of exceeding the Tariff Target over the Low Setting.
- 14. High Setting Sheds loads earlier over a longer amount of time than the Medium Setting to minimize the probability of exceeding the Tariff Target.
  - a. Have both a Shed Mode and a Monitor Only Mode of operation.
    - 1) When the Shed Mode is engaged, the BAS shall actively control the Demand.
    - 2) When the Monitor Mode is engaged, the BAS will simulate the shedding action but will not take any action.
  - b. Support a Maximum Shed Time for each load as determined by the user. The BAS shall restore the load before the Maximum Shed time has expired.
  - c. Support a Minimum Shed Time for each load as determined by the user.
  - d. The BAS shall not restore the load sooner than the Minimum Shed Time has expired.
  - e. Support a Minimum Release Time for each load as determined by the user. The BAS shall not shed the load until it has been off for the Minimum Release time.
  - f. Support three user defined options if the meter goes unreliable.

- 1) Shedding The currently shed loads will be released as their Maximum shed times expire.
- 2) Maintain the Current Shed Rate The BAS will use the Demand Limiting shed rate that was present when the meter went unreliable.
- 3) Use Unreliable Meter Shed Rate the BAS will control to a user defined Unreliable Shed Rate target.
- g. The Demand Limiting program shall:
- h. Monitor the energy consumption rate and compare it to a user defined Tariff Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined strategy.
- i. Be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.
- j. Be capable of supporting a minimum of 12 separate Tariff Targets defining the maximum allowed average power during the current interval.
- 15. The Load Rolling program shall:
  - a. Sum the loads currently shed and compare it to a user defined Load Rolling Target. The BAS shall maintain consumption below the target by selectively shedding loads based upon a user defined Load Priority.
  - b. Be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.
  - c. Be capable of supporting a minimum of 12 separate Tariff Targets defining the amount of power by which the demand must be reduced.
- 16. Provide the user with a Load Tab that displays all of the Demand Limiting and Load Rolling parameters for any selected load.
- 17. Provide the user with a Load Summary that displays all of the loads associated with the Demand Limiting and Load Rolling programs. Status Icons for each load shall indicate:
  - a. Load is Offline
  - b. Load is Disabled
  - c. Load is Shed
  - d. Load is Locked
- e. Load is in Comfort Override
- 18. The Load Summary shall include a Load Summary Runtime view listing the following load conditions:
  - a. Load Priority
  - b. Shed Strategy
  - c. Load Rating
  - d. Present Value
  - e. Ineligibility Status
  - f. Active Timer
  - g. Time Remaining
  - h. Last Shed Time
- 19. Other Utilities Software
  - a. The BAS shall be capable of supporting any other LAWA-approved utilities software, including, but not limited to Energy Star and Maximo.

#### 2.5 DDC SYSTEM CONTROLLERS

- A. Unitary Controller (UC)
  - 1. General
    - a. The facility BAS shall include BTL-listed, microprocessor-based, direct digital control UCs.
    - b. UCs shall provide control of HVAC and other integrated controllable functions.
    - c. Each controller shall have its own control programs and shall continue to operate in the event of a failure or communication loss to its associated DDCP.
    - d. UCs shall be provided for variable air volume (VAV) boxes and fan coil units as required to satisfy the sequences of operation.
    - e. VAV box UCs shall be provided with 120/24 Volt transformers (or as required/coordinated with mechanical specifications for operation) to the VAV box manufacturers for factory mounting.

- f. UCs shall be programmable from either the FMCS workstations or by the Portable Terminal Unit connected locally. The necessary hardware and software required for communication with the UC, from either the FMCS (Servers) or via a Portable Operator Terminal Unit, shall be provided including licensing requirements.
- g. The BACnet Protocol Implementation Statement shall be submitted for each type of the UC.
- 2. Components
  - a. Memory: Control programs shall be stored in battery backed-up RAM and EPROM. Each system controller shall have a minimum of 64 MB of user RAM memory and 64 MB of EPROM.
  - b. Communication Ports: UCs shall provide a communication port to the field bus.
  - c. In addition, a port shall be provided for connection of a portable service tool to support local commissioning and parameter changes with or without the DDCP online. It shall be possible from a service port on any UC to view, enable /disable, and modify values of any point or program on any controller on the local field bus, any DDCP or any UC on a different field bus.
  - d. I/O: Each UC shall support the addition of the following types of inputs and outputs:
    - 1) Digital inputs for status and alarm contacts;
    - 2) Counter inputs for summing pulses from meters;
    - 3) Thermistor inputs for measuring temperatures in space, ducts, and thermo wells;
    - 4) Analog inputs for pressure, humidity, flow, and position measurements; V. Digital outputs for on and off equipment control; and
    - 5) Analog outputs for valve and damper position control, and capacity control of primary equipment.
  - e. Expandability: Input and output capacity shall be expandable through the use of plug-in modules. A minimum of two modules shall be added to the base UC before additional power is required.
  - f. Networking: Each UC shall be able to exchange information on a peer-topeer basis with other Stand-alone Digital Control Units during each field bus

scan. Each UC shall be capable of storing and referencing global variables (on the LAN) with or without any FMCS workstations online. Each UC shall be able to have its program viewed and/or enabled/disabled either locally through a BAS Portable Operator's Terminal or through a FMCS workstation.

- g. Indicator Lamps: UCs shall have an optional, LED indication of CPU status, and field bus status.
- h. Real-Time Clock. A UC shall have a real-time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The real-time clock shall provide the following information: time of day, day, month, year, and day of week. Each UC shall receive a signal, every hour, over the network from the DDCP that synchronizes all UC real-time clocks.
- i. Automatic Restart after Power Failure: Upon restoration of power, the UC shall automatically and without human intervention, update all monitored functions; resume operation based on current, synchronized time and status; and implement special startup strategies as required.
- j. Battery Back-Up: Each UC shall have at least three (3) years of battery backup to maintain all volatile memory. System shall be interfaced with the building UPS System.
- k. Alarm Management.
  - 1) For each system point, alarms can be created based on high and low limits or conditional expressions. All alarms shall be tested each scan of the UC and can result in the display of one or more alarm messages or reports.
  - 2) Up to eight (8) alarms can be configured for each point in the controller, enabling the escalation of the alarm priority (urgency) based upon which alarm(s) is/are triggered.
  - 3) Alarms shall be generated based on their priority. A minimum of 255 priority levels shall be provided.
  - 4) If communication with the DDCP is temporarily interrupted, the alarm shall be buffered in the UC. When communications return, the alarm shall be transmitted to the DDCP if the point is still in the alarm condition.

# B. System Software

- 1. General
  - a. All necessary software to form a complete operating system as described

in this specification shall be provided.

- b. The software programs specified in this section shall be provided as an integral part of the DDC controller and shall not be dependent upon any higher level computer for execution.
- 2. Control Software Description:
  - a. Pre-Tested Control Algorithms: The DDC controllers shall have the ability to perform the following pre-tested control algorithms:
    - 1) Two Position Control
    - 2) Proportional Control
    - 3) Proportional plus Integral Control
    - 4) Proportional, Integral, plus Derivative Control
    - 5) Automatic Control Loop Tuning
  - b. Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.
  - c. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
  - d. Power fail Motor Restart: Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation. (i.e. - Restart of equipment following the return to normal condition after equipment shutdown by the Fire Alarm System).
  - e. Sequential Start: Provide sequential start for all equipment. After a power failure, and after restoration of normal power, equipment shall start per a predetermined sequence as programmed via the BAS.
- 3. Energy Management Applications: DDC controllers shall have the ability to perform any or all of the following energy management routines:
  - a. Time-of-Day Scheduling
  - b. Calendar Based Scheduling

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- c. Holiday Scheduling
- d. Temporary Schedule Overrides
- e. Optimal Start/Optimal Stop
- f. Night Setback Control
- g. Enthalpy Switch Over (Economizer)
- h. Peak Demand Limiting
- i. Energy Usage & Demand
- j. Fan Speed/CFM Control
- k. Heating/Cooling Interlock
- 1. Supply Air Reset
- m. Hot Water Reset
- 4. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow operator customization. Programs shall be applied to building equipment as described in the Execution portion of this specification.
- 5. Custom Process Programming Capability: DDC controllers shall be able to execute custom, job- specific processes defined by the operator, to automatically perform calculations and special control routines.
  - a. Process Inputs and Variables: It shall be possible to use any of the following in a custom process:
    - 1) Any system-measured point data or status
    - 2) Any calculated data
    - 3) Any results from other processes
    - 4) User-Defined Constants
    - 5) Arithmetic functions (+,-,\*,/, square root, exponential, etc.)
    - 6) Boolean logic operators (and, or, exclusive or, etc.)
    - 7) On-delay/Off-delay/One-shot timers

- b. Process Triggers: Custom processes may be triggered based on any combination of the following:
  - 1) Time interval
  - 2) Time of day
  - 3) Date
  - 4) Other processes
  - 5) Time programming
  - 6) Events (e.g., point alarms)
  - 7) Restart of equipment following the return to normal condition after equipment shutdown by the Fire Alarm System (FAS)
- 6. Dynamic Data Access: A single process shall be able to incorporate measured or calculated data from any and all other DDC controllers on the local area network. In addition, a single process shall be able to issue commands to points in any and all other DDC panels on the local area network.
- 7. Advisory/Message Generation: Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer.
- 8. Custom Process Documentation: The custom control programming feature shall be selfdocumenting. All interrelationships defined by this feature shall be documented via graphical flowcharts and English language descriptors.
- 9. Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each DDC controller shall perform distributed independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the DDC's ability to report alarms be affected by either operator activity at a PC Workstation or local I/O device, or communications with other panels on the network. Each analog input shall have associated alarm and pre-alarm (warning) levels that are software adjustable. Provide a minimum of one high alarm, one high warning alarm, one low alarm and one low warning alarm level per analog input.
  - a. Point Change Report Description: All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
  - b. Prioritization: The user shall be able to define the specific system reaction for

each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Each DDC shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point as well as be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.

- c. Report Routing: Alarm reports, messages, and files will be directed to a userdefined list of operator devices or PC disk files used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.
- Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a minimum 65-character alarm message to more fully describe the alarm condition or direct operator response. Each standalone DDC shall be capable of storing a library of at least 250 Alarm Messages which are assignable to any number of points in the panel.
- e. Auto-Dial Alarm Management: In Dial-up applications, only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until an operator scheduled time, a manual request, or until the buffer space is full. The alarm buffer must store a minimum of 50 alarms.
- f. Transaction Logging: Operator commands and system events shall be automatically logged to disk in Personal Computer industry standard database format. Operator commands initiated from Direct-connected workstations, dial-up workstations, and local DDC panel Network Terminal devices shall all be logged to this transaction file. This data shall be available at the Operator Interface Workstation (OIW). Facility shall be provided to allow the user to search the transaction file using standard database query techniques, including searching by dates, operator name, data point name, etc. In addition, this transaction file shall be accessible with standard third party database and spreadsheet packages.
- 10. Historical Data and Trend Analysis: A variety of historical data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways:
  - a. Continuous Point Histories: Standalone DDC's shall store Point History Files for all analog and binary inputs and outputs. The Point History routine shall continuously and automatically sample the value of all analog inputs at half hour intervals. Samples for all points shall be stored for the past 24 hours to allow the user to immediately analyze equipment performance and all problem-related events for the past day. Point History Files for binary input or output points and

analog output points shall include a continuous record of the last ten status changes or commands for each point.

- b. Control Loop Performance Trends: Standalone DDC's shall also provide high resolution sampling capability in one-second increments for verification of control loop performance. Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assignable to user-definable trends for the purpose of collecting operator- specified performance data over extended periods of time. Sample intervals of 1 minute to 2 hours shall be provided. Each standalone DDC shall have a dedicated buffer for trend data, and shall be capable of storing a minimum of 5000 data samples.
- c. Data Storage and Archiving: Trend data shall be stored at the Standalone DDC's, and uploaded to hard disk storage when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full.
- d. All trend data shall be available in disk file format compatible with Third Party personal computer applications.
- e. Runtime Tantalization: Standalone DDC panels shall automatically accumulate and store run timers for binary input and output points as specified in the Execution portion of this specification.
- f. The Tantalization routine shall have a sampling resolution of one minute or less.
- g. The user shall have the ability to define a warning limit for Runtime Tantalization.
- h. Unique, user-specified messages shall be generated when the limit is reached.
- 11. Analog/Pulse Tantalization: Standalone DDC's shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.
  - a. Tantalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, gallons, KBTU, tons. etc.).
  - b. The Tantalization routine shall have a sampling resolution of one minute or less.
  - c. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.
- 12. Event Totalization: Standalone DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event Totalization shall be performed on a daily, weekly, or monthly basis.

- a. The Event Tantalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset
- b. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.
- C. VAV TERMINAL UNIT CONTROLLER (VAV UC)
  - 1. General: Ship VAV UC Controllers to terminal box manufacturer's factory for controller mounting prior to shipping to site. Coordinate with Box manufacturer.
  - 2. The VAV UC shall provide both standalone and networked direct digital control of pressure- independent, variable air volume terminal units.
  - 3. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 30 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.
  - 4. The VAV UC shall be a configurable digital controller with an integral differential pressure transducer.
  - 5. It shall be compatible with 3 wire (incremental) and proportional damper actuators.
  - 6. The VAV UC shall determine airflow by dynamic pressure measurement using an integral dead- ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters.
  - 7. Each VAV UC shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
  - 8. The VAV UC shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.
  - 9. Each VAV UC shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.
  - 10. The VAV UC shall provide the ability to download and upload UC configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.
  - 11. UC control set point changes initiated over the network shall be written to UC nonvolatile memory to prevent loss of set point changes and to provide consistent operation in the event of communication failure.

- 12. The VAV UC firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.
- 13. The VAV UC shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
- 14. The VAV UC shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow set points.
- 15. The VAV UC shall be capable of direct electronic connection to a balancing hood. Connection shall be through a port located on the room sensor, or directly at the controller. As an alternative, software balancing tools shall be provided that will run in a hand-held Palm Pilot type PC (such as the 3COM Palm Pilot or IBM Workpad). The balancing tools shall allow adjustment of airflow set points and parameters, and provide permanent upload of the values entered to the UC. The Palm Pilot shall connect to the terminal unit through the room sensor port.
- 16. The VAV UC performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The UC shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.
  - a. Absolute temperature loop error.
  - b. Signed temperature loop error.
  - c. Absolute airflow loop error.
  - d. Signed airflow loop error.
  - e. Average damper actuator duty cycle.
- 17. The VAV UC shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:
  - a. Unreliable space temperature sensor.
  - b. Unreliable differential pressure sensor.
  - c. Starved box.
  - d. Insufficient cooling.
  - e. Insufficient heating.

- 18. The VAV UC shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow based on the percent of outdoor air in the primary air stream.
- 19. The VAV UC shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.
- 20. The VAV UC shall be compatible with the U.S. EPA Energy Star Buildings recommendations for fan energy reduction via demand-based static pressure reset down to 2/3 of duct static pressure set point, "VSD 2/3 Reset."
- 21. Inputs:
  - a. Analog inputs shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:
    - 1) 0-10 VDC Sensors
    - 2) 4-20 mA Sensors
    - 3) 1000ohm RTDs
    - 4) NTC Thermistors
  - b. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."
  - c. For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.
- 22. Outputs
  - a. Analog outputs shall provide the following control outputs:
    - 1) 0-10 VDC
    - 2) 4-20 mA
  - b. Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.
  - c. For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.

## 2.6 FIELD DEVICES

- A. Input/Output Module (IOM)
  - 1. The Input/Output Module (IOM) provides additional inputs and outputs for use in the UC.
  - 2. The IOM shall communicate with the UC over the Bus.
  - 3. The IOM shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
    - a. The IOM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
    - b. The IOM shall be tested and certified as a BACnet Application Specific Controller (B- ASC).
    - c. A BACnet Protocol Implementation Conformance Statement shall be provided for the UCorFC .
    - d. The Conformance Statement shall be submitted 10 days prior to bidding.
  - 4. The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
  - 5. The IOM shall have a minimum of 4 points to a maximum of 17 points.
  - 6. The IOM shall support the following types of inputs and outputs:
    - a. Universal Inputs shall be configured to monitor any of the following:
      - 1) Analog Input, Voltage Mode
      - 2) Analog Input, Current Mode
      - 3) Analog Input, Resistive Mode
      - 4) Binary Input, Dry Contact Maintained Mode
      - 5) Binary Input, Pulse Counter Mode
    - b. Binary Inputs shall be configured to monitor either of the following:
      - 1) Dry Contact Maintained Mode
      - 2) Pulse Counter Mode
    - c. Analog Outputs shall be configured to output either of the following

## LOS ANGELES INTERNATIONAL AIRPORT CONSOLIDATED RENTAL CAR FACILITY DA 4881

- 1) Analog Output, Voltage Mode
- 2) Analog Output, current Mode
- d. Binary Outputs shall output the following:
  - 1) 24 VAC Triac
- e. Configurable Outputs shall be capable of the following:
  - 1) Analog Output, Voltage Mode
  - 2) Binary Output Mode
- 7. The IOM shall include troubleshooting LED indicators to identify the following conditions:
  - a. Power On
  - b. Power Off
  - c. Download or Startup in progress, not ready for normal operation
  - d. No Faults
  - e. Device Fault
  - f. Normal Data Transmission
  - g. No Data Transmission
  - h. No Communication
- B. Terminal Controller (TC)
  - 1. The TC shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters or other similar equipment, pressure dependent Variable Air Volume System or other similar zoning type systems employing reheat including local hydraulic reheat valves, two pipe fan coil, cabinet unit heater or other similar equipment with single-speed fan control.
  - 2. The TC shall communicate over the Field Controller Bus using BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
  - 3. The TC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
    - a. The TC shall be tested and certified as a BACnet Application Specific

Controller (B-ASC).

- b. A BACnet Protocol Implementation Conformance Statement shall be provided for the TC.
- c. The Conformance Statement shall be submitted 10 days prior to bidding.
- 4. The TC shall support remote read/write and parameter adjustment from the web based User Interface through a Network Automation Engine.
- 5. The TC shall include an intuitive User Interface providing plain text messages.
  - a. Two line, 8 character backlit display
- 6. The TC shall provide the flexibility to support any one of the following inputs:
  - a. Integral Indoor Air Temperature Sensor
  - b. Duct Mount Air Temperature Sensor
  - c. Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator
  - d. Two configurable binary inputs
- 7. Provide the flexibility to support any one of the following:
  - a. Three Speed Fan Control
  - b. Two On/Off
  - c. Two Floating
  - d. Two Proportional (0 to 10V)
- 8. The TC shall provide a minimum of six (6) levels of keypad lockout.
- 9. The TC shall provide the flexibility to adjust the following parameters:
  - a. Adjustable Temporary Occupancy from 0 to 24 hours
  - b. Adjustable heating/cooling deadband from 2° F to 5° F
  - c. Adjustable heating/cooling cycles per hour from 4 to 8
- 10. Where required by application and indicated on plans or room schedules provide the TEC with an integral Passive Infra-Red (PIR) occupancy sensor.

- 11. The TC shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.
- 12. The VMA (Variable Modular Assembly) shall provide both standalone and networked direct digital control of pressure- independent, variable air volume terminal units. It shall address both single and dual duct applications.
- 13. The VMA shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
  - a. The VMA shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
  - b. A BACnet Protocol Implementation Conformance Statement shall be provided for the VMA.
  - c. The Conformance Statement shall be submitted. The VMA shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.
- 14. The VMA shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.
- 15. The VMA shall be a configurable digital controller with integral differential pressure transducer.. All components shall be connected and mounted as a single assembly that can be removed as one piece.
- 16. The VMA shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
- 17. The controller shall determine airflow by dynamic pressure measurement using an integral dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters.
- 18. Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
- 19. The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.
- 20. Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.
- 21. The controller shall provide the ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be

loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.

- 22. Control set point changes initiated over the network shall be written to VMA nonvolatile memory to prevent loss of set point changes and to provide consistent operation in the event of communication failure.
- 23. The controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.
- 24. The controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
- 25. The controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow set points.
- 26. Controller performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The VMA shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.
  - a. Absolute temperature loop error
  - b. Signed temperature loop error
  - c. Absolute airflow loop error
  - d. Signed airflow loop error
  - e. Average damper actuator duty cycle
- 27. The controller shall detect system error conditions to assist in managing the VAV zones.
- 28. The error conditions shall consist of:
  - a. Unreliable space temperature sensor
  - b. Unreliable differential pressure sensor
  - c. Starved box
  - d. Actuator stall

- e. Insufficient cooling
- f. Insufficient heating
- 29. The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The VMA would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.
- 30. The controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow Based on the percent of outdoor air in the primary air stream.
- 31. The controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.
- 32. Inputs:
  - a. Analog inputs with user defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:
    - 1) 0-10 VDC Sensors
    - 2) 10000hm RTDs
    - 3) NTC Thermistors
  - b. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."
  - c. For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.
  - d. Provide side loop application for humidity control.
- 33. Outputs
  - a. Analog outputs shall provide the following control outputs:
    - 1) 0-10 VDC
    - 2) 4-20 mA.
  - b. Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.

- c. For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.
- 34. Application Configuration
  - a. The VMA shall be configured with a software tool that provides a simple Question/Answer format for developing applications and downloading.
- 35. Sensor Support
  - a. The VMA shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.
  - b. The VMA shall support an LCD display room sensor.
  - c. The VMA shall also support standard room sensors as defined by analog input requirements.
  - d. The VMA shall support humidity sensors defined by the AI side loop.
- C. Installation, testing, and calibration of all devices shall be provided to meet the system requirements.

#### 2.7 INPUT DEVICES

- A. General Requirements:
  - 1. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
  - 2. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
  - 3. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	Accuracy
Chilled Water	<u>+</u> .5°F.
Room Temperature	<u>+</u> .5°F.
Duct Temperature	<u>+</u> .5°F.
All Others	<u>+</u> .75°F.

- B. Room Temperature Sensors
  - 1. Room sensors shall be constructed for either surface or wall box mounting.

- 2. Room sensors shall have the following options when specified:
  - a. Set point reset slide switch providing a +3 degree (adjustable) range.
  - b. Individual heating/cooling set point slide switches.
  - c. A momentary override request push button for activation of after-hours operation.
  - d. Analog thermometer.
- C. Room Temperature Sensors with Integral Display
  - 1. Room sensors shall be constructed for either surface or wall box mounting.
  - 2. Room sensors shall have an integral LCD display and four button keypad with the following capabilities:
    - a. Display room and outside air temperatures.
    - b. Display and adjust room comfort set point.
    - c. Display and adjust fan operation status.
    - d. Timed override request push button with LED status for activation of after-hours operation.
    - e. Display controller mode.
    - f. Password selectable adjustment of set point and override modes.
- D. Thermo Wells
  - 1. When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
  - 2. Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.
  - 3. Thermo wells and sensors shall be mounted in a threadolet or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.
  - 4. Thermo wells shall be constructed of 316 stainless steel.
- E. Outside Air Sensors
  - 1. Outside air sensors shall be designed to withstand the environmental conditions to

which they will be exposed. They shall also be provided with a solar shield.

- 2. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
- 3. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
- F. Duct Mount Sensors
  - 1. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
  - 2. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
  - 3. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
- G. Averaging Sensors
  - 1. For ductwork greater in any dimension that 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
  - 2. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
  - 3. Acceptable Manufacturers: Johnson Controls.
- H. Humidity Sensors
  - 1. The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
  - 2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2- wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
  - 3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.
  - 4. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.

- 5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
- 6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
- 7. Acceptable Manufacturers: Veris Industries, and Mamac.
- I. Differential Pressure Transmitters
  - 1. General Air and Water Pressure Transmitter Requirements:
    - a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
    - b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
    - c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Mechanical Contractor and LAWA permanent, easy-to-use connection.
    - d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
  - 2. Low Differential Water Pressure Applications (0" 20" W.C.)
    - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.
    - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
      - 1) .01-20" W.C. input differential pressure range.
      - 2) 4-20 mA output.
      - 3) Maintain accuracy up to 20 to 1 ratio turndown.
      - 4) Reference Accuracy: +0.2% of full span.
    - c. Acceptable Manufacturers: Setra and Mamac.

- 3. Medium to High Differential Water Pressure Applications (Over 21" W.C.)
  - a. The differential pressure transmitter shall meet the low pressure transmitter specifications with the following exceptions:
    - 1) Differential pressure range 10" W.C. to 300 PSI.
    - 2) Reference Accuracy: +1% of full span (includes non-linearity, hysteresis, and repeatability).
  - b. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
  - c. Acceptable Manufacturers: Setra, Mamac Rosemount .
- 4. Building Differential Air Pressure Applications (-1" to +1" W.C.)
  - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
  - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
    - 1) -1.00 to +1.00 W.C. input differential pressure ranges. (Select range appropriate for system application)
    - 2) 4-20 mA output.
    - 3) Maintain accuracy up to 20 to 1 ratio turndown.
    - 4) Reference Accuracy: +0.2% of full span.
  - c. Acceptable Manufacturers: Johnson Controls.
- 5. Low Differential Air Pressure Applications (0" to 5" W.C.)
  - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
  - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:

- 1) (0.00 1.00" to 5.00") W.C. input differential pressure ranges. (Select range appropriate for system application.)
- 2) 4-20 mA output.
- 3) Maintain accuracy up to 20 to 1 ratio turndown.
- 4) Reference Accuracy: +0.2% of full span.
- c. Acceptable Manufacturers: Johnson Controls.
- 6. Indoor Air Quality (CO2) Sensors- Wall and Duct Mounted
  - a. Provide indoor air quality sensors to monitor Carbon Dioxide (CO2). The sensors shall be of microprocessor-based photo-acoustic type with heated stannic dioxide semiconductor.
  - b. The CO2 sensors shall have no more than 1% drift during the first year of operation and minimal drift thereafter so that no calibration will be required.
  - c. The units shall be wall or duct mounted type as indicated on plans and in the sequence of operation.
  - d. Wall mounted sensors shall be provided with white plastic cover, without LED indicators.
  - e. Duct mounted sensors shall be provided with LED indicators in a dust proof plastic housing with transparent cover.
  - f. The sensor shall meet the following requirements:
    - 1) Operating voltage: 24 VAC +/- 20%
    - 2) Frequency: 50/60 Hz
    - 3) Power consumption: max. 6 VA
    - 4) CO2 measuring range:0 2000 ppm
    - 5) Tolerance: +/- 100 ppm
    - 6) Output: 0 10 VAC
    - 7) Calibration: none required
    - 8) Permissible air velocity in duct: <26.2 Ft/s.

- 9) The sensors shall be Johnson Controls.
- 7. Carbon Monoxide (CO) Transmitter
  - a. Sensor assemblies to be rated general purpose and suitable for N.E.C. installation. (NEMA 1 enclosure).
  - b. Carbon monoxide analyzer shall be capable of measurement in the range of 0-500 parts per million with 4-20 mA output. (7000 to 9000 square feet per sensor).
  - c. Operating temperature: -15 deg C to 40 deg C
  - d. Stability:  $\pm 1\%$
  - e. Repeatability: less than  $\pm 2\%$  full scale
  - f. Manufacturer: Sensor shall be Brasch gas detector or as approved by the Engineer
- 8. Medium Differential Air Pressure Applications (5" to 21" W.C.)
  - a. The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressures transmitters shall be provided that meet the following performance requirements:
    - 1) Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability.
    - 2) Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 PSIG.
    - 3) Thermal Effects: <+.033 F.S./Deg. F. over 40°F. to 100°F. (calibrated at 70°F.).
  - b. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
  - c. Acceptable manufacturers: Johnson Controls.
- J. Flow Monitoring
  - 1. Air Flow Monitoring

- a. AHU Fan Inlet Air Flow Measuring Stations
  - 1) At the inlet of each fan and near the exit of the inlet sound trap, airflow sensors which continuously monitor the fan air volumes and system velocity pressure shall be provided. The AHU air flow measuring stations and the transmitters are to be provided and installed by the AHU manufacturer.
  - 2) Each sensor shall be surface mount type. Unit shall be capable of monitoring and reporting the airflow and temperature at each fan inlet location through two or four sensing circuits. If a static pressure manifold is used, it shall incorporate dual offset static tops on the opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as  $+ 20^{\circ}$  in the approaching air stream.
  - 3) Devices creating fan performance degradation, resulting in additional energy consumption, caused from pressure drop associated with probes or mounting apparatus in the center of the fan inlet are not allowed. The device shall not induce a measurable pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the air stream. Sensor circuit casings shall be constructed of U.L. 94 flame rated high impact ABS and include a stainless steel thermistor cap that maintains the precise calibrated flow over the heated and ambient measurement points. Each sensor circuit shall consist of two ceramic base, glass encapsulated, thermistors for measuring ambient temperature and velocity. Circuit shall be designed for operation in a wide range of environments, including high humidity and rapid thermal cycling.
  - 4) Acceptable manufacturers are: Johnson Controls, Air Monitor Corp., Tek-Air Systems, Inc., or Dietrich Standard.
- b. Single Probe Air Flow Measuring Sensor
  - 1) The single probe airflow-measuring sensor shall be duct mounted with an adjustable sensor insertion length of up to eight inches. The transmitter shall produce a 4-20 mA or 0-10 VDC signal linear to air velocity. The sensor shall be a hot wire anemometer and utilize two temperature sensors and a heater element temperature. The other sensor shall measure the downstream air temperature. The temperature differential shall be directly related to airflow velocity.
- c. Static Pressure Traverse Probe
  - 1) Duct static probes shall be provided where required to monitor duct static pressure. Acceptable manufacturers: Cleveland Controls

- K. Water Flow Monitoring
  - 1. Water flow meters shall be electromagnetic type with integral microprocessor-based electronics. The meter shall have an accuracy of 0.25%.
  - 2. Acceptable manufacturers: Onicon
- L. Status and Safety Switches
  - 1. General Requirements
    - a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BAS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.
  - 2. Current Sensing Switches
    - a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
    - b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
    - c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
    - d. Acceptable manufacturers: Veris Industries
  - 3. Air Filter Status Switches
    - a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
    - b. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
    - c. Provide appropriate scale range and differential adjustment for intended service.
    - d. Acceptable manufacturers: Cleveland Controls
  - 4. Air Flow Switches

- a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
- b. Acceptable manufacturers: Cleveland Controls
- 5. Air Pressure Safety Switches
  - a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
  - b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
  - c. Acceptable manufacturers, Cleveland Controls
- 6. Water Flow Switches
  - a. Water flow switches shall be equal to the Johnson Controls P74.
- 7. Low Temperature Limit Switches
  - a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
  - b. The sensing element shall be a minimum of 22 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
  - c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
  - d. The low temperature limit switch shall be Johnson Controls A70.

# 2.8 OUTPUT DEVICES

- A. Actuators
  - 1. General Requirements
    - a. Damper and valve actuators shall be electronic and/or pneumatic, as specified.
  - 2. Electronic Damper Actuators
    - a. Electronic damper actuators shall be direct shaft mount.

- b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, or a gear release to allow manual positioning.
- c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 22 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper assembly shall be wired back to the BAS Controller.
- d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds.
- e. Acceptable manufacturers:
  - 1) Belimo, Mamac.
  - 2) Electronic Valve Actuators
  - 3) Electronic valve actuators shall be manufactured by the valve manufacturer.
  - 4) Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
  - 5) Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close- off against the system pressure for the required application. The valve actuator shall be sized based on the valve manufacturer's recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in

# LOS ANGELES INTERNATIONAL AIRPORT CONSOLIDATED RENTAL CAR FACILITY DA 4881

either direction.

- 6) Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
- 7) Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.
- 8) Acceptable manufacturers: Belimo
- B. Control Relays
  - 1. Control Pilot Relays
    - a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
    - b. Mounting Bases shall be snap-mount.
    - c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
    - d. Contacts shall be rated for 10 amps at 120VAC.
    - e. Relays shall have an integral indicator light and check button.
    - f. Acceptable manufacturers: Johnson Controls.
  - 2. Lighting Control Relays
    - a. Lighting control relays shall be latching with integral status contacts.
    - b. Contacts shall be rated for 20 amps at 277 VAC.
    - c. The coil shall be a split low-voltage coil that moves the line voltage contact armature to the ON or OFF latched position.
    - d. Lighting control relays shall be controlled by:

- 1) Pulsed Tri-state Output Preferred method.
- 2) Pulsed Paired Binary Outputs.
- 3) A Binary Input to the BAS shall monitor integral status contacts on the lighting control relay. Relay status contacts shall be of the "drycontact" type.
- e. The relay shall be designed so that power outages do not result in a change-ofstate, and so that multiple same state commands will simply maintain the commanded state. Example: Multiple OFF command pulses shall simply keep the contacts in the OFF position.
- C. Control Valves (PICV)
  - 1. All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the BAS contractor, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Section.
  - 2. Chilled water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Modulating water valves shall be sized per manufacturer's recommendations for the given application. In general, valves (2 or 3-way) serving variable flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no less than 5 PSI. Valves (3-way) serving constant flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.
  - 3. Ball valves shall be used for hot and chilled water applications, water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units except those described hereinafter.
  - 4. Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all special applications as indicated on the valve schedule. Valve discs shall be composition type. Valve stems shall be stainless steel.
  - 5. Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless steel

vane. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.

- 6. Acceptable manufacturers: Belimo
- D. Electronic/Pneumatic Transducers Pneumatic transducers shall provide:
  - 1. Output: 3-Div 22 PSIG.
  - 2. Input: 4-20 mA or 0-10 VDC.
  - 3. Manual output adjustment.
  - 4. Pressure gauge.
  - 5. External replaceable supply air filter.
  - 6. Acceptable manufacturers: Mamac
- E. Local Control Panels
  - 1. All control panels shall be constructed by a UL certified panel manufacturer, incorporating the BAS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with sub-panel, hinged door, and lock.
  - 2. In general, the control panels shall consist of the DDC controllers and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function.
  - 3. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
  - 4. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed 300-volt service and provide adequate clearance for field wiring.
  - 5. All wiring shall be neatly installed in plastic trays or tie-wrapped.
  - 6. A 120 volt convenience outlet, fused on/off power switch, and required transformers shall be provided in each enclosure.
- F. Power Supplies
  - 1. Required AC or DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.

- 2. Input: 120 VAC +10%, 60Hz.
- 3. Output: 24 VAC or VDC as required.
- 4. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
- 5. A power disconnect switch shall be provided next to the power supply.
- G. Thermostats
  - 1. Electric room thermostats of the heavy-duty type shall be provided by Mechanical Contractor for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all roomtype instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

## PART 3 - EXECUTION

## 3.1. BAS SPECIFIC REQUIREMENTS

- A. Programming
  - 1. All programming shall be by a LAWA approved contractor listed below.
    - a. Johnson Controls: Main Office 562.594.3200
  - 2. The technician shall be experienced in programming the system and have certificates demonstrating that they have completed the required training courses
- B. Provision of Supervisory Controllers
  - 1. When installing new control devices and points ensure that the Controller serving the area has sufficient capacity. If Controller utilization is over 80% provide and install a new any required point expansion modules.
- C. Tenant Sub Metering
  - 1. Each service in a tenant space shall be metered and BACnet connection of pulsed output from the meter shall be tied into the BAS for tenant billing purposes. Metered services shall include:
    - a. Heating Hot Water Onicon electromagnetic BTU Meter with BACnet connection
    - b. Chilled Water Onicon electromagnetic BTU Meter with BACnet connection

- c. Gas Meter shall be provided by the Section 22000 plumbing contractor with a BACnet connection or pulsed output.
- d. Electricity Meter shall be provided by the Electrical Contractor with a BACnet connection.
- D. Graphic Displays
  - 1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
  - 2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection.
- E. Actuation / Control Type
  - 1. Primary Equipment
    - a. Controls shall be provided by equipment manufacturer as specified herein.
    - b. Each damper and valve actuation shall be electric.
  - 2. Air Handling Equipment
    - a. Each air handers shall be controlled with dedicated HVAC-DDC Controller
    - b. The AHU BAS controls shall be factory installed.
    - c. All damper and valve actuation shall be electric.
  - 3. Terminal Equipment:
    - a. Each terminal Units (VAV, UV, etc.) shall be controlled with dedicated electric damper and valve actuation.
    - b. All Terminal Units shall be controlled with HVAC-DDC Controller)
    - c. Terminal unit BAS controls shall be factory installed.
- F. The BAS system shall monitor common alarm, common trouble and common supervisory condition from the Fire Life Control System.

#### 3.2. INSTALLATION PRACTICES

A. BAS Wiring

- 1. All low voltage conduit, wiring, accessories and wiring connections required for the installation of the Building Automation System, as herein specified, shall be provided by the BAS Contractor. All wiring shall comply with the requirements of applicable portions of Division 26 Electrical System Specifications (Section 26 0519 "Low-voltage Electrical Power Conductors and Cables" and Section 26 2200 "Low-voltage Transformer") and all local and national electric codes, unless specified otherwise in this section.
- 2. All BAS wiring materials and installation methods shall comply with BAS manufacturer recommendations.
- 3. The sizing, type and provision of cable, conduit and cable trays, shall be the design responsibility of the BAS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, conduit by the BAS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
- 4. Class 2 Wiring
  - a. All Class 2 (24VAC or less) wiring shall be installed in conduits. The VAV shall be supplied with 24VAC power.
- 5. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
- 6. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.
- 7. Notify LAWA FMCS SA within 72 hours of when BAS is acknowledging that the BAS data is available to be integrated into the FMCS. BAS BACnet system shall be fully capable of auto-discovery by the FMCS BACnet system.
- B. BAS Line Voltage Power Source
  - 1. 120-volt AC circuits used for the Building Automation System shall be taken from panel boards and circuit breakers provided by Electrical Contractor.
  - 2. Circuits used for the BAS shall be dedicated to the BAS and shall not be used for any other purposes.
  - 3. DDC terminal unit controllers may use AC power from motor power circuits.
- C. BAS Conduits
  - 1. All wiring shall be installed in conduit. Minimum control wiring conduit size is 3/4".
  - 2. All conduits shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.

- 3. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 6 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.
- D. Penetrations BAS Contractor shall:
  - 1. Provide fire stopping for all conduits penetrations through fire-rated walls and/floors
  - 2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
  - 3. All wiring passing through penetrations, including walls shall be in conduit.
  - 4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.
- E. BAS Identification Standards
  - 1. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location. Cable types specified in Item A shall be color coded for easy identification and troubleshooting. BAS Contractor shall submit color coding legend to LAWA for approval prior to installation.
  - 2. The conduits shall be painted in 10 feet intervals with Navy Blue paint. The junction box covers shall be painted with Navy Blue paint.
- F. BAS Panel Installation
  - 1. The BAS controls components such as communication modules, hubs, servers, controllers, network connections, etc. shall be mounted in cabinets. Cabinets shall have hinged doors. Cabinets in the indoor dry location shall confirm to NEMA 1 standards. Cabinets in the damp locations (pump rooms) shall be a steel construction with baked enamel coating and shall confirm to NEMA 3R standards. Cabinets in the outdoor location shall be of a stainless steel construction and shall confirm to NEMA 3R standards.
  - 2. The BAS contractor shall be responsible for coordinating panel locations with other trades and Electrical and Mechanical Contractors and LAWA.
  - 3. The BAS panel shall be equipped with the minimum 500 VA UPS.

## G. Input Devices

- 1. All Input devices shall be installed per the manufacturer recommendation
- 2. Locate components of the BAS in accessible local control panels wherever possible.

## H. HVAC Input Devices – General

- 1. All input devices shall be installed per the manufacturer recommendation.
- 2. Locate components of the BAS in accessible local control panels unless otherwise approved in writing by LAWA.
- 3. The Mechanical Contractors shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
- 4. Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.
- 5. Outside Air Sensors
  - a. Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately. If access to the North wall is limited, the sensor may be installed in the AHU outside intake air duct when approved in writing by LAWA.
  - b. Sensors shall be installed with a rain proof, perforated cover.
- 6. Water Differential Pressure Sensors
  - a. Differential pressure transmitters used for flow measurement shall be sized to the flow- sensing device.
  - b. Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
  - c. The transmitters shall be installed in an accessible location unless otherwise approved in writing by LAWA.
- 7. Medium to High Differential Water Pressure Applications (Over 21" W.C.):
  - a. Air bleed units, bypass valves and compression fittings shall be provided.
- 8. Building Differential Air Pressure Applications (-1" to +1" W.C.):
  - a. Transmitter's exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
  - b. The interior tip shall be inconspicuous and located as shown on the drawings.
- 9. Air Flow Measuring Stations:
  - a. Where the stations are installed in insulated ducts, the airflow passage of the
station shall be the same size as the inside airflow dimension of the duct.

- b. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.
- 10. Duct Temperature Sensors:
  - a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
  - b. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
  - c. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
  - d. The sensor shall be mounted to suitable supports using factory approved element holders.
- 11. Space Sensors, Room Thermostats:
  - a. Shall be mounted per ADA requirements.
  - b. Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.
- 12. Low Temperature Limit Switches:
  - a. Install on the discharge side of the first water or steam coil in the air stream.
  - b. Mount element horizontally across duct in a serpentine pattern for large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
- 13. Air Differential Pressure Status Switches:
  - a. Install with static pressure tips, tubing, fittings, and air filter.
- 14. Water Differential Pressure Status Switches:
  - a. Install with shut off valves for isolation.
- I. HVAC Output Devices

- 1. All output devices shall be installed per the manufacturer's recommendation. The Mechanical Contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
- 2. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.
- 3. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
- 4. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.

## 3.3 TRAINING

- A. Provide training in accordance with LAWA (PR) project requirement documents.
- B. In addition, the BAS contractor shall provide the following training services:
  - 1. Operator Training (provide 40 hours): Operator training shall include the detailed review of the control installation drawings, points list, and equipment list. The instructor shall then walk through the building identifying the location of the control devices installed. For each type of systems, the instructor shall demonstrate how the system accomplishes the sequence of operation.
    - a. From the workstation, the operator shall demonstrate the software features of the system. As a minimum, the operator demonstrate and explain logging on, setting passwords, setting up a schedule, trend, point history, alarm, and archiving the database.
    - b. One day (8 hours) of the 40 hours will be devoted to on-site orientation by a field engineer who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as- built drawings, the control system software layout and naming conventions, and a walk through of the facility to identify panel and device locations.
  - 2. Factory training for a minimum of six (6) LAWA representatives for 40 hours (minimum) in a factory training lab. This training shall be performed by a factory-certified professional trainer and, at a minimum, shall consist of:
    - a. Two days (16 hours) basic system operation.

- b. One days (8 hours) system reporting and alarm management.
- c. One days (8 hours) scheduling and point trending
- 3. The LAWA shall be issued Continuing Education Credits (C.E.U.s) for the factory training.
- 4. Third Party Interface Training: BAS contractor shall provide a minimum of 24 hours detail training for systems such as lighting control, VFD, emergency generator, electrical switchgear and any other system or equipment that will interface with the BAS.

### 3.4 COMMISSIONING AND TESTING.

- A. Provide commissioning LAWA Guidelines.
  - 1. General
    - a. Commissioning the Building Automation System is a mandatory documented performance requirement of the selected BAS Contractor for all control systems detailed in this Specification and sequence of operations. Commissioning shall include verification of proper installation practices by the BAS Contractor and subcontractors under the BAS Contractor, point verification and calibration, system/sequence of operation verification with respect to specified operation, and network/workstation verification. Documentation shall be presented upon completion of each commissioning step and final completion to ensure proper operation of the Building Automation System.
    - b. BAS commissioning and testing documentation is to be provided separately to LAWA.
  - 2. Testing Requirements
    - a. Intent: Demonstrate to satisfaction of authorized representative that BAS is performing in accordance with requirements of this Section.
    - b. Logs of Tests: Complete logs of tests retained by Contractor for inspection and review of authorized representative at any time after testing started. Upon final completion of system tests log records submitted.
    - c. Witness of Tests: At time directed by authorized representative complete functional, operational test shall be performed by contractor. Test witnessed by personnel directed by authorized representative. Tests continue until functions of points, of alarms and command functions are proven to satisfaction of authorized representative.
    - d. Performance of Field Tests: Complete tests required at different and distinct

times for various phases of construction as designated by authorized representative.

- 3. Testing Procedure
  - a. Upon completion of the installation, the BAS Contractor shall start-up the system and performs all necessary testing and run diagnostic tests to ensure proper operation. The BAS Contractor shall be responsible for generating all software and entering all database information necessary to perform existing control sequences.
- 4. Testing Documentation
  - a. Prior to acceptance testing, BAS Contractor shall create, on an individual system basis, trend logs of input and output points, or have an automatic Point History feature for documentation purposes.
- 5. Field Points Testing
  - a. This step shall verify that all of the installed points receive or transmit the correct information prior to loading/activating the system software.
  - b. ON/OFF commands from the workstation shall be performed in order to verify each binary output point.
  - c. All binary input points are to be tested by observing a change of state upon command at PC workstation or locally in the field.
  - d. All analog output points shall be tested using a command from the PC workstation to modulate the output device from minimum calibrated signal to maximum calibrated output.
  - e. All analog input points are to be tested by comparing the reading obtained through the workstations to the value of an independent testing meter
  - f. All two-way communication interfaces (Modbus, Bacnet, etc.) tested and monitored values and commanded verified at the BAS workstation and in the field.
- 6. Verify that activation of site related alarms specifically identifies and notifies LAWA remote monitoring sites and selected personnel.
- 7. VAV box performance verification and documentation: (Perform testing if required).
  - a. As part of the commissioning of the terminal unit control (UC) and air distribution system, the Contractor shall initiate an automated test where the dampers in one half of a group of boxes are stepped towards full open while the

other half are stepped towards full closed. At each step, after a settling time, box airflow and damper positions will be sampled. Following the cycle, a pass/fail report indicating results shall be produced. Possible results are Pass, No change in flow between full open and full close, Reverse operation, or Maximum flow not achieved. The report shall be submitted as documentation of the installation.

- b. The controls contractor shall issue a report based on a sampling of the UC calculated loop performance metrics. The report shall indicate performance criteria, include the count of conforming and non-conforming boxes, list the non-conforming boxes along with their performance data, and shall also include graphical representations of performance. The sampling shall take place after completion of Test and Balance, when design cooling and heating media have been available and occupied conditions approximated for five consecutive days.
- c. Verify that new graphics are complete and contain dynamic (real-time) information that can be viewed at both workstation locations.
- 8. Non-compliant Items
  - a. The Contractor shall remove and replace, at its expense, all items that are not in compliance with the requirements of this section or other portions of LAWA's Design and Construction Handbook.

# 3.5 SEQUENCES OF OPERATION AND CONTROL DIAGRAMS

- A. Control points and sequences
  - 1. All equipment shall be user-definable as to which piece of equipment is the lead unit, the lag unit or the spare (standby) unit. The unit arrangements called out for initial start-up conditions only.
  - 2. All set points shall be user-definable; set points called out are for initial start-up conditions only.
  - 3. See plans for control details, point list for each equipment and Sequences of Operation.

# 3.6 POINT LISTS

A. The BAS Contractor shall provide the system's point list for engineer's review and approval. The sample is show below:

AHU 1,2,3,4

Systems

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Sam	ле	F U	ш	LISU	L

Point	Description		Type Units		Alarm	Totalize
DA-P	Discharge Static Pressure	AI	in WC	Х		
DA-T	Discharge Air Temperature	AI	Deg F	Х		
PH-T	Preheat Temperature	AI	Deg F	Х		
SF-S	Supply Fan Status	BI	Off On	Х	X	X
PH-O	Preheat Output	AO	%	Х		
RH-O	Reheat Output	AO	%	Х		
CLG-O	Cooling Output	AO	%	Х		
SF-O	Supply Fan Output	AO	%	Х		
SF-C	Supply Fan Command	BO	Off On	Х		
PH-LCKO	Preheat Lockout Command	BO	Off On	Х		
CLG-LCKO	Cooling Lockout Command	BO	Off On	Х		
RH-LCKO	Reheat Lockout Command	BO	Off On	Х		
DAT-SP	Discharge Temperature Set point		Deg F	Х		
PHT-SP	Preheat Temperature Set point	AO	Deg F	Х		
DAP-SP	Discharge Static Pressure Set point AO		in WC	Х		

END OF SECTION