GENERAL MECHANICAL PROVISIONS

1. GENERAL

1.1 Intent

.1 Contract Documents and Drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.

.2 Follow Manufacturers' recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

.3 Install equipment generally in locations and routes shown. Run piping and ductwork close to building structure, parallel to building lines to maximize head room and with minimum interference with other services. Remove and replace improperly installed equipment to satisfaction of the Contract Administrator at the Contractor's cost.

.4 Install equipment to provide access and ease of maintenance.

.5 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the City. Uncrate equipment, move in place and install complete; start-up and test.

1.2 Coordination of Work

.1 Cooperate and coordinate with other trades on the Site.

.2 Where dimensional details are required, work with the applicable architectural and structural Drawings.

.3 Any areas indicated as space for future materials or equipment shall be left clear.

1.3 References

.1 Conform to all referenced codes and standards to their latest edition.

1.4 Metric Conversion

.1 All units in this Division are expressed in SI units.

.2 Submit all Shop Drawings and maintenance manuals in SI units.

.3 On all submittals (Shop Drawings etc.) use the same SI units as stated in the Specification.

.4 Equivalent Nominal Diameters of Pipes - Metric and Imperial:

.1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, supply and install equivalent nominal Imperial sized pipe as indicated in the

table, and supply and install at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment and piping.

.2 When CSA approved pipes for equipment where nominal SI Metric pipes are supplied, the Contractor shall supply and install at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

mm (in) (NPS)	mm (in) (NPS)	mm (in) (NPS)
3 (1/8)	65 (2-1/2)	375 (15)
6 (1/4)	75 (3)	450 (18)
10 (3/8)	100 (4)	500 (20)
15 (1/2)	125 (5)	600 (24)
20 (3/4)	150 (6)	750 (30)
25 (1)	200 (8)	
30 (1-1/4)	250 (10)	
40 (1-1/2)	300 (12)	
50 (2)		

.5 Metric Duct Sizes:

.1 The metric duct sizes are expressed as 25 mm = 1 in.

1.5 Shop Drawings

.1 Provide printed copies of Shop Drawing, in accordance with Section 01300 – Submittals, for all scheduled equipment and as specified in specific equipment sections of this Specification.

.2 Identify materials and equipment by manufacturer, trade name and model number. Include copies of applicable brochure or catalogue material. Do not assume applicable catalogues are available in the Contract Administrator's office. O&M Manuals are not suitable submittal material.

.3 Clearly mark submittal material using arrows, underlining or circling to show differences from specified, e.g. ratings, capacities and options being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pumps seals materials or painting.

.4 Include weights, dimensional, and technical data sufficient to check if equipment meets requirements. Include wiring, piping, and service connection data and motor sizes. Provide additional information as specified in specific equipment sections of this specification.

.5 Installed materials and equipment shall meet specified requirements regardless of whether or not Shop Drawings are reviewed by the Contract Administrator.

.6 Do not order equipment or material until the Contract Administrator has reviewed and returned Shop Drawings.

.7 Submit shop drawings for pipe and equipment labels.

.8 Retain one (1) copy of Shop Drawings On-Site for review.

1.6 Cutting, Patching and Coring

.1 Provide holes and Supply and Install sleeves, cutting and fitting required for mechanical Work.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from the Contract Administrator before cutting into structural members.

.4 Provide openings and holes required in precast members for mechanical work. Cast holes 100 mm (4 in) or larger in diameter. Field-cut smaller than 100 mm (4 in).

.5 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective section.

1.7 Excavation and Backfill

.1 Refer to requirements of Division 2.

.2 Provide all excavating to facilitate installation of the mechanical work, including shoring, pumping, 150 mm compacted sand bedding under and first 300 mm of compacted sand over piping and ducting.

1.8 Installation of Equipment

.1 Pipe all equipment drains to building drains.

.2 Unions and flanges shall be provided in piping or ductwork to permit easy removal of equipment.

.3 Maintain permanent access to equipment for maintenance.

1.9 Fire-Stopping

.1 Fire-stop all pipe, duct, conduit and wire penetrations through floors and walls, designated as fire and/or smoke separations. The contractor is required to coordinate with the architectural drawings to contractual rated wall types and installation details.

.2 Fire-stopping materials to meet ULC CAN 2S115. Acceptable Materials: "Tremco" or "National Firestopping", or Hilti CP680 Cast-in-Place Firestopping System.

.3 Preparation of surfaces and installation of fire-stopping materials shall be carried out as per manufacturer's instructions.

1.10 Connections to Existing Services

.1 Maintain liaison with the Contract Administrator and provide a schedule to interrupt, re-route or connect to water, sewer, heating, or gas systems, with minimum interruption of services.

.2 Major services shall not be interrupted before all preparatory work is completed and all required materials are on site. Provide a minimum of forty eight (48) hours notice for all service shutdown.

.3 Interruptions and shutdowns of existing services shall be by the WTP maintenance staff.

1.11 Equipment Protection and Clean-Up

.1 Protect equipment and materials in storage on Site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Operate, drain and flush out unsealed bearings and refill with new change of oil, before final acceptance.

.3 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.

.4 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extensions to grease nipples at accessible locations for lubrication purposes.

.5 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.12 Electrical Motors

.1 Supply mechanical equipment complete with electrical motors.

.2 Supply and Install motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: NEMA, EEMAC, CSA, Canadian Electrical Code Part 1, IEEE and ANSI. All motors to be CSA labelled. All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch.

.3 All motors intended for use with a variable speed drive (VFD) shall be inverter only rated. Variable speed drive shall be matched to motor.

.4 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B. Motors driving high torque or high inertia loads may be EEMAC Design C or D.

.5 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection.

.6 Motors less than 0.37 kW (½ hp) shall be 120 V, 60 Hz, 1 phase. Motors ½ hp and larger shall be 3 phase at the indicated voltage.

.7 All motors shall be 1800 rpm unless indicated otherwise.

.8 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.

.9 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.

.10 Refer to Division 16 for voltage, frequency, and phase data. This shall take precedence over any reference in Division 15.

.11 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, will be used as the conversion factor.

.12 Minimum certified motor efficiency shall be as outlined in Manitoba Hydro's latest high efficiency motor incentives program.

.13 Acceptable Manufacturers

.1 GE Canada

.2 Leeson Canada

.3 Reliance Electric

.4 MagneTek

.5 Siemens Energy and Automation, Inc., Motors and Drives Division

.6 Baldor

.7 U.S. Electrical Motors

.8 TECO-Westinghouse Motor Co

.9 Toshiba International Corp., Industrial Division

1.13 Access Doors

.1 Supply and Install access doors for maintenance or adjustment purposes for all mechanical system components including:

.1 Valves

.2 Volume and splitter dampers

.3 Fire dampers

.4 Cleanouts and traps

.5 Controls, coils and terminal units

.6 Expansion joints

.7 Filters

.8 Strainers

.2 Steel frame access panel with stainless steel piano-type hinge, channel reinforced steel door panel, three "Symmons" fasteners per door. Door panel recessed to receive ceiling or wall material to give finished appearance showing only hinge and fasteners. Supply and Install acoustic gasket between door panel perimeter and steel frame. Rated access doors shall be UL-listed.

.3 Mark removable ceiling tiles used for access with colour coded dots.

.4 Sizes to be 200 mm x 200 mm (8 in x 8 in) for cleanout, 300 mm x 300 mm (12 in x 12 in) for hand 600 mm x 600 mm (24 in x 24 in) for body access minimum.

.5 Supply and Install UL-listed fire rated access doors installed in rated wall and ceilings.

1.14 Miscellaneous Metals

.1 Supply and Install all necessary miscellaneous metals to hang or support materials, equipment and provide access for Work under this Contract.

.2 All miscellaneous metals shall be galvanized. Miscellaneous metals shall include but are not limited to:

.1 Hangers for equipment, piping and ductwork.

.2 Support for equipment.

.3 Access platforms and catwalks.

1.15 Pipe Sleeves

.1 Minimum thickness: 4.7 mm.

.2 Seep Ring:

.1 Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 4.7 mm minimum thickness.

.2 Outside Diameter: Unless otherwise shown, 75 mm greater than pipe sleeve outside diameter.

.3 Continuously fillet weld on each side all around.

.4 Factory Finish:

.3 Above Grade in Nonsubmerged Areas: Hot-dip galvanized after fabrication.

.1 Hot-dip applied, meeting requirements of ASTM A153/A153M.

.2 Electroplated zinc or cadmium plating is unacceptable.

.3 As specified in Section 15200-000 – Process Piping.

.4 Below Grade or in Submerged or Damp Environments: Shop-lined and coated.

.1 Lining and coating in accordance with Section 09870 – Coating Systems for Steel Tanks and Pipes.

1.16 Temporary or Trial Usage

.1 Temporary or trial usage by the City or Contract Administrator of mechanical equipment supplied under Contract shall not represent acceptance.

.2 Repair or replace permanent equipment used temporarily.

.3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

1.17 Acceptable Manufacturers

.1 The following listed Manufacturers are acceptable for their ability to meet the general design intent, quality and performance characteristics of the specified product. The list does not endorse the acceptability of all products available from the listed Manufacturers.

.2 It remains the responsibility of the Contractor to ensure the products supplied are equal to the specified products in every respect, operate as intended, and meet the performance specifications and physical dimensions of the specified product.

.3 The Contractor shall be fully responsible for any additional work or materials, to accommodate the use of equipment from the acceptable Manufacturer's list.

.4 List of Acceptable Manufacturers:

.1	Access Doors	Maxam, Acudor, Milcor, Can.Aqua, Mifab
.2	Air Separators, Relief Valves	Armstrong, Bell & Gossett, Taco, Wheatley
.3	Air Terminals - Grilles Registers,	E.H. Price, Titus, Anemostat, Nailor

	Diffusers	
.4	Air Vents	Hoffman, Maid-O-Mist, Taco
.5	Backflow Preventers	Febco, Watts, Hersey, Singer, Ames
.6	Bypass Filter (HW)	Sumco, GESL, Pace Chemicals
.7	Chimney and Breeching	Metalbestos P/S, Van Packer P/S, Metal Fab PIL
.8	Coils - Heating and Cooling	Trane, Aerofin, Engineered Air, Colmac, McQuay
.9	Condensers - Air Cooled Refrigerant	Aaon, Engineered Air, McQauy
.10	Controls Contractors and/or Suppliers	Johnson Controls
.11	Convectors - Electric	Chromalox, Q-Mark
.12	Convectors - HW	Engineered Air, Trane, Rosemex, McQuay, Dunham Bush
.13	Dampers – Backdraft	Airolite, Vent-Aire, Penn, T.A. Morrison
.14	Dampers – Balancing	Maxam, Ruskin
.15	Dampers – Control	Ruskin, Tamco
.16	Dampers – Fire	Controlled Air, Ruskin, Canadian Advanced Air, Maxam, Nailor
.17	Drains - Floor, Roof, Cleanouts Trap Primers, Water Hammer Arrestors	Zurn, Ancon, PPP, J.R. Smith
.18	Expansion Compensators	Flexonics, Tube Turn, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
.19	Expansion Joints	Flexonics, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
.20	Emergency Eye Wash Fountains, Showers	Bradley, Haws, Western
.21	Fan Coil Units	Trane, Engineered Air, Williams
.22	Fans - Axial (Belted-Fixed Pitch, Direct Drive-Adjustable Pitch)	Northern, Chicago, Twin City, Woods, Joy, CB&F
.23	Fans - Bathroom Exhaust	ACME, Broan, Penn Zephyr, Reversomatic, Nutone, Broan

.24	Fans - In-Line Centrifugal	Greenheck, Jenn Air, Ammerman, ILG, Cook, Penn, Twin-City, Carnes
.25	Fans - In-Line Centrifugal (Tubular)	Chicago, Greenheck, Twin-City, Barry/CML, Northern Blower
.26	Fans - Propeller	Greenheck, Cook, Penn, Jenn Air, ACME, Powerline, Joy
.27	Fans - Roof and Wall Mounted	Greenheck, Ammerman, Powerline, ACME, Loren Cook, Penn, Jenn Fan, ILG, Carnes, Twin City
.28	Filters	Cambridge, AAF, Pacific, FARR
.29	Fire Hose Cabinets, Valves and Extinguishers	NFE, Grigor, Wilson & Cousins, Flag
.30	Flexible Connectors - Ducting	Thermaflex, G.I. Industries Type IHP
.31	Flexible Connectors - Piping	Flexonics, Tube Turn, Atlantic, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
.32	Flexible Duct	Thermaflex, Wiremold, GI Industries Type H.P.
.33	Grooved Mechanical Pipe Joints	Victaulic, Mech Line (only where permitted)
.34	Heat Exchangers - Plate	Alpha Laval, Tranter, Armstrong, APV
.35	Hose Bibbs	Jenkins, Dahl, Crane, Toyo, Kitz, Mifab
.36	Immersion Heaters	Armstrong, Taco, B&G
.37	Insulation - Piping and Duct	Fibreglass Canada, Manson, Knauf Fibreglass, Plasti-Fab, Manville
.38	Louvres	Price/Airolite, Penn, Airstream, West Vent, Nailor, Ruskin, Ventex
.39	Pipe Restraints	Trelleborg
.40	Piping Hangers and Saddles	Grinnell, Myatt
.41	Plug Cocks	DeZurik, Newman-Milliken
.42	Plumbing Brass	Crane, American Standard, Cambridge Brass, Waltec, Kohler, Symmons
.43	Plumbing Fixtures	Crane, American Standard, Kohler
.44	Plumbing: Floor Drains, Roof Drains,	Mifab, Zurn, Smith

	Hose Bibbs	
.45	Pump - Condensate Packages	Paco, Leitch
.46	Pumps - Deaerators and Boiler Feed	York Shipley, Cleaver Brooks, Duro
.47	Pumps - In-Line Circulators	Armstrong, B & G, Taco, Grundfos
.48	Pumps - Manual	Crane
.49	Pumps - Positive Displacement	Viking, Fairbanks, Morse, Ebara
.50	Pumps - Submersible Bilge or Sewage	Monarch, Barnes, Hydromatic or Sewage, Myers, Zoeller
.51	Pumps - Vertical In-Line and Base Mounted	Armstrong, B & G, Taco, Leitch, Grundfos
.52	Silencers - Fan and Duct	Vibro Acoustics, Vibron, Korfund, I.A.C, Koopers
.53	Sinks - Mop	Fiat, Crane, American Standard
.54	Sinks - Stainless Steel	KIL, American Standard, Elkay
.55	Steam Fittings - High Pressure	Grinnel
.56	Steam Pressure Reducing Station	Spirax/Sarco, Fisher
.57	Steam Relief Valves	Spirax/Sarco
.58	Steam Traps	Spirax/Sarco, Armstrong, Erwal
.59	Strainers	Armstrong, Sarco, Mueller, Toyo, Anderson, Metraflex, Yarway
.60	Tank - Diaphragm Type Expansion	Amtrol, Hamlet and Garneau Inc.
.61	Tanks - Boiler Feed and Blowdown	York Shipley, Cleaver Brooks
.62	Tanks - Expansion	Bell & Gossett, AS Leitch, Sanford, Westeel-Rosco Steelweld, Clemmer, Wheatley
.63	Unit Heaters - Cabinet	Trane, Engineered Air, Rosemex, McQuay
.64	Unit Heaters - Electric	Chromalox, Q-Mark
.65	Unit Heaters - Hydronic	Engineered Air, Trane, Rosemex, McQuay, Dunham Bush

.66	Valves - Butterfly	Jenkins, Keystone, DeZurik, Centreline, Monotight, Dresser, Lunkenheimer, Crane, Bray, Toyo, Grinnell
.67	Valves - Circuit Balancing	Armstrong, B & G, Wheatley, Tour & Anderson
.68	Valves - Drain, Radiator	Jenkins, Dahl, Crane, Toyo, Kitz
.69	Valves - Eccentric Plug	DeZurik, Homestead
.70	Valves - Gate, Globe, Swing, Check, Ball	Jenkins, Toyo, Crane, Kitz, Milwaukee
.71	Valves - Plumbing Flush	Crane, Sloan, Teck
.72	Valves - Pressure Balanced Mixing	Symmons
.73	Valves - Pressure Reducing	Armstrong, Bell & Gossett, Taco
.74	Valves - Relief	Armstrong, Bell & Gossett, Taco, Wheatley
.75	Valves - Silent Check	Val-matic, APCO, StreamFlo
.76	Valves - Suction Diffusers Combination Check and Balance	Armstrong, B&G, Taco
.77	Valves - Thermostatic Mixing	Lawler, Leonard, Powers, Symmons
.78	Valves - Water Pressure Reducing	Watts, Clayton, Singer, Zurn. Wilkins, BCA, Cash Acme, Braukman
.79	Vibration Isolation	Mason, Vibro Acoustic
.80	Water Closet Seats	Olsonite, Moldex, Beneke
.81	Water Softening	Duro, Petwa, Gladwell, Water Conditioning Canada

2. PRODUCTS

2.1 Counter Flashing Materials

.1 Counterflashings: galvanized sheet steel of 0.85 mm (22 gauge) minimum thickness.

.2 Counterflashings are attached to mechanical equipment and lap the base flashings on the roof curbs.

.3 Roof flashing and curb cants shall be Supplied and Installed by the Contractor.

.4 All joints in counterflashings shall be flattened and soldered double seam. Storm collars shall be adjustable to draw tight to pipe with bolts. Caulk around the top edge. Storm collars shall be used above all roof jacks.

.5 Vertical flange section of roof jacks shall be screwed to face of curb.

2.2 Identification Labels

.1 Pipe Labels:

.1 Labels:

.1 Snap-on, reversible type with lettering and directional arrows, sized for outside diameter of pipe and insulation.

.2 Provided with ties or straps for pipes of 150 mm and over diameter.

.3 Designed to firmly grip pipe so labels remain fixed in vertical pipe runs.

.2 Material: Heavy-duty vinyl or polyester, suitable for exterior use, long lasting, and resistance to moisture, grease, and oils.

.3 Letters and Arrows: Black on OSHA safety yellow background.

.4 Colour Field and Letter Height: Meet ASME A13.1.

.5 Message: Piping system name as indicated in Section 15200-00S – Piping Schedule.

.6 Acceptable Manufacturers:

.1 Brady Signmark; B-915 BradySnap-On and Strap-On Pipe Markers.

.2 Seton Identification Products; Ultra-mark Pipe Markers.

.2 Equipment Labels:

.1 Applies to equipment with assigned tag numbers, where specified.

.2 Letters: Black engraved, 19 mm high minimum.

.3 Background: White.

.4 Materials:

.1 Rigid laminate.

.2 Multi-layered acrylic.

.5 Supply and Install 25 mm margin with holes at each end of label, for mounting. On fibreglass labels, Supply and Install grommets at each hole.

.6 Size:

.1 50 mm minimum and 75 mm maximum high, by 350 mm minimum and 450 mm maximum long.

.2 Furnish same size base dimensions for all labels.

.7 Message: Equipment names and tag numbers as used in sections where equipment is specified.

.8 Manufacturers:

.1 Brady Signmark.

.2 Seton Identification Products.

3. EXECUTION

3.1 General

.1 Do not install water piping immediately over or within a 1 metre horizontal clearance of any electrical panel, motor starter, or HCP. Where piping must be located within these zones, install piping inside a PVC conduit or shield the electrical device to protect it from direct water access.

3.2 Identification

.1 Pipe Labels:

.1 Supply and Install pipe labels and flow direction arrows. Locate at connections to equipment, valves, or branching fittings at wall boundaries.

.2 At intervals along piping not greater than 6 m on center with at least one label applied to each exposed horizontal and vertical run of pipe.

.3 At exposed piping not normally in view, such as above suspended ceilings and in closets and cabinets.

.4 Supplementary Labels: Supply to City those listed in Piping Schedule that do not receive arrows.

.5 Application: To pipe only after painting in vicinity is complete or as approved by Contract Administrator.

.6 Installation: In accordance with manufacturer’s instructions.

.2 Equipment Labels:

.1 Locate and install on equipment or concrete equipment base.

.2 Anchor to equipment or base for easy removal and replacement with ordinary hand tools.

.3 Valves:

.1 Supply and Install 20 mm ($^3/_4$ in) diameter brass, with metal photo black numbers, or white lamacoid with black engraved numbers, secured to valve stem with key chain.

Provide neat, typewritten directories, giving valve number, services and location. Frame one copy under glass for wall mounting as directed, second copy to be forwarded to Contract Administrator. Include copies in O&M Manuals.

.4 Controls:

.1 Tag automatic controls, instruments and relays and match/key to control Shop Drawing identification numbers. Tag all equipment and control panels.

.2 Identify electric starting switches, thermostats controlling motors, remote push button stations, and controls equipment supplied under this division with lamacoid plates having 6 mm ($^1/_4$ in) minimum letter size. Identification to state equipment controlled.

.5 Heating, Ventilation, Fire Protection:

.1 Identify the usage of duct access panels with self adhesive Brady stick-on coloured labels. Apply labels conforming to the following schedule.

	Color	Letters
Cleaning and service access	yellow	C.A.
Controls, including heat sensors	black	C.
Dampers (backdraft, balance & control)	blue	D.
Fire dampers	red	F.D.
Smoke dampers and detectors	red	S.D.

Note: Provide black lettering for yellow or white background, white for all other colours.

.2 All ductwork to be identified as follows, complete with directional arrows:

Return Air	R.A.
Supply Air	S.A.
Mixed Air	M.A.

Combustion Air	Comb.Air
Relief Air	Relief Air
Exhaust Air	Exh.Air.

.3 Identify the location of the following items of equipment, which are concealed above a ceiling with Avery "Data Dots". Place identification dots on the access panel. The colours shall conform to the following schedule:

Concealed equipment and cleaning access	yellow
Control equipment, including control dampers and valves, and heat sensors	black
Fire, smoke, and sprinkler equipment including dampers	red
Pipe mounted equipment with the exception of fire, smoke, sprinkler and control equipment	green
Balancing Dampers	blue

When T-bar ceilings are installed, adhere "Data Dots" on T-bar framing adjacent to panel to be removed.

3.3 Colour Coding Schedule

.1 Coordinate colour coding of piping and equipment with Work of Division 9.

END OF SECTION

TESTING

1. GENERAL

1.1 Scope

.1 Test domestic water piping.

.2 Test chemical piping.

.3 Test chemical storage tanks.

.4 Test sanitary sewer piping.

.5 Test storm sewer piping.

.6 Test natural gas piping.

.7 Test heating water piping.

.8 Test refrigerant piping.

.9 Test compressed air piping.

.10 Test steam heating piping.

.11 Test condensate piping.

.12 Test low velocity ducts.

.13 Test glycol piping.

.14 Performance Verification of equipment.

.15 Manufacturer's start-up of equipment.

1.2 Quality Assurance

.1 Test equipment and material where required by specification or authority having jurisdiction to demonstrate its proper and safe operation.

.2 Test procedures in accordance with the current applicable portions of ASME, ASHRAE, and other recognised test codes as far as field conditions permit.

.3 Perform tests on site to the satisfaction of the Contract Administrator.

.4 Piping, fixtures or equipment shall not be concealed or covered until inspected and approved by the Contract Administrator. Provide ample written notice (two Business Days) to the Contract Administrator before tests.

.5 Co-ordinate with Contract Administrator at start of the Work, those tests that will require witnessing by the Contract Administrator.

.6 Provide services of a Manufacturer's Representative and submit Manufacturer's check sheets for starting the following specialty equipment:

.1 Air handling units

.2 Pumps

.3 Boilers

.4 Compressors

.5 Variable speed drive units

.6 Air flow measuring stations

.7 Control components

.8 Chemical cleaning and treatment

.9 Softeners

.10 Domestic water heaters

.7 Prior to starting, testing, balancing, adjusting and cleaning processes, verify with Contract Administrator any tests required to be witnessed. Provide sufficient notice to Contract Administrator prior to commencement of procedures.

.8 Contract Administrator shall be allowed to witness any testing, adjusting, starting, balancing and cleaning procedures.

.9 Assume all costs associated with starting and testing, including the supply of testing or cleaning medium.

.10 Prior to starting equipment or systems, secure and review Manufacturer's installation, operation and starting instructions. Read in conjunction with procedures defined herein.

.11 Use Manufacturer's or supplier's starting personnel where required to ensure integrity of Manufacturer's warranty.

.12 Compare installations to published Manufacturer's data and record discrepancies. Items proving detrimental to equipment performance shall be corrected prior to equipment starting.

.13 Some processes involved in starting procedures defined in this section may be duplications of authorities' verification. To facilitate expedient completion of the Work, arrange for

authorities to assist or witness these procedures. (Gas inspectors, boiler and pressure vessels inspections etc.)

.14 All starting, testing procedures shall be in accordance with applicable portions of the latest, current ASME, ASHRAE, AABC, CSA, NFPA, SMACNA, ASTM and ASPE codes and standards.

.15 Personnel involved in starting, testing, balancing and adjusting procedures shall be experienced in the design and operation of mechanical equipment and systems being checked and shall be able to interpret results of the reading and tests.

1.3 Submittals

.1 Obtain certificates of approval, acceptance, and comply with current rules and regulations from authorities having jurisdiction and include in O&M Manuals.

.2 Perform tests as specified and upon completion of mechanical installation. Provide certification of tests with detailed data as required. Itemise each test as to time performed and personnel responsible. Include in O&M Manuals.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Pressure Tests

.1 Provide equipment, materials and labour for tests and pay expenses. Use test instruments from approved laboratory or Manufacturer and furnish certificate showing degree of accuracy. Install permanent gauges and thermometers used for tests just prior to tests to avoid possible changes in calibration.

.2 Carry out tests in accordance with ASME B31.1 and ASME B31.3 maintain pressure with no appreciable pressure drop. Where leakage occurs, repair and re-test and pay necessary costs for re-witnessing.

.3 Drainage Systems: Test by filling with water to produce water pressure to 30 kPa (5 psi) minimum and 62 kPa (10 psi) maximum.

.4 Water Piping: Test to 1 $^{1}/_{2}$ times maximum working pressure or 1033 kPa (150 psi), whichever is greater, water pressure measured at system low point.

.5 Natural Gas: Test as required by current edition of CAN/CGA 149.1, and authority having jurisdiction.

.6 Low Pressure Steam and Condensate Piping: Test to 690 kPa (100 psi) hydrostatic pressure.

.7 Ducts: Test ducts as per current edition of SMACNA Manual.

.8 Check systems during application of test pressure including visual check for leakage of water test medium, soap bubble test for air.

.9 During heating and cooling piping system tests, check linear expansion at elbows, U bends, expansion joints and offsets for proper clearance.

.10 When using water as test medium for system not using water, evacuate and dehydrate the piping and certify the lines are dry. Use agency specialising in this type of work.

.11 Should tests indicate defective work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by re-making joints in screwed fittings, cutting out and re-welding welded joints, re-making joints in copper lines. Do not caulk.

3.2 Testing of Soldered Copper Joints

.1 Submit two (2) sample soldered copper pipe joints prepared by each tradesmen to be used on the Work, to the Contract Administrator within two (2) months of contract award. These samples may be subjected to radiographic testing to verify quality of workmanship.

.2 Remove ten (10) samples of soldered copper pipe joints on heating system during performance of the Work as selected by the Contract Administrator and remake joints removed. Arrange and pay for radiographic testing of removed joints to verify quality of workmanship.

.3 Rejection of a sample will require re-test of adjacent joints at the Contractor's expense.

.4 Failure of more than 75% of the above removed samples will necessitate removal and replacement of all joints completed up to the time of test, at Contractor's expense.

3.3 General

.1 Conduct Performance Verification to demonstrate equipment and systems meet specified requirements after mechanical installations are completed and pressure tested. Conduct tests as soon as conditions permit. Make changes, repairs, and adjustments required prior to Performance Verification.

.2 Where required by the authority having jurisdiction, gas fired appliances rated in excess of 117 kW (400 MBH) shall be subjected to an operational test established by the authority and shall pass this test before being approved for operation.

.3 Operate and test motors and speed switches for correct wiring and sequences and direction of rotation. Check and record overload heaters in motor starters.

.4 Confirm voltages and operating amperages at full load.

.5 Failure to follow instruction pertaining to correct starting procedures may result in re-evaluation of equipment by an Independent Testing Agency selected by the Contract Administrator at Contractor's expense. Should results reveal equipment has not been properly started, equipment may be rejected, removed from Site, and replaced. Replacement equipment shall also be subject to full starting procedures, using same procedures specified on the originally installed equipment.

END OF SECTION

PIPING SUPPORT SYSTEMS

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 ASTM:

.1 A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.2 A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.2 Building Officials and Code Administrators: Basic Building Code.

.3 International Conference of Building Officials: Uniform Building Code.

.4 NBC

.5 Manufacturers' Standardization Society:

.1 SP 58, Pipe Hangers and Supports - Materials, Design and Manufacture.

.2 SP 69, Pipe Hangers and Supports - Selection and Application.

.3 SP 89, Pipe Hangers and Supports - Fabrication and Installation Practices.

1.2 Submittals

.1 Shop Drawings:

.1 Drawings of piping support system, locating each support, brace, hanger, guide, component, and anchor. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.

.2 Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.

.2 Information Submittals: Maintenance information on piping support system.

1.3 Qualifications

.1 Piping support systems shall be designed and Shop Drawings prepared and sealed by a Professional Engineer registered in the Province of Manitoba.

1.4 Design Requirements

.1 General:

.1 Design, size, and locate piping support systems throughout facility, whether shown or not.

.2 Piping smaller than 750 mm: Supports are shown only where specific types and locations are required; additional pipe supports may be required.

.3 Piping 750 mm and larger: Support systems have been designed for piping shown.

.4 Meet requirements of MSS SP 58, MSS SP 69, and MSS SP 89, or as modified by this Section.

.2 Pipe Support Systems:

.1 Support Load: Dead loads imposed by weight of pipes filled with intended service commodity except air and gas pipes, plus insulation.

.2 Maximum Support Spacing and Minimum Rod Size:

.1 Mild Steel or Ductile Iron Piping:

Pipe Size	**Maximum Support/ Hanger Spacing**	**Minimum Rod Size Single Rod Hangers**
25 mm & smaller	1.8 m	6 mm
30 mm through 65 mm	2.4 m	6 mm
75 mm & 100 mm	3.0 m	10 mm
150 mm	3.6 m	10 mm
200 mm	3.6 m	13 mm
250 mm & 300mm	4.3 m	16 mm
350 mm	4.8 m	19 mm
400 mm & 450 mm	4.8 m	22 mm
500 mm	5.4 m	25 mm
600 mm	5.4 m	32 mm
750 mm & larger	As shown on Drawings	As shown on Drawings

.2 Copper Piping:

.1 Maximum Support Spacing: 600 mm less per size than listed for steel pipe, with 25 mm and smaller pipe supported every 1.5 m.

.2 Minimum Hanger Rod Sizing: Same as listed for steel pipe.

.3 Plastic and Fibreglass Piping:

.1 Maximum support spacing: As recommended by Manufacturer for flow temperature in pipe.

.2 Minimum Hanger Rod Sizing: Same as listed for steel pipe.

.4 Stainless Steel Piping:

SST Pipe Size	Maximum Support/ Hanger Spacing	Minimum Rod Size Single Rod Hangers
25 mm through 100 mm	2.4 m	6 mm
150 mm	2.4 m	10 mm
200 mm & 250 mm	3.0 m	13 mm
300 mm	3.0 m	13 mm
350 mm& 400 mm	3.6 m	16 mm
450 mm & 500 mm	4.3 m	19 mm
600 mm	4.3 m	22 mm

.3 Framing Support System:

.1 Beams: Size such that beam stress does not exceed 172 MPa and maximum deflection does not exceed $^{1}/_{240}$ of span.

.2 Column Members: Size in accordance with Manufacturer's recommended method.

.3 Support Loads: Calculate using weight of pipes filled with intended service commodity.

.4 Maximum Spans:

.1 Steel and Ductile Iron Pipe, 75 mm diameter and larger: 3 m centres, unless otherwise shown.

.2 Other Pipelines and Special Situations: May require supplementary hangers and supports.

.4 Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

.5 Vertical Sway Bracing: 3 m maximum centres, or as shown.

.6 Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show that they are adequate for additional load, or if they are strengthened to support additional load.

2. PRODUCTS

2.1 General

.1 When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated by catalogues.

.2 Special support and hanger details are shown for cases where standard catalogue supports are inapplicable.

.3 Materials: In accordance with Tables 1 and 2, in this Section.

2.2 Hangers

.1 Clevis Type: MSS SP 58 and SP 69, Type 1 or 6.

.1 Anvil; Figure 104 or 260

.2 B-Line; Figure B3198 or B3100

.2 Hinged Split-Ring Pipe Clamp: MSS SP 58 and SP 69, Type 6 or 12.

.1 Anvil; Figure 104

.2 B-Line; Figure B3198H

.3 Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

.4 Attachments:

.1 I-Beam Clamp: Concentric loading type, MSS SP 58 and SP 69, Type 21, 28, 29, or 30, which engage both sides of flange.

.2 Concrete Insert: MSS SP 58 and SP 69, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.

2.3 Saddle Supports

.1 Pedestal Type: Schedule 40 pipe stanchion, saddle, and anchoring flange.

.1 Nonadjustable Saddle: MSS SP 58 and SP 69, Type 37 with U-bolt.

.1 Anvil; Figure 259

.2 B-Line; Figure B3090

.2 Adjustable Saddle: MSS SP 58 and SP 69, Type 38 without clamp

.1 Anvil; Figure 264

.2 B-Line; Figure B3093

2.4 Wall Brackets

.1 Welded Steel Bracket: MSS SP 58 and SP 69, Type 33 (heavy-duty).

.1 Anvil; Figure 199.

.2 B-Line; Figure B3067.

.2 One-Hole Clamp: Anvil; Figure TBA.

.3 Channel Type:

.1 Unistrut

.2 Anvil; Power-Strut

.3 B-Line; Strut System

.4 Aickinstrut (FRP)

2.5 Pipe Clamps

.1 Riser Clamp: MSS SP 58 and SP 69, Type 8.

.1 Anvil; Figure 261

.2 B-Line; Figure B3373

2.6 Channel Type Support Systems

.1 Channel Size: 2.7 mm (12 gauge), 41.3 mm wide minimum steel, 27.6 mm wide minimum FRP.

.2 Members and Connections: Design for all loads with safety factor of 5.

.3 Manufacturers:

.1 B-Line; Strut System

.2 Unistrut

.3 Anvil; Power-Strut

.4 Aickinstrut (FRP System)

2.7 Accessories

.1 Insulation Shields:

.1 Type: Galvanized steel or stainless steel, MSS SP 58 and SP 69, Type 40.

.2 Acceptable Manufacturers:

.1 Anvil; Figure 167

.2 B-Line; Figure B3151

.2 Welding Insulation Saddles:

.1 Type: MSS SP 58 and SP 69, Type 39

.2 Acceptable Manufacturers:

.1 Anvil; Figure Series 160

.2 B-Line; Figure Series B3160.

.3 Vibration Isolation Pads:

.1 Type: Neoprene Waffle.

.2 Acceptable Manufacturers:

.1 Mason Industries; Type W

.2 Korfund; Korpad 40

2.8 Intermediate Pipe Guidelines

.1 Piping 150 mm and Smaller:

.1 Type: Pipe clamp with oversized pipe sleeve to provide minimum 3.2 mm clearance.

.2 Acceptable Manufacturers:

.1 B-Line; B3148 or B3180

.2 Anvil; Figure 103

.2 Piping 200 mm and Larger:

.1 Type: Specially formed U-bolts with double nuts to provide 6.4 mm minimum clearance around pipe.

.2 U-Bolt Stock Size:

.1 200 mm Pipe: 16 mm

.2 250 mm Pipe: 19 mm

.3 300 mm through 400 mm Pipe: 22 mm

.4 450 mm through 762 mm Pipe: 25 mm

2.9 Pipe Alignment Guides

.1 Type:

.1 Piping 200 mm and smaller: Spider or sleeve type

.2 Piping 250 mm and larger: Roller type

.2 Manufacturers:

.1 Flexonics

.2 Anvil

.3 B-Line

2.10 Pipe Anchors

.1 Type: Anchor chair with U-bolt strap.

.2 Acceptable Manufacturers:

.1 Anvil; Figure TBA

.2 B-Line; Figure B3147A or B3147B

3. EXECUTION

3.1 Installation

.1 General:

.1 Install support systems in accordance with MSS SP 69 and MSS SP 89, unless shown otherwise.

.2 Support piping connections to equipment by pipe support and not by equipment.

.3 Support large or heavy valves, fittings, and appurtenances independently of connected piping.

.4 Support no pipe from pipe above it.

.5 Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.

.6 Do not install pipe supports and hangers in equipment access areas or bridge crane runs.

.7 Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after start-up.

.8 Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.

.9 Repair mounting surfaces to original condition after attachments are made.

.2 Standard Pipe Supports:

.1 Horizontal Suspended Piping:

.1 Single Pipes: Adjustable swivel-ring, split-ring, or clevis hangers.

.2 Grouped Pipes: Trapeze hanger systems.

.3 Supply and Install galvanized steel protection shield and oversized hangers for insulated pipe.

.4 Supply and Install precut sections of rigid insulation with vapor barrier at hangers for insulated pipe.

.2 Horizontal Piping Supported From Walls:

.1 Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall mounted framing also acceptable.

.2 Stacked Piping:

.1 Wall mounted framing system and clips acceptable for piping smaller than 75 mm minimal diameter.

.2 Piping clamps that resist axial movement of pipe through support not acceptable.

.3 Wall mounted piping clips not acceptable for insulated piping.

.3 Horizontal Piping Supported From Floors:

.1 Stanchion Type:

.1 Pedestal type; adjustable with stanchion, saddle, and anchoring flange.

.2 Use yoked saddles for piping whose centreline elevation is 450 mm or greater above floor and for exterior installations.

.3 Supply and Install neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.

.2 Floor Mounted Channel Supports:

.1 Use for piping smaller than 75 mm nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.

.2 Attach channel framing to floors with anchor bolts.

.3 Attach pipe to channel with clips or pipe clamps.

.3 Concrete Cradles: Use for piping larger than 75 mm along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.

.4 Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.

.5 Standard Attachments:

.1 To Concrete Ceilings: Concrete inserts.

.2 To Steel Beams: I-beam clamp or welded attachments.

.3 To Wooden Beams: Lag screws and angle clips to members not less than 62 mm thick.

.4 To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.

.6 Existing Walls and Ceilings: Install as specified for new construction, unless shown otherwise.

.3 Intermediate and Pipe Alignment Guides:

.1 Supply and Install pipe alignment guides (or pipe supports that provide same function) at expansion joints and loops.

.2 Guide piping on each side of expansion joint or loop at 4- and 14-pipe diameters from each joint or loop.

.3 Supply and Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

.4 Accessories:

.1 Insulation Shield: Install on insulated nonsteel piping. Oversize rollers and supports.

.2 Welding Insulation Saddle: Install on insulated steel pipe. Oversize rollers and supports.

.3 Vibration Isolation Pad: Install under base flange of pedestal type pipe supports adjacent to equipment, and where required to isolate vibration.

.4 Dielectric Barrier:

.1 Install between carbon steel members and copper or stainless steel pipe.

.2 Install between stainless steel supports and nonstainless steel ferrous metal piping.

.5 Electrical Isolation: Install 6.4 mm by 75 mm neoprene rubber wrap between submerged metal pipe and oversized clamps.

3.2 Field Finishing

.1 Coat supports in accordance with Section 09901 – Painting and Finishing – Process Mechanical.

3.3 Hanger Materials

.1 Select hanger material in accordance with the following tables:

Table 1
Nonchemical Areas

Exposure Conditions	Hanger Material
Control & Electrical Rooms	Galvanized steel or precoated steel
Pipe Galleries	Galvanized steel or precoated steel
Process areas: high humidity	Stainless steel or FRP
Process areas: wetted or submerged	Stainless steel or FRP

Notes:
1. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
2. Stainless steel to be Type 304.
3. Galvanized steel to be per ASTM A653, Class G90, or hot-dip galvanized after fabrication to ASTM A123.

Table 2
Chemical Areas

Exposure Conditions	Hanger Material
Aqua Ammonia	Stainless steel
Ferric Chloride	Stainless steel
Sodium Hydroxide	Stainless steel
Sodium Hypochlorite	Stainless steel
Sulfuric Acid	Stainless steel

END OF SECTION

VIBRATION ISOLATION

1. GENERAL

1.1 Scope

.1 Supply all labour, materials and equipment required and necessary to isolate and restrain the equipment as indicated on the Drawings and Specifications.

.2 Install 300 mm long flex connection on all duct work connected to isolated equipment.

1.2 Qualifications

.1 Supply shop and placement drawings for all vibration isolation elements for review, before materials are ordered. The drawings shall bear the stamp and signature of the responsible Manufacturer's Representative.

.2 The work shall be carried out in accordance with the specification and, where applicable, in accordance with the Manufacturer's instructions and only by personnel experienced in this type of work.

2. PRODUCTS

2.1 Isolators

.1 Spring isolators located out of doors or in humid areas shall have Rustoleum painted housing and neoprene coated springs, unless otherwise indicated on drawings.

.2 Isolation mounts for equipment with operating weights substantially different from the installed weights, such as chillers or boilers, shall have adjustable limit stops.

2.2 Open Spring Isolators

.1 Springs shall be "ISO-Stiff" having equal stiffness in the horizontal and vertical planes with a working deflection between 0.3 and 0.6 of solid deflection.

.2 Spring mounts shall be complete with levelling devices, minimum 6 mm ($^1/_4$ in) thick neoprene sound pads and zinc chromate plated hardware.

.3 Sound pads shall be sized for a minimum deflection of 1.2 mm ($^1/_{16}$ in) and shall meet the requirements for neoprene isolators.

2.3 Closed Spring Isolators

.1 Compression springs shall be used both for hangers and floor mount isolators.

.2 Springs shall be stable under operating conditions.

.3 Housings shall incorporate a minimum 6 mm ($^1/_4$ in) thick sound pad sized for a minimum static deflection of 1.2 mm ($^1/_{16}$ in) meeting the requirements for neoprene isolators.

.4 Floor mount units shall incorporate neoprene side stabilisers with a minimum 6 mm ($^1/_4$ in) clearance.

2.4 Neoprene Isolators

.1 All neoprene isolators shall be tested to latest ASTM specifications.

.2 Where a ribbed pad is used, the height of the ribs shall not exceed 0.7 times the width of the rib. A steel layer shall be used to distribute the load in a multi-layered unit.

.3 Neoprene pads or elements shall be selected at the manufacturer's optimum recommended loading and shall not be loaded beyond the limit specified in the neoprene manufacturer's literature.

2.5 Inertia Bases

.1 Concrete inertia bases shall be a minimum of 1.5 times the weight of the isolation equipment and shall be constructed using a channel iron perimeter and adequate reinforcing. The concrete shall be rated at 20 MPa (3000 psi). Design shall be by the isolation Manufacturers.

.2 Concrete inertia bases shall meet the requirements of the isolation Manufacturer's shop drawings.

.3 Structural steel bases shall be sufficiently rigid to prevent misalignment or undue stress on the machine, and to transmit design loads to the isolators.

2.6 Spring Hangers

.1 Hangers capable of a 10 degree misalignment shall be Supplied and Installed unless otherwise specified.

2.7 Manufacturers

.1 Accepted Manufacturers: Mason, Vibro Acoustic.

3. EXECUTION

3.1 Application

.1 Supply and Install vibration isolator for mechanical motor driven equipment throughout, unless specifically noted otherwise.

.2 Set steel bases for 25 mm clearance between housekeeping pad and base. Set concrete inertia bases for 50 mm clearance. Adjust equipment level.

.3 Deflections 12 mm and over shall use steel spring isolators.

.4 Deflections 5 mm (0.2 in) and under shall use neoprene isolators.

.5 Horizontal limit springs shall be Supplied and Installed on fans in excess of 1.5 kPa (6 in wg) static pressure except vertical discharge fans and on hanger supported, horizontally mounted axial fans where thrust due to static pressure exceeds 300 N (68 lbs).

.6 All equipment mounted on vibration isolators shall have a minimum clearance of 50 mm to other structures, piping equipment, etc. All isolators shall be adjusted to make equipment level.

.7 Prior to making piping connections to equipment with operating weights substantially different from installed weights, the equipment shall be blocked up with temporary shims to the final heights. When full load is applied, the isolators shall be adjusted to take up the load just enough to allow shim removal.

.8 Adjustable, horizontal stabilisers on close spring isolators shall be adjusted so that the side stabilisers are clear under normal operating conditions.

.9 All piping connections to isolated equipment shall be supported resiliently for the following distances or to the nearest flexible pipe connector.

Pipe Size	Distance, m (ft)
15 - 40 mm	3.0 (10)
50 - 65 mm	4.5 (15)
75 - 100 mm	7.0 (25)
125 - 200 mm	9.0 (30)
225 - 275 mm	13.5 (45)
300 - 350 mm	15.0 (50)

The three closest hangers to the vibration source shall be selected for the lesser of a 25 mm static deflection or the static deflection of the isolated equipment. The remaining isolators shall be selected for the lesser of the 25 mm static deflection or $^1/_2$ the static deflection of the isolated equipment.

.10 Spring hangers shall be installed without binding.

.11 Adjust isolators as required and ensure springs are not compressed.

.12 Supply and Install neoprene side snubbers or retaining springs where side torque or thrust is developed.

.13 Where movement limiting restraints are Supplied and Installed, they shall be set in a position with minimum 6 mm ($^1/_4$ in) air gap. Restraints, isolator equipment and attachment points shall be designed to withstand the impact of the isolated equipment subjected to an acceleration not exceeding 3 g without permanent distortion or damage.

.14 Wiring connections to isolated equipment shall be flexible.

3.2 Performance

.1 Install inertia bases of type and thickness as indicated on Isolation Schedule.

.2 Install isolators of type and deflection as indicated on the Isolation Schedule or according to the following table, whichever provides the greater deflection.

The required static deflection of isolators for equipment exceeding 0.35 kW ($^1/_2$ hp) is indicated below. Spring isolators shall be "open spring". Closed spring isolators shall only be used where specified.

Machine Speed, r/min	Basement		Upper Floor	
	Under 15 kW (20 hp)	Over 15 kW (20 hp)	Normal	Critical
Under 400	Special*	Special*	Special*	Special*
400 - 600	25 mm (1 in)	50 mm (2 in)	90 mm (3½ in)	Special*
600 - 800	12 mm (½ in)	25 mm (1 in)	50 mm (2 in)	90 mm (3½ in)
800 - 1100	5 mm ($^3/_{16}$ in)	12 mm ($^1/_2$ in)	25 mm (1 in)	50 mm (2 in)
1100 - 1500	3 mm ($^1/_8$ in)	4 mm ($^5/_{32}$ in)	5 mm ($^3/_{16}$ in)	12 mm (½ in)

Note: * "Special" indicates as directed by the Contract Administrator.

END OF SECTION

METERS AND GAUGES

1. GENERAL

1.1 Scope

.1 Supply and Install meters, gauges, and taps where shown on Drawings and/or specified herein.

.2 Submit shop drawings of proposed products to the Contract Administrator for review.

.3 Submit data sheets on thermometers and pressure gauges indicating service, and temperature or pressure ranges to the Contract Administrator for review.

2. PRODUCTS

2.1 Thermometers

.1 Dial Thermometers: 75 mm diameter dial in drawn steel case, bimetallic helix actuated, brass separable socket of flange and bushing, glass cover, adjustable pointer.

.2 Mercury Thermometer: Red reading mercury filled, 2° graduations, aluminum case, 230 mm (9 in) scale, straight shank, separable socket, adjustable angle.

2.2 Thermometer Well

.1 Stainless steel suitable for stem type thermometer with gasket and cap except in potable water and open systems, in which case brass type shall be used.

2.3 Pressure Gauges

.1 100 mm diameter, drawn steel case, phosphor bronze bourdon tube, brass movement, extruded brass socket, 1% midscale accuracy, front calibration adjustment, black figures on white background. Supply and Install gauge cocks and syphons for steam service, pulsating damper and pet cock for water service.

2.4 Pressure Gauge Taps

.1 Brass needle valve.

2.5 Static Pressure Gauges

.1 Dial Gauge: 100 mm dial, diaphragm actuated, suitable for positive, negative or differential pressure measurement. Accuracy within +2% of full scale, complete with static pressure tips and mounting accessories.

.2 Inclined Vertical Manometer: Molded plastic manometer, accuracy within +3% of full scale, suitable for positive, negative or differential pressure measurement, complete with static pressure tips and mounting accuracy.

2.6 Positive Displacement Meters

.1 Nutating disc measuring chamber, disc material to suit fluid encountered, odometer-type direct reading totaliser counter with six numerical wheels for cumulative readings, complete with 4 to 20 mA or 0-10 VDC output for DDC system connection.

2.7 Venturi Flow Meters

.1 Supply and Install calibrated Venturi flow meter elements where shown on drawings.

.2 Each Venturi element shall be complete with safety shut-off valves and quick coupling connections. A permanent metal tag shall be attached with a chain showing designed flow rates, meter readings for designed flow rates, metered fluid, line size and tag number.

.3 Liquid Service: Insert type carbon steel Venturi element.

.4 Steam Service:

.1 Size to 50 mm: Machined carbon steel, welded connections. Stainless steel valves. Rating: 1725 kPa (250 psi), 120°C (250°F). Presco.

.2 Size over 50 mm: Machined cast steel, stainless steel valves, welded ends. Rating: 2760 kPa (400 psi), 150°C (300°F).

.5 Accuracy of flow measuring elements shall be $+^{1}/_{4}$% calibrated and +1% uncalibrated.

.6 Supply and Install a portable meter set of dry diaphragm type with a round 150 mm diameter dial. All wetted parts shall be of 316 SS construction. Meter shall include pulsation dampers, equalising valve, 2-bleed valves, master chart for direct conversion of meter readings to metric engineering units, rust proof carrying case, two 3.0 m each rubber test hoses with brass quick connect valves to Venturi element. Supply and Install meter complete with 4 to 20 mA or 0-10 VDC output for connection to DDC system, c/w calibration and algorithm software as required.

2.8 Accepted Manufacturers

.1 Gauges – Air: Dwyer, Magnehelic

.2 Gauges – OWG Pressure: Trerice, Marsh, Ashcroft, Weiss

.3 Meters – Positive Displacement: Neptune, Rockwell.

.4 Air Flow Measuring, Air Monitor, Air Stations: Cambridge, Sentinel Ebtron.

.5 Flow Meters:

.1 Orifice Plate: Gerand

.2 Pitot Tube: Annubar, Presco

.3 Venturi: Gerand, Presco

3. EXECUTION

3.1 Installation

.1 Install positive displacement meters with isolating valves. Supply and Install valved bypass for all service meters.

.2 Install flow meters in uninterrupted straight pipe, minimum five (5) pipe diameters downstream and ten (10) pipe diameters upstream, or according to manufacturer's recommendations.

.3 Supply and Install one pressure gauge per pump installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

.4 Select gauges so that normal operating point is approximately mid-point of instrument range.

.5 On pipes 65 mm and smaller, place well in tee used in lieu of an elbow to accommodate well.

3.2 Meters and Gauges Installation Schedule

.1 Meters, gauges and appurtenances shall be installed as indicated and as follows:

.1 Positive Displacement Meter:

.1 Domestic cold water

.2 Heating system make-up

.3 Glycol charging tank

.2 Flow Meters:

.1 Heating water system

.2 Glycol system

.3 Condenser water system

.4 Steam system

.3 Pressure Gauges:

.1 Pumps

.2 Expansion tanks

.3 Pressure tanks

.4 Steam header

.5 Leaving side of automatic make-up valves

.6 Boiler, inlet and outlet

.7 Supply and return headers

.8 Heat exchangers, all inlets and outlets

.9 Heating water zone supply and return mains and major branches

.10 Heating coils, inlet and outlet

.4 Pressure Gauge Taps:

.1 Both sides of two-way control valves

.2 All lines to three-way control valves

.3 Major coils, inlet and outlet

.4 Heat exchangers, inlet and outlet, tube and shell side

.5 Chillers, inlet and outlet

.5 Thermometers:

.1 Boiler, inlet and outlet

.2 Supply and return headers equipment

.3 Heat exchangers, all inlets and outlets

.4 Heating water zone supply and return mains and major branches

.5 Heating coils, inlet and outlet

.6 Thermometer Wells Only:

.1 All lines to three-way control valves

.7 Static Pressure Gauges:

.1 Across built-up filter banks

.2 Across unitary filter sections

.3 Across supply and return fans

.8 Static Pressure Taps:

.1 Across all major dampers

.2 Across heating and cooling coils

.3 Across heat recovery sections

END OF SECTION

MECHANICAL THERMAL INSULATION

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 ASHRAE:

.1 Standard 90.1, Energy-Efficient Design of New Buildings Except Low-Rise Residential Buildings.

.2 ASTM:

.1 B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.2 C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

.3 C195, Standard Specification for Mineral Fiber Thermal Insulating Cement.

.4 C335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.5 C411, Test Method for Hot Surface Performance of High Temperature Thermal Insulation.

.6 C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

.7 C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

.8 C547, Standard Specification for Mineral Fibre Pipe Insulation.

.9 C552, Standard Specification for Cellular Glass Thermal Insulation.

.10 C553, Standard Specification for Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.

.11 C592, Standard Specification for Mineral Fibre Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Meshed Covered) (Industrial Type).

.12 C916, Standard Specification for Adhesives for Duct Thermal Insulation.

.13 C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

.14 C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.

.15 D1784, Standard Specification for Rigid PVC Compounds and Chlorinated CPVC Compounds.

.16 D2310, Standard Classification for Machine-Made 'Fibreglass' (Glass-Fibre-Reinforced Thermosetting Resin) Pipe.

.17 E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.18 E96, Test Methods for Water Vapour Transmission of Materials.

.19 G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

.20 G22, Standard Practice for Determining Resistance of Plastics to Bacteria.

.3 Association of the Non-Woven Fabrics Industry, INDA.

.4 MSS:

.1 SP 58, Pipe Hangers and Supports - Materials, Design and Manufacture.

.2 SP 69, Pipe Hangers and Supports - Selection and Application.

.5 NFPA:

.1 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

.3 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.

.4 259, Standard Test Method for Potential Heat of Building Materials.

.6 UL: 723, UL Standard for Safety Test for Surface Burning Characteristics of Building Materials.

.7 TIAC, Thermal Insulation Association of Canada – Standards Manual for Mechanical Insulation.

.8 CAN/ULC-S102, Standard Method & Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 Definitions

.1 Piping: Includes fittings, flanges, valves, special pipe fittings, drains, vents and similar items, both indoors and outdoors.

.2 Ducting: Includes fittings, drains, accessories and similar items.

.3 Concealed: Insulated mechanical services and equipment above suspended ceilings and non-accessible chases and furred spaces.

.4 Exposed: Not concealed.

1.3 Submittals

.1 Submittals: product description, list of materials and thickness for each service or equipment scheduled, locations, and Manufacturer's installation instructions.

.2 Informational Submittals:

.1 Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

1.4 Quality Assurance

.1 Materials Supplied and Installed under this Specification shall be standard, catalogued products, new and commercially available, suitable for service requiring high performance and reliability with low maintenance, and free from all defects.

.2 Supply and Install materials by firms engaged in the manufacture of insulation products of the types and characteristics specified herein, whose products have been in use for not less than five (5) years.

.3 UL Listing or satisfactory certified test report from an approved testing laboratory is required to indicate fire hazard ratings for materials proposed for use do not exceed those specified.

1.5 Coordination

.1 Some piping shall be electrically heat traced. Coordinate installation of insulation with installation of heat tracing power.

1.6 Delivery, Storage, and Handling

.1 Manufacturer's Stamp or Label:

.1 Every package or standard container of insulation, jackets, cements, adhesives and coatings delivered to Site for use must have Manufacturer's stamp or label attached, giving name of Manufacturer, brand, and description of material.

.2 Insulation packages and containers shall be marked "asbestos-free."

2. PRODUCTS

2.1 General

.1 Insulation exterior shall be cleanable, grease-resistant, nonflaking, and nonpeeling.

.2 Insulation shall conform to referenced publications and specified temperature ranges and densities in kg/m^3.

.3 Insulation for fittings, flanges, and valves shall be premolded, precut, or job-fabricated insulation of same thickness and conductivity as used on adjacent piping.

.4 Fire Resistance:

.1 Insulation, adhesives, vapour barrier materials and other accessories, except as specified herein, shall be noncombustible.

.2 Use no fugitive or corrosive treatments to impart flame resistance.

.3 Flame proofing treatments subject to deterioration due to effects of moisture or high humidity are not acceptable.

.4 Materials including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke, developed as per tests conducted in accordance with ASTM E84 (NFPA 255) methods.

.5 Materials exempt from fire-resistant rating:

.1 Nylon anchors.

.2 Treated wood inserts.

.6 Materials exempt from fire-resistant rating when installed in outside locations, buried, or encased in concrete:

.1 Polyurethane insulation.

.2 PVC casing.

.3 Fibreglass-reinforced plastic casing.

2.2 Pipe Insulation

.1 Type P1—Fibreglass (ASTM C547, Class 1):

.1 Fibreglass, UL-rated, preformed, sectional rigid, with factory-applied ASJ composed of reinforced Kraft paper and aluminum foil laminate. Jacket shall have self-sealing lap to facilitate closing longitudinal and end joints.

.2 Minimum density: 64 kg/m^3.

.3 Thermal conductivity K factor 0.039 W/m°C maximum at 24°C mean per ASTM C177 or ASTM C518.

.4 Temperature Rating: -28 to 260°C.

.5 Fitting Insulation: wired-in-place premolded insulation or mitred secments, or soft fibreglass insulation inserts, covered with 0.51 mm minimum thickness PVC fitting covers.

.6 Acceptable Manufacturers:

.1 CertainTeed; 500° Snap-On ASJ/SSL

.2 Schuller (Manville); Micro-Lok 650 with AP-T jacket.

.3 Owens/Corning Fiberglass; 25 ASJ/SSL.

.4 Knauf Pipe Insulation; ASJ/SSL.

.2 Type P3—Elastomeric (ASTM C534):

.1 Flexible, closed cell elastomeric, nominal 96 kg/m^3 density,

.2 Thermal conductivity K factor 0.039 W/m°C maximum at 24°C mean per ASTM C177 or ASTM C518.

.3 Temperature Rating: -40 to 104°C.

.4 Flame Spread Rating: Less than 25 per ASTM E84.

.5 Fitting Insulation: same as pipe.

.6 Acceptable Manufacturers:

.1 Armstrong; AP Armaflex.

.2 Schuller (Manville); Aerotube II.

.3 Nomaco; Therma-Cel.

.4 Rubatex; R-180-FS.

.3 Type P4—Cellular Glass:

.1 Temperature Rating: -179 to 482°C.

.2 Acceptable Manufacturers:

.1 Pittsburg Corning Foamglass.

2.3 Duct Insulation

.1 Type D1—Blanket (ASTM C553, Type 1, Class B3):

.1 Fibreglass, nominal 16 kg/m^3 density blanket, K factor 0.045 W/m°C maximum at 24°C mean, with factory-applied foil-scrim-kraft vapour barrier jacket, for temperatures to 121°C.

.2 Acceptable Manufacturers:

.1 CertainTeed; Standard Duct Wrap.

.2 Schuller (Manville); Microlite.

.3 Owens/Corning Fiberglass; RFK-75.

.4 Knauf; Ductwrap.

.2 Type D2—Board:

.1 Fibreglass, minimum 44 kg/m^3 density board, K factor 0.033 W/m°C maximum at 24°C mean, with factory-applied FSK vapour barrier jacket, for temperatures from 38°C to 454°C.

.2 Acceptable Manufacturers:

.1 CertainTeed; IB 850.

.2 Knauf; Elevated Temperature Board.

.3 Owens/Corning Fiberglass; TIW.

.4 Schuller (Manville); 1000 Series Spin-Glass.

.3 Type D3—Liner (ASTM C1071, Type 1):

.1 Fibreglass, nominal 24 kg/m^3 density liner, K factor 0.036 W/m°C maximum at 24°C mean, black composite coated surface exposed to airstream to prevent erosion of glass fibres, for temperatures to 121°C.

.2 Liquid water repellency rating not less than 4 when tested in accordance with INDA IST 80.6.

.3 Potential heat value not exceeding 8140 kJ/kg when tested in accordance with NFPA 259 and meeting the classification of “Limited Combustible” as defined by NFPA 90A.

.4 Maximum rated velocity not less than 30 m/s when tested in accordance with ASTM C1071.

.5 Resistant to microbial growth using a "no growth criteria" when tested in accordance with ASTM C1139, G21 and G22.

.6 Acceptable Manufacturers:

.1 CertainTeed; Toughgard.

.2 Schuller (Manville); Linacoustic.

.3 Knauf; Duct Liner M.

2.4 Equipment Insulation

.1 Type E1—Elastomeric (ASTM C534):

.1 Flexible, closed-cell elastomeric, nominal 96 kg/m^3 density, K factor 0.039 W/m°C maximum at 24°C mean.

.2 Acceptable Manufacturers:

.1 Armstrong; Armaflex II.

.2 Schuller (Manville); Aerotube II.

.3 Nomaco; Therma-Cel.

.4 Rubatex; R-180-FS.

2.5 Insulation Finish Systems

.1 Type F1—PVC:

.1 PVC jacketing, white, for straight run piping and fitting locations, temperatures to 70°C.

.2 Acceptable Manufacturers:

.1 Knauf; Proto.

.2 Schuller (Manville); Zeston.

.2 Type F3—Aluminum:

.1 Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100 or 3105 to ASTM B209 with H-14 temper, minimum 0.4 mm thickness, with embossed finish.

.2 Moisture Barrier: Supply and Install factory applied moisture barrier, consisting of 18 kg kraft paper with 1 mil thick low density polyethylene film, heat and pressure bonded to inner surface of the aluminum jacketing.

.3 Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, specialty fittings, etc.

.4 Manufacturer:

.1 Permaclad

.2 Childers

.3 Insul-Coustic

.4 RPR Products

3. EXECUTION

3.1 Application of Piping Insulation

.1 Install insulation products in accordance with Manufacturer's written instructions, and in accordance with recognized industry practices.

.2 Apply insulation over clean, finish painted, and dry surfaces.

.3 Install insulation after piping system has been pressure tested and leaks corrected.

.4 Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.

.5 Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces of scraps abutting each other.

.6 Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

.7 Maintain integrity of vapour-barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Seal open ends of insulation with mastic. Sectionally seal all butt ends of chilled water and condensate drain piping insulation at fittings with white vapour barrier coating.

.8 Cover valves, flanges, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory

molded, precut or job-fabricated units. Finish cold pipe fittings with white vapour barrier coating and hot piping with white vinyl acrylic mastic, both reinforced with glass cloth.

.9 Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

.10 Install protective metal shields and foamglass inserts where pipe hangers bear on outside of insulation. Insulation shall be continuous through pipe supports and hangers.

.11 Insulation on piping that is to be heat traced shall be installed after installation of heat tape.

.12 Insulate valve bodies, flanges, and pipe couplings.

.13 Insulate and vapour seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.

.14 Do not insulate flexible pipe couplings and expansion joints.

.15 Do not allow insulation to cover nameplates or code inspection stamps.

.16 Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.

.17 Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

.18 Cold Surfaces: Supply and Install continuous vapour seal on insulation on cold surfaces where vapour barrier jackets are used.

.19 Placement:

.1 Slip insulation on pipe or tubing before assembly, when practical, to avoid longitudinal seams.

.2 Insulate valves and fittings with sleeved or cut pieces of same material.

.3 Seal and tape joints.

.20 Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.

.21 Roof Drains: Insulated entire length of roof drain piping.

.22 Vapour Barrier:

.1 Supply and Install continuous vapour barrier at joints between rigid insulation and pipe insulation.

.2 Install vapour barrier jackets with pipe hangers and supports outside jacket.

.3 Do not use staples and screws to secure vapour sealed system components.

3.2 Installation of Ductwork Insulation

.1 General: Install insulation products in accordance with the Manufacturer's written instructions and in accordance with recognized industry practices.

.2 Install insulation materials with smooth and even surfaces.

.3 Clean and dry ductwork prior to insulation. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

.4 Maintain integrity of vapour-barrier on ductwork insulation and protect it to prevent puncture and other damage. Tape all punctures.

.5 Seal longitudinal and circumferential joints with FSK tape, and finish with fibreglass mesh fabric embedded in vapour barrier mastic.

.6 Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated.

.7 Except as otherwise indicated, omit external insulation on ductwork where internal insulation or sound absorbing linings have been installed.

.8 Refer to Section 15810 – Metal Ductwork and Accessories, for installation of internal duct liner.

3.3 Installation of Equipment Insulation

.1 Application Requirements: Insulate where external surface temperature of equipment is below ambient temperature in the space, including surfaces that have a recognized possibility for condensation.

.2 Install equipment thermal insulation products in accordance with Manufacturer's written instructions and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

.3 Install insulation materials with smooth and even surfaces and on clear and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.

.4 Maintain integrity of vapour-barrier on equipment insulation and protect it to prevent puncture and other damage.

.5 Supply and Install removable insulation sections to cover parts of equipment that must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, and accessories.

.6 Replace damaged insulation that cannot be repaired satisfactorily, including units with vapour barrier damage and moisture-saturated units.

.7 Avoid using scrap pieces of insulation where larger sheets will fit.

3.4 Installation of Insulation Finish Systems

.1 Use a continuous friction type joint to hold jacket in-place, providing positive weatherproof seal over entire length of jacket.

.2 Secure circumferential joints with preformed snap straps containing weatherproof sealant.

.3 On exterior piping, apply coating over insulation and vapour barrier to prevent damage when aluminum fitting covers are installed.

.4 Do not use screws or rivets to fasten the fitting covers.

.5 Install removable prefabricated aluminum covers on exterior flanges and unions.

.6 Caulk and seal all exterior joints to make watertight.

3.5 Piping Insulation Requirements

.1 Install insulation over entire length of pipes unless noted otherwise.

.2 Condensate Drain:

.1 Type P3, elastomeric.

.2 12 mm thickness for pipe sizes up to 65 mm ID.

.3 20 mm thickness for pipe sizes over 65 mm ID.

.3 Potable Cold Water (DCW, PW), Plant Service Water (PSW):

.1 Type P3, elastomeric.

.2 12 mm thickness for pipe sizes 32 mm and smaller.

.3 25 mm thickness for pipe sizes larger than 32 mm.

.4 Potable Hot Water (DHW, DHWR, TDW):

.1 Type P1, fibreglass.

.2 25 mm thickness for all pipe sizes.

.5 Hot Water Heating (GHS, GHR):

.1 Type P1, fibreglass.

.2 40 mm thickness for all pipe sizes.

.6 Low Pressure Steam and Condensate (LPS, LPC):

.1 Type P1, fibreglass.

.2 40 mm thickness for all pipe sizes.

.7 Roof Drain (RD):

.1 Type P3, elastomeric.

.2 25 mm thickness.

.8 Caustic (CS)

.1 Type P1, fibreglass.

.2 Temperature: 25 to 90°C.

.3 40 mm thickness.

.9 Pipe Hangers:

.1 Type P1, Fibreglass: UL-rated, preformed rigid pipe insulation inserts of thickness equal to adjoining insulation, 250 mm in length, with factory-applied, vinyl-coated and embossed vapour barrier jacket with self-sealing lap.

.2 Type P3, Elastomeric: Rigid insulation section with 225 mm long, 1.6 mm thick (16 gauge) galvanized steel saddle.

3.6 Ductwork Insulation Requirements

.1 Mechanically Cooled Supply Air:

.1 Type D2, board.

.2 40 mm thickness.

.3 Insulate full length of ductwork, unless otherwise noted.

.2 Mechanically Heated Supply Air:

.1 Type D2, board.

.2 40 mm thickness.

.3 Insulate full length of ductwork, unless otherwise noted.

.3 Mechanically Cooled and Heated Supply Air:

.1 Type D3, liner.

.2 40 mm thickness.

.4 Exhaust Air (1200 mm from external wall or roof):

.1 Type D2, board.

.2 40 mm thickness.

.5 Unheated Supply Air:

.1 Type D3, liner.

.2 25 mm thickness.

.3 Insulate full length of ductwork, unless otherwise noted.

.6 Sheet Metal Plenums:

.1 Type D3, liner.

.2 40 mm thickness.

3.7 Insulation Finish Requirements

.1 Piping, Duct, and Equipment Insulation (Concealed Areas): Factory finish.

.2 Piping Insulation (Exposed to View, Indoors):

.1 Type F1, PVC.

.3 Ductwork Insulation (Exposed to View, Indoors):

.1 Factory finished.

.4 Equipment Insulation (Exposed to View, Indoors):

.1 Type F3, Aluminum.

.5 Piping Insulation (Outdoors):

.1 Type F3, aluminum.

.6 Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

3.8 Field Quality Control

.1 Test factory-applied materials assembled. Field-applied materials may be tested individually.

END OF SECTION

PRE-OCCUPATIONAL CLEANING AND CHEMICAL TREATMENT

1. GENERAL

1.1 Scope

.1 Provide for cleaning and degreasing of hot water heating, glycol, steam and condensate.

.2 Supply all necessary equipment and chemicals to treat hot water heating, glycol, steam and condensate.

.3 Provide for flushing and disinfection of domestic water systems.

1.2 Acceptable Agency

.1 The Contractor shall Supply and Install equipment, chemicals and Site supervision so as to fully comply with all requirements and their intent contained within this specification section.

.2 Acceptable Chemical Treatment Agency: Drew, GE Infrastructure, Pace.

1.3 Quality Assurance

.1 Perform the cleaning and degreasing operation on site and submit written reports on all situations found, actions taken and final results. Reports shall be signed by the Contractor. Inform the Contract Administrator fifteen (15) Business Days prior to commencing of work.

.2 Supply and Install chemical treatment as specified herein and provide written reports. Reports shall be signed by the chemical treatment agency and Contractor.

.3 The Contractor shall degrease, clean and perform the chemical treatment of all piping systems. Use of the permanent mechanical systems for pumping or heating of cleaning and dilution solutions is not permitted. Permanent systems shall be isolated and portable pumps and boilers utilised for the duration of the cleaning process. Permanent equipment shall be flushed, degreased and chemically treated independent of the piping systems.

1.4 Submittals

.1 Submit Shop Drawings with complete description of proposed chemicals, quantities, calculations, procedures, test kits and equipment to be supplied. Along with product shop drawings, provide copies of data sheets, procedure instructions and analysis reports to be used in the performance of the Work.

.2 Include with the shop drawings MSDS for all chemicals to be used.

.3 Provide written reports to the Contract Administrator containing procedure of system cleaning and degreasing, giving times, dates, conditions of water and problems and actions encountered.

.4 Submit written reports to the Contractor Administrator containing results of tests taken every seven days after completion of chemical treatment. Reports shall be done every seven (7) days for a minimum time period of thirty five (35) days.

.5 Provide monthly site visits (12 minimum) within the warranty year to check the treatment, take samples, analyse and recommend proper addition of treatment. Provide written reports to the Contract Administrator.

2. PRODUCTS

2.1 Materials

.1 Supply sufficient chemicals to treat and test the systems for the first year of operation by the City.

.2 Materials which may contact finished areas shall be colourless and non-staining. Chemicals used must comply with environmental and health standards applicable to the usage on this Contract.

.3 System Cleaner: Alkaline compound which in solution removes grease and petroleum products.

.4 Close System Treatment: Sequestering agent to reduce deposits and adjust pH, and a corrosion inhibitor.

.5 Steam System Treatment: Supply and Install an oxygen scavenging agent, corrosion inhibitor, alkalinity control compound, sequencing agent to reduce hardness, and carbon dioxide neutraliser.

2.2 Equipment

.1 Solution Pumps: Supply and Install positive displacement diaphragm type metering pumps for adding chemicals. Pumps shall have an adjustable flow rate and be suitable for chemicals to be pumped. Pumps shall be self flushing. Supply and Install pumps with plastic solution tanks complete with agitator, pump mounting, cover, provision for fill line and pump strainer. Size the pumps and tanks to permit operation for three days at 50% pump capacity without refill of tanks. Supply and Install agitator motor with terminals and junction box for electric wiring.

.2 Supply and Install chemical pot feeder with a minimum of 10 L (2.6 USgal) capacity, semi-sphere top and bottom, one pot feeder per system, located as shown on system schematics and floor plans. If location is in question obtain clarification from the Contract Administrator prior to installation.

.3 Steam Boiler:

.1 Supply and Install complete automatic blowdown consisting of two-position solenoid valve and conductivity metering device. Blowdown is to be Supplied with a parallel manual blowdown. Blowdown is to take place when the conductivity level of boiler water increases above the set point. HyDac Model 300.

.2 Chemical feed pump complete with foot valve and suction line to be mounted on chemical tank by Contractor; 205L polyethylene chemical solution tank complete with steel stand, pump mounting shelf and hinged lid.

.3 Flow meter and panel on make up line to control chemical feed pump.

2.3 Test Kits

.1 Supply test kits as required to determine proper system treatment consisting of, but not limited to the following:

.1 Steam boiler water treatment test kit to determine proper treatment blowdown.

.2 Heating water test kit to determine proper treatment.

.3 Glycol systems treatment test kits to determine proper concentration and glycol inhibitor, this shall include a hydrometer type tester.

.2 Supply test kits for hardness and chlorides in addition to those listed above.

.3 Supply an electronic pH meter complete with three different calibration standard solutions.

.4 All test kits shall be Supplied with adequate chemicals and reagents for one year of testing.

2.4 Chemical

.1 Steam Boiler: GE Infrastructure Optiguard MCM4277.

3. EXECUTION

3.1 System Cleaning

.1 Ensure reasonable care is exercised to prevent debris, dirt and other foreign material from entering the pipe during construction. This is to include proper protection of piping on site prior to installation, temporary caps on partial systems, and complete evacuation of moisture within systems being hydrostatically pressure tested.

.2 Chemical treatment agency shall, in conjunction with the Contractor, review connections for complete draining and venting of the systems. The Contractor shall Supply and Install

adequate drain connections to completely drain the systems within one hour. Utilise water meter to record capacity within each system, and record for maintenance manuals.

.3 Protect and/or remove control devices from systems during cleaning. All terminal control valves shall be in open position during cleaning. Particular attention is to be made to control valves which have a normally closed position.

.4 Make systems completely operational, totally filled, thoroughly vented, and completely started.

.5 Add system cleaner and degreasant to flow systems at concentration of 1 kg per 1000 L (8.3 lb per 1000 USgal) of water contained in systems for hot systems, 1 kg per 500 L (8.3 lb per 500 USgal) of water for cold systems, and fill the boilers only with cleaner for steam systems.

.6 For hot water heating systems apply heat while circulating, raise temperature to 71°C (160°F) slowly and maintain at 71°C (160°F) for a minimum of 12 hours. Remove heat and circulate systems to 38°C (100°F) or less. Drain system, entirely at one time, including all low points and coils. Intermittent start/stop of drainage is not approved. The Contractor shall Supply and Install additional temporary pipe, pumps as necessary and drainage location for complete drainage. Refill the entire system with clean water, circulate for six hours at design temperature, Supply and Install complete venting and deaeration, repeat the draining procedure. Refill complete system with clean water and retest.

.7 For glycol systems utilise the same procedure for hot water heating systems specified above.

.8 Steam Systems:

.1 Chemical Treatment Agency to supervise boil-out of each boiler.

.2 All labour to be provided by the Contractor who will arrange for qualified personnel to operate equipment during boil-out.

.3 Boiler is to be filled to operating level with zero soft water from pre-treatment system.

.4 Boil-out compound shall be introduced into boiler according to instructions provided on site by the Chemical Treatment Agency and shall be heated by firing boiler to bring pressure up to desired operating pressure.

.5 Throughout boil-out period, steam is to be vented in order to re-fire boiler and maintain circulation in the boiler. Blowdown from all blowdown valves is to be used to remove all grease and oil from boiler.

.6 On completion of boil-out, boilers to be cooled, drained, opened, washed down and inspected.

.7 Provide two (2) litres of boil-out compound per 100 litres of water in the boiler.

.9 For open systems clean, degrease and flush in the same methods utilised for closed systems of same temperature. Drain completely and refill.

.10 Inspect, clean of sludge and flush all low points with clean water after cleaning and degreasing process is completed. Include disassembly of components as required. All cleaning and flushing of low points, coils, boilers, etc. shall be done prior to final fill and chemical treatment.

.11 All domestic hot, cold and domestic recirculation water systems will be required to be flushed and disinfected. Add chlorine to water in system to 50 milligrams per litre (190 mg per USgal) and let stand for 24 hours. Check chlorine content after 24 hours and insure the content is not less than 20 mg per L (75 mg per USgal). If less than 20 mg per L (75 mg per USgal) repeat process. Flush system until the chlorine content of water being drained is equal to the chlorine content of the make-up water. Utilise plumbing fixtures (i.e. lavatories, sinks, flushometers, etc.) for drainage.

3.2 Heating Water and Glycol Systems

.1 Supply and Install one pot feeder for each individual system. Install complete with isolating and drain valves and necessary piping. Install as indicated on schematics.

.2 Treat closed systems with closed systems treatment introduced through pot feeder when required or indicated by test.

.3 Supply and Install one side stream 5 µ filter per main circulation pump system, c/w isolation valves, unions, and bypass with N.C. valve.

.4 Supply and Install "Dowfrost" brand propylene glycol to 50% for heating system to act as an antifreeze solution.

3.3 Steam System

.1 Supply and Install solution pump and solution tank to feed sequestering agent and oxygen recovery base, and corrosion inhibitor into boiler feed tank. Supply and Install minimum of one pump per make-up line where treatment materials can be mixed. Supply and Install one pump and solution tank per material where materials cannot be premixed.

.2 Control solution pumps and feed from flow meter in make-up water line. Activate solution pumps when flow meter senses flow in make-up water line.

END OF SECTION

1. GENERAL

1.1 Scope of Work

.1 The Section covers the requirements for the Supply and Installation of building services piping. Building services piping includes:

.1 Drainage, vent and waste piping.

.2 Trap primer piping.

.3 Potable water piping including hot and cold water.

.4 Stormwater drainage piping.

.5 Plant service water piping.

.6 Natural gas piping.

.7 Sanitary sump pump discharge piping.

.8 Water systems for building heating, including heat pumps.

.9 Compressed air piping.

.10 Instrument air piping for sizes larger than 15 mm.

.11 Condensate drains from heating and ventilation equipment.

1.2 References

.1 The following is a list of standards which may be referenced in this Section:

.1 ANSI:

.1 B2.1.001, Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel.

.2 B16.1, Cast Iron Pipe Flanges and Flanged Fittings.

.3 B16.3, Malleable Iron Threaded Fittings.

.4 B16.5, Pipe Flanges and Flanged Fittings.

.5 B16.9, Factory-Made Wrought Steel Buttwelding Fittings.

.6 B16.12, Cast Iron Threaded Drainage Fittings.

.7 B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

.2 ASTM:

.1 A47, Standard Specification for Ferritic Malleable Iron Castings.

.2 A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

.3 A74, Standard Specification for Cast Iron Soil Pipe and Fittings.

.4 A105/A105M, Standard Specification for Forgings, Carbon Steel, for Piping Components.

.5 A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

.6 A181/A181M, Standard Specification for Forgings, Carbon Steel, for General-Purpose Piping.

.7 A197/A197M, Standard Specification for Cupola Malleable Iron.

.8 A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

.9 A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

.10 A518/A518M, Standard Specification for Corrosion-Resistant High-Silicon Iron Castings.

.11 A536, Standard Specification for Ductile Iron Castings.

.12 A563, Standard Specification for Carbon and Alloy Steel Nuts.

.13 A861, Standard Specification for High-Silicon Iron Pipe and Fittings.

.14 B32, Standard Specification for Solder Metal.

.15 B61, Standard Specification for Steam or Valve Bronze Castings.

.16 B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

.17 B75, Standard Specification for Seamless Copper Tube.

.18 B88, Standard Specification for Seamless Copper Water Tube.

.19 B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

.20 B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.

.21 B139, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.

.22 B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.

.23 B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.

.24 B306, Standard Specification for Copper Drainage Tube.

.25 C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

.26 D1784, Standard Specification for Rigid PVC Compounds and CPVC Compounds.

.27 D1785, Standard Specification for PVC Plastic Pipe, Schedules 40, 80, and 120.

.28 D2000, Standard Classification System for Rubber Products in Automotive Applications.

.29 D2466, Standard Specification for PVC Plastic Pipe Fittings.

.30 D2564, Standard Specification for Solvent Cements for PVC Plastic Piping Systems.

.31 D2855, Standard Practice for Making Solvent-Cemented Joints with PVC Pipe and Fittings.

.32 E438, Standard Specification for Glasses in Laboratory Apparatus.

.33 F1412, Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems.

.3 AWWA:

.1 C104/A21.4, Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.

.2 C110/A21.10, Ductile-Iron and Gray-Iron Fittings, 75 mm. Through 1200 mm for Water and Other Liquids.

.3 C111/A21.11, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

.4 C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.

.5 C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water.

.6 C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied.

.7 C207, Standard for Steel Pipe Flanges for Waterworks Service-Sizes 100 mm Through 3,600 mm

.8 C606, Grooved and Shouldered Joints.

.9 C651, Disinfecting Water Mains.

.4 CSA B149.1, Natural Gas and Propane Installation Code.

.5 Cast Iron Soil Pipe Institute (CISPI): 301, Specification for Cast Iron No-Hub Pipe.

.6 NSF:

.1 60, Drinking Water Treatment Chemicals - Health Effects.

.2 61, Drinking Water System Components - Health Effects.

.7 Conform with the Plumbing Code and the requirements of Provincial and local authorities having jurisdiction.

1.3 Submittals

.1 Shop Drawings:

.1 Product data sheets.

.2 Drawings showing changes in location of fixtures or equipment that are advisable in the opinion of Contractor.

.2 Quality Control Submittals:

.1 Changes in location of equipment or piping that affect connecting or adjacent Work, before proceeding with the Work.

.2 Complete list of products proposed for installation.

.3 Test records produced during testing.

2. PRODUCTS

2.1 Piping

.1 Refer to Section 15200-00S – Piping Schedule for piping materials and testing requirements.

.2 Piping Legend: Refer to Section 15200-00L – Piping Service Legend.

.3 Piping Material: Refer to Piping Data Sheets:

.1 Section 15100-01 – Data Sheet – Polyvinyl Chloride Drain Waste and Vent (PVC-DWV) Pipe and Fittings.

.2 Section 15200-03 – Data Sheet- Carbon Steel Pipe and Fittings, General Service.

.3 Section 15200-13 – Data Sheet- Copper and Copper Alloy Pipe, Tubing and Fittings.

.4 Section 15200-21 – Data Sheet- Carbon Steel Pipe and Fittings-Natural Gas Service.

2.2 Pipe Hangers and Supports

.1 As specified in Section 15060 – Piping Support Systems.

2.3 Insulation

.1 As specified in Section 15085 – Mechanical Thermal Insulation.

2.4 Valves

.1 Gate Valves:

.1 50 mm and Smaller for Water, Air, Drainage and Sewage Services: Use valve type V100 as specified in Section 15202 – Process Valves and Operators.

.2 65 mm and Larger for Water, Air, Drainage and Sewage Services: Use valve type V108 as specified in Section 15202 – Process Valves and Operators.

.2 Ball Valves:

.1 50 mm and Smaller for Water and Air Services: Use valve type V300 as specified in Section 15202 – Process Valves and Operators.

.2 65 mm to 100 mm for Water Service: Use valve type V308 as specified in Section 15202 – Process Valves and Operators.

.3 50 mm and Smaller for Drainage and Sewage Service: Use valve type V307 as specified in Section 15202 – Process Valves and Operators.

.4 Thermoplastic Ball Valves 75 mm and Smaller for Water Service: Use valve type V330 as specified in Section 15202 – Process Valves and Operators.

.3 Butterfly Valves:

.1 65 mm and Larger: Use valve type V513 as specified in Section 15202 – Process Valves and Operators.

.4 Globe Valves:

.1 65 mm and Smaller: Use valve type V236 as specified in Section 15202 – Process Valves and Operators.

.2 75 mm through 200 mm: Use valve type V210 as specified in Section 15202 – Process Valves and Operators.

.5 Angle Valves:

.1 50 mm and Smaller: Use valve type V201 as specified in Section 15202 – Process Valves and Operators.

.6 Check Valves:

.1 50 mm and Smaller for Water, Sewage and Drainage Service: Use valve type V602 as specified in Section 15202 –, Process Valves and Operators.

.2 65 mm and Larger for Water Service: Use valve type V604 as specified in Section 15202 –, Process Valves and Operators.

.3 100 mm and Larger for Drainage and Sewage Service: Use valve type V632 as specified in Section 15202 – Process Valves and Operators.

.7 Flap Valves:

.1 150 mm to 450 mm: Use valve type V695 as specified in Section 15202 – Process Valves and Operators.

.8 Water Pressure Reducing Valves 15 mm through 65 mm:

.1 Spring controlled, with a neoprene diaphragm.

.2 Sizes and Ratings:

.1 PRV-x: 15 mm IPS, maximum 0.5 L/s, with inlet pressure 700 kPa; outlet pressure 400 kPa.

.3 Acceptable Manufacturers:

.1 Fisher; Type 75

.2 Watts; No. 223 S

.9 Gauge Cock Valves 3 mm To Class 125:

.1 Bronze body, hexagon male and female ends and tee head.

.2 Rated for 125-pound SWP.

.3 Acceptable Manufacturers:

.1 Ernst Gage Co.

.2 Lunkenheimer.

.10 Manual Air Vent Valves:

.1 With coin-operated air vent.

.2 Acceptable Manufacturers:

.1 Bell & Gossett; No. 4V.

.2 Dole; No. 9.

.11 Solenoid Valves:

.1 Two-way, full line size, normally open, 1035 kPa body pressure, 35 kPa operating differential, for use with cold water.

.2 Suitable for 115 V, 60 Hz, AC power supply.

.3 Manufacturers:

.1 Asco Valve Inc.

.2 Parker Skinner Valve.

.12 Pressure Reducing Valve:

.1 Service: Truck and Railcar Unloading.

.2 Inlet pressure: 500 to 860 kPa(g).

.3 Outlet pressure: 140 kPa to 200kPa (adjustable).

.4 Connections: 15 mm NPT.

.5 Integral pressure gauge, kPa units.

.6 Body material: cast iron.

.7 Acceptable Manufacturers:

.1 Fisher Controls, 95L Series

.2 Control Air Inc.

.13 Needle Valve (for compressed air purge of electrical panels): Use valve type V950, 6 mm, as specified in Section 15202 – Process Valves and Operators.

2.5 Miscellaneous Piping Specialties

.1 Strainers for Water Service:

.1 Iron body, Y-pattern, Class 125 rated, with screwed bronze or bolted iron cap.

.2 Screen: Heavy-gauge stainless steel or monel, 30-mesh.

.3 Acceptable Manufacturers:

.1 Crane; No. 988-1/2.

.2 Asco Red Hat.

.2 Flexible Connectors for Stainless Steel Gas Lines:

.1 Corrugated, Type 316 stainless steel hose, with 250 mm live length and Type 316 stainless steel male NPT pipe connectors at each end.

.2 Manufacturers:

.1 Flexonics Ltd.

.2 North American Mfg. Co.

.3 Vacuum Breakers 50 mm and Smaller:

.1 Angle type, as required.

.2 Manufacturers:

.1 Febco.

.2 Watts.

.4 Water Hammer Arrestors:

.1 Acceptable Manufacturers:

.1 J. R. Smith; Series 5000.

.2 Zurn Z-1700.

.3 P.P.P. Inc., SS Series

.5 Water Hose:

.1 Supply and Install six 15 m length(s) of 25 mm and three 15 m length(s) of 40 mm, Ethylene Propylene Diene Monomer (EPDM) black cover and EPDM tube, reinforced with two textile braids. Supply and Install each length with brass male and female NST hose thread couplings to fit hose nozzle(s) and hose valve(s) specified.

.2 Rated minimum working pressure of 1369 kPa.

.3 Manufacturers:

.1 Goodyear.

.2 Boston.

.6 Hose Nozzles:

.1 For each hose, Supply and Install 25 mm and 40 mm cast brass satin finish nozzle(s) with adjustable fog, straight-stream, and shut-off features and rubber bumper. Supply and Install nozzle(s) with female NST hose thread.

.2 Manufacturers:

.1 Croker.

.2 Elkhart.

.7 Sleeves:

.1 Acceptable Manufacturers:

.1 J. R. Smith; Figure 1720.

.2 Zurn Z198.

.8 Insulating Dielectric Unions and Flanges:

.1 Galvanically compatible with piping to which attached and pressure ratings suitable for system working pressures.

.2 Unions 50 mm and Smaller: Screwed or solder-joint type.

.3 Unions 65 mm and Larger: Flanged type, complete with bolt insulators, dielectric gasket, bolts, and nuts.

.4 Manufacturers:

.1 Epco Sales, Inc., Cleveland, OH.

.2 Capitol Insulation Unions.

.9 Joint Solder: 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.

.10 Pipe Joint Sealer: Compound insoluble in water or Teflon tape; approved by NSF 61 for use in potable water.

.11 Rubber Gaskets: ASTM C564.

2.6 Metering and Measuring Devices

.1 Refer to Section 15070 – Meters and Gauges.

.2 Thermometers:

.1 Adjustable angle, bi-metal type with 225 mm case and scale range in degrees C, as shown.

.2 Supply and Install with 90 mm stem length and separable NPT brass thermowell.

.3 Manufacturers:

.1 Weksler.

.2 Trerice.

.3 Pressure Gauges:

.1 90 mm gauge size, 0 to 690 kPa, 0 to 1103 kPa range, steel case, glass crystal, brass movement, and 6 mm NPT lower connection.

.2 Supply and Install with 6 mm brass gauge cock.

.3 Acceptable Manufacturers:

.1 Ashcroft; Type 1000.

.2 Marsh; J80.

3. EXECUTION

3.1 Piping Material Selection

.1 Select piping material for the various services based on Section 15200-00S – Piping Schedule.

3.2 General

.1 Field Obstructions:

.1 Drawings do not attempt to show exact details of piping. Provide offsets around obstructions.

.2 Do not modify structural components, unless approved by Contract Administrator.

.2 Sleeves:

.1 Pipe sizes shown are nominal sizes, unless shown or specified otherwise.

.2 Supply and Install piping passing through walls, floors, or ceilings with standard-weight pipe sleeves.

.3 Supply and Install pipes passing through finished walls with chrome-plated canopy flanges.

.3 Concrete Encasement: Encase in concrete all plumbing piping installed under the building foundations or below the lower floor slab of the building, unless otherwise noted.

.4 Supply and Install unions in piping systems at connections to equipment.

.5 Supply and Install insulating dielectric unions and flanges between ferrous and nonferrous piping and where otherwise required for electrically insulated connection, as shown.

.6 Pipe air release valves, water-lubricated bearings, and other appurtenances having water effluent to nearest drain with copper tubing.

3.3 Installation

.1 Steel Pipe:

.1 Ream, clean, and remove burrs and mill scale from piping before making up.

.2 Seal joint with pipe joint sealer of Teflon tape.

.2 Copper Tubing:

.1 Cut tubing square and remove burrs.

.2 Clean both inside of fittings and outside of tubing with steel wool and hydrochloric acid before soldering.

.3 Prevent annealing of fittings and hard-drawn tubing when making connections.

.4 Do not use mitered joints for elbows or notching of straight runs of pipe for tees.

.3 Rigid PVC or CPVC:

.1 Cut, make up, and install in accordance with pipe Manufacturer's recommendations.

.2 Ream, clean, and remove burrs from cut ends before joining pipe.

.3 Lay in trench by snaking pipe from one side to the other.

.4 Offset: as recommended by Manufacturer for maximum temperature variation between time of solvent welding and final use.

.5 Do not lay pipe when temperature is below 4.5°C or above 32°C when exposed to direct sunlight.

.6 Shield ends to be joined from direct sunlight prior to and during laying operation.

.7 Use strap wrenches only for tightening threaded plastic joints. Do not over tighten fittings.

.4 Water System Balancing: Provide a qualified Professional Engineer or firm specializing in testing and balancing to adjust domestic water system. Balance system for required water flows at each plumbing fixture, terminal device, and recirculating hot water loop.

.5 Water Hammer Arrestors:

.1 Install in piping systems where shown on Drawings and adjacent to pieces of equipment where quick closing valves are installed.

.2 Install at all emergency safety showers and eyewashes.

.3 Size and install in accordance with Plumbing and Drainage Institute Standard PDI-WH201.

.4 Shock arresters to have access panels or to be otherwise accessible.

.6 Valves: Install in accordance with Manufacturer's recommendations.

.7 Miscellaneous Piping Specialties: Install in accordance with Manufacturer's recommendations.

.8 Metering and Measuring Devices: Install in accordance with Manufacturer's recommendations.

.9 Condensate Drains: Discharge to sanitary drainage system. Provide continuous slope.

3.4 Sanitary Drain, Waste and Vent Piping

.1 Installation:

.1 Set piping occurring above floor slab true and plumb.

.2 Set exposed risers as close to walls as possible.

.3 Where vent stacks pass through roof slab, fit with flashing sleeve secured to roof.

.4 Extend vents minimum 305 mm above roof.

.5 Supply and install cleanouts where shown and where required by code.

3.5 Water Piping

.1 Water supply piping includes potable water, plant service water, hot and cold domestic water, trap primer water, building heating system water.

.2 Flush water piping systems clean of internal debris, clean faucet aerators, and adjust plumbing fixture valves for manufacturer's recommended flow.

.3 Except where otherwise shown on Drawings, do not run water piping through electrical rooms, stairwells, or immediately over or within a 1 m horizontal clearance of electrical panels, motor starters, or environmental control panels.

.4 Hose Valves and Hydrants: Attach handle with setscrew and provide Manufacturer's recommended gravel fill around drain hole of post hydrants.

.5 Supply and Install valve operators with position indicators, where indicated, to show position of valve disc or plug.

.6 Supply and Install bypass with globe valve for emergency throttling around each reducing valve.

.7 Protect buried copper and steel pipe and fittings with a single wrap of coal-tar saturated felt in accordance with AWWA C203.

.8 Supply and Install manual air vents at high points in domestic hot water system.

3.6 Gas Piping

.1 Slope piping 2% downward in direction of flow toward respective drip traps.

.2 Supply and Install union adjacent to each flexible connector hose.

.3 Purge natural gas piping before putting into service using carbon dioxide or nitrogen gas to not more than the maximum positive pressure setting of the gas burner excess pressure relief valve but not exceeding 20 kPa whichever is less.

3.7 Insulation

.1 As specified in Section 15085 – Mechanical Thermal Insulation.

3.8 Hangers and Supports

.1 As specified in Section 15060 – Piping Support Systems.

.2 Hanger Rod Sizing and Spacing: As specified in National Plumbing Code, Table 2.3.4.5.

3.9 Interim Cleaning

.1 As specified in Section 15200-000 – Process Piping.

3.10 Testing

.1 As specified in Section 15200-000 – Process Piping and Section 15200-00S – Piping Schedule.

3.11 Cleaning and Disinfection

.1 As specified in Section 15200-000 – Process Piping and Section 15200-00S – Piping Schedule.

3.12 Protection of Installed Work

.1 Protective Covers:

.1 Supply and Install covers over floor and shower drains during construction, to prevent damage to drain strainers and keep foreign material from entering drainage system.

.2 Cover roof drains and emergency overflow drains during roofing process so roofing material and gravel do not enter drain piping.

3.13 Field Finishing

.1 Coat the exterior of ferrous metal piping, copper piping, iron piping and PVC piping in accordance with Section 09901 – Painting and Finishing – Process Mechanical**.**

.2 Repair any damage to coating and lining on embedded pipes and sleeves.

END OF SECTION

DATA SHEET – POLYVINYL CHLORIDE DRAIN WASTE AND VENT (PVC-DWV) PIPE AND FITTINGS

Item	Size	Description
Pipe and Fittings	All	PVC-DWV Schedule 40 non-pressure application, Class 12454B conforming to ASTM D2665, ANSI/NSF Standard 14 system, and CSA B181.2.
Joints	All	Solvent cemented conforming to ASTM D2855 except where connection to equipment may require future removal.
Solvent Cement	All	As recommended by the pipe and fitting Manufacturer conforming to ASTM D2564.

END OF SECTION

HYDRONIC SPECIALTIES

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 ASME.

.2 NEMA:

.1 MG 1-12.53a, Motors and Generators.

.2 NEMA 250.

.3 OSHA.

.4 CSA: CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.

.5 ULC.

1.2 Submittals

.1 Action Submittals:

.1 Shop Drawings:

.1 Complete specifications, descriptive drawings, catalog cuts, and descriptive literature including make, model, dimensions, weight of equipment, and electrical schematics for products specified.

.2 Informational Submittals:

.1 Recommended procedures for protection and handling of equipment and materials prior to installation.

.2 Certificate of Satisfactory Installation, Form 102, as per Section 01650 - Equipment Installation.

.3 O&M Data: As specified in Section 01730 – Operation and Maintenance Manuals.

2. PRODUCTS

2.1 Hydronic Specialties

.1 Diaphragm Expansion Tank:

.1 Steel diaphragm type with heavy-duty butyl rubber bladder.

.2 ASME rated for 115°C working temperature and 862 kPa working pressure.

.3 Conform to the requirement of CSA B51.

.4 Performance Data: Refer to Section 15999 – List of Schedules.

.5 Accepted Manufacturers: S.A. Armstrong, Bell & Gossett, Amtrol

.2 Pot Feeder: Bypass feeder for injecting chemical treatment into closed loop systems.

.1 Feeder Working Pressure: 1034 kPa (150 psi).

.2 Acceptable Manufacturers:

.1 Aqua-Serv; Type AV, 20 litre capacity.

.2 Neptune; Model VS-BF**,** 20 litre capacity.

.3 Balancing Valve (CBV):

.1 Bronze body, globe type, and carbon filled TFE seat rings (15 mm to 75 mm).

.2 Heavy duty cast iron, bronze seat, bronze disc with EPDM seal insert, and stainless steel stem (100 mm to 300 mm).

.3 Hand adjusted.

.4 Graduated dial indicator.

.5 Line size (unless otherwise indicated).

.6 Integral valved readout ports.

.7 Adjustable memory stop.

.8 Drain connection.

.9 Preformed insulation.

.10 Acceptable Manufacturers:

.1 S.A. Armstrong; Type CBV

.2 Bell & Gossett

.3 Taco.

.4 Triple Duty Valve

.1 Combination valve incorporating three functions in one body: tight shut-off, spring-closure type silent non-slam check and flow measurement ports.

.2 Ductile iron body.

.3 6mm NPT measuring ports, one on each side of valve seat, with Nordel check valves and gasketted caps.

.4 Bronze plug disc, stainless steel stem.

.5 Pre-formed removable PVC insulation jacket.

.6 Manufacturers:

.1 S.A. Armstrong, Model FTV-S

.5 Bimetallic Industrial Thermometer

.1 Precision calibrated bimetallic sensing element

.2 Silicone dampened coil

.3 Adjustable angle type with swivel union connection

.4 125mm diameter face

.5 Hermetically sealed stainless steel case

.6 Double strength glass window

.7 External recalibrator

.8 Stem:

.1 Stainless steel

.2 Length as recommended by manufacturer for pipe or duct size and insulation thickness at installed thermometer location

.9 When installed on piping, installed with thermowell supplied by same Manufacturer as thermometer

.10 When installed on ductwork, install with mounting flange and adapter hub supplied by the same manufacturer as thermometer

.11 Maximum 1 degree per scale division of Celsius scale

.12 Accurate to plus or minus 1% of full scale in accordance with ASME B40.200

.13 Celsius only scale

.14 Temperature range: 0 to 100°C

.15 Manufacturers and Products:

.1 H. O. Trerice Co.; B8

.2 Ashroft

.3 Weksler.

.6 Pressure Gauge

.1 Bourdon tube sensing element

.2 Range:

.1 0 to 890 kPa

.2 Indelibly mark ranges with black figures on a white background

.3 Connection: 6mm male NPT.

.4 Case: Painted steel, stainless steel, fibreglass reinforced polypropylene, or aluminum

.5 Wetted Parts: Bronze, brass, stainless steel, or monel

.6 Ring: Stainless steel or fibre glass reinforced polypropylene

.7 Window: Acrylic or glass

.8 Dial Face:

.1 100 mm diameter, minimum

.2 Black figures on white background

.9 Accuracy: Plus or minus 1 percent of full scale in accordance with ASME B40.100

.10 Temperature Rating: 121°C, minimum

.11 Manufacturers:

.1 H.O. Trerice Co.

.2 Ashroft

.3 Weksler

.7 Pressure and Temperature Test Plug:

.1 Brass body.

.2 7 mm NPT.

.3 Removable threaded brass protective cap.

.4 Dual neoprene core rated for 93°C.

.5 Manufacturer and Product: Sisco; Model BNE-250.

.8 Air Separator:

.1 Full-line size (50 mm and larger), without strainer.

.2 Tangential construction.

.3 Steel tank with stainless steel collector tube.

.4 ASME constructed for 862 kPa operating pressure.

.5 Blowdown connection.

.6 Acceptable Manufacturers:

.1 Bell & Gossett; Rolairtrol

.2 Taco; 400 Series

.3 S.A. Armstrong

.9 Pressure Relief Valve:

.1 ASME rated

.2 Bronze body

.3 EPDM diaphragm

.4 Maximum operating temperature: 40°C

.5 Maximum operating pressure: 862 kPa

.6 Relief Pressure: 227 kPa

.7 Manufacturers and products:

.1 Bell & Gossett; Type 790 or 1170

.2 Taco; No. 321

.10 Automatic Air Vent: Brass body with nonferrous internals.

.1 Acceptable Manufacturers: For 1034 kPa (150 psi) maximum operating pressure and 115°C maximum operating temperature.

.1 Hoffman; No. 78

.2 Bell & Gossett; No. 87

.3 S.A. Armstrong, No. 71

.2 Acceptable Manufacturers: For 240 kPa maximum working pressure and 110°C maximum operating temperature.

.1 Hoffman; No. 77.

.2 Bell & Gossett; No. 67.

.3 S.A. Armstrong, No. 67.

.11 Manual Air Vents: Brass body with nonferrous internals.

.1 Maximum Operating Pressure: 1340 kPa.

.2 Maximum Operating Temperature: 107°C.

.3 Manufacturer and Product: Bell & Gossett; No. 4V.

.12 Drain and Charge Valve: Brass body with nonferrous internals.

.1 Maximum Operating Pressure: 862 kPa.

.2 Maximum Operating Temperature: 115°C.

.3 Acceptable Manufacturers:

.1 Bell & Gossett; Drain-O-Tank DT-2.

.2 Taco; Air-Scoop.

.13 Pressure Reducing Valve:

.1 20 mm cast iron body.

.2 Brass mounted.

.3 Integral strainer and anti-siphon check valve.

.4 Factory Pressure Setting: 83 kPa with adjustable range of 55 to 170 kPa.

.5 Acceptable Manufacturers:

.1 Bell & Gossett; No. 12.

.2 Taco; No. 329.

.14 Suction Diffuser:

.1 Flanged cast iron angle body.

.2 Flow straightening vanes.

.3 Bronze mesh startup strainer.

.4 Seals (O-ring): EPDM.

.5 Maximum operating pressure: 1207 kPa.

.6 Accepted Manufacturers:

.1 Bell & Gossett.

2.2 Hydronic System Circulating Water Pumps

.1 Base Mounted End Suction Pump:

.1 Single stage, end suction type.

.2 Ductile Iron casing with flanged suction and discharge, drilled and tapped for seal flush and gauge connection.

.3 Impeller: Bronze, Fully enclosed. Dynamically balanced.

.4 Stainless steel shaft.

.5 Mechanical seal: ceramic seal seat and carbon seal ring for continuous operation to 104°C. Replaceable bronze shaft sleeve shall completely cover the wetted area under the seal.

.6 Oil-lubricated ball bearings.

.7 Motor:

.1 1,800 rpm.

.2 Totally enclosed fan cooled.

.8 Bearings and impeller removable without disturbing piping.

.9 Baseplate: structural steel or fabricated steel channel with fully enclosed sides and ends with welded crossmembers.

.10 Construct for 860 kPa working pressure.

.11 Acceptable Manufacturers:

.1 S.A. Armstrong; Series 4300

.2 Bell & Gossett

.3 Taco

2.3 Accessories

.1 Equipment Identification Plates: Supply and Install 1.6 mm (16 gauge) stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 10mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

.2 Lifting Lugs: Supply and Install suitably attached for equipment assemblies and components weighing over 45 kg.

.3 Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer.

2.4 Finishes

.1 Manufacturers' standard machine enamel finish.

3. EXECUTION

3.1 Balancing Devices

.1 Install balancing devices with unrestricted flow and straight pipe for four pipe diameters up and downstream per manufacturer’s recommendations.

.2 Install well tappings and fittings for control sensors.

3.2 End Suction Pumps

.1 Install in accordance with Manufacturer's written directions**.**

.2 Install pumps on concrete bases. Coordinate location of pump bases. Concrete base size shall be at least 100 mm wider and longer than the pump and driver base, and a minimum of 100 mm thick.

.3 Anchor pump securely in place.

3.3 Access and Clearance Considerations

.1 Obstructions: Drawings do not attempt to show exact details of piping. Anticipate and work around obstructions.

.2 Cover piping installed across aisles or other main access walkways with a protective checkered plate steel ramp, pitched a maximum of 2:12 to allow safe wheeled or foot traffic, and paint with a prime coat and two finish coats of Safety Yellow. Support ramp from the floor, and do not rest ramp directly on pipe.

.3 Install specialties with suitable access clearances for maintenance or removal of replaceable components. Provide necessary couplings or flanges to maintain or remove specialties without removing connecting appurtenances.

.4 Provide an alternate safe means of access where equipment requiring periodic maintenance cannot be reached by walkways because of substitution of equipment or interference with ductwork, piping, or other mechanical conflicts resulting from construction. These may include:

.1 Overhead platform with stairway or ladder access and safety railings or handholds.

.2 Walk-through duct plenums with hinged access doors.

.3 Other means as necessary to meet OSHA Standards for safe maintenance procedures.

3.4 Cleaning and Adjusting

.1 Cleanup:

.1 Thoroughly clean all parts of the installation and remove refuse material at completion of the Work.

.2 Check belt-drive tensions and alignments.

.3 Lubricate motors and bearings in accordance with Manufacturer's service manuals prior to equipment start-up.

.2 Repair Work: Perform repair work of existing facilities affected by mechanical work performed under this section. Include such items as:

.1 Replacement of ceiling tiles or plaster removed or damaged for access to ceiling.

.2 Patching walls and ceilings for piping and ductwork penetrations.

.3 Repair of concrete or asphalt paving removed for pipe access.

.4 Other repairs due to extension and remodelling of existing mechanical systems.

3.5 Circulating Pump Schedule

.1 Refer to Pump Schedule in Section 15999 – List of Schedules.

END OF SECTION

EXPANSION COMPENSATION

1. GENERAL

1.1 Scope

.1 Flexible pipe connections.

.2 Expansion joints and compensators in pipe systems.

.3 Pipe loops, offsets, and swing joints.

1.2 Reference Standard

.1 Conform to current Standards of "Expansion Joint Manufacturers Association" and manufacturer's recommendations.

1.3 Shop Drawings

.1 Provide shop drawings for all equipment in this section.

.2 Flexible pipe connector shop drawing data shall include maximum allowable temperature and pressure rating, overall face-to-face length, live length, hose wall thickness, hose convolutions per 300 mm and per assembly, fundamental frequency of assembly, braid structure and total number of wires in braid.

.3 Expansion joint shop drawings shall include maximum allowable temperature and pressure rating, and maximum expansion compensation.

1.4 Inspection

.1 Provide inspection services by flexible pipe Manufacturer's Representative for final installation and certify installation is in accordance with Manufacturer's recommendations.

2. PRODUCTS

2.1 Flexible Pipe Connectors

.1 Flexible Rubber Spools: Neoprene twin sphere connector of molded multiple plys of nylon tire cord fabric and neoprene, rated for 1035 kPa (150 psi) at 120°C (250°F). Union end connections for sizes 50 mm and under; floating galvanised ductile iron flanges for sizes over 50 mm.

.2 Spherical Rubber Spools: Neoprene single sphere elbow connector, construction and service rating same as 2.1.1 above.

.3 Braided Spools for Copper Piping: Stainless steel inner core and braid braized to copper tube ends, suitable for 1035 kPa (150 psi) at 120°C (250°F).

.4 Braided Spools for Steel Piping: Stainless steel inner core and braid welded to steel pipe nipples, threaded for pipe up to 50 mm diameter, flanged for 65 mm diameter pipe and over. Suitable for service at 1035 kPa (150 psi) at 120°C (250°F).

2.2 Expansion Joints

.1 Copper Piping: Laminated stainless steel bellows brazed to copper tube ends, internal guide, stainless steel external shroud. Suitable for 1035 kPa (150 psi) at 260°C (500°F).

.2 Steel Piping up to 100 mm: Laminated stainless steel bellows welded to steel pipe nipples. Anti-torque device and threaded ends for sizes to 50 mm, flanged ends for sizes 65 mm and over. Internal guide and carbon steel shroud suitable for 1035 kPa (150 psi) at 260°C (500°F).

.3 Steel Piping 100 mm and over: Guided externally pressurised laminated stainless steel bellows, flanged ends, internal guide tube and ring, external shroud and guide ring. Suitable for 1035 kPa (150 psi) at 260°C (500°F).

2.3 Pipe Guides

.1 Four finger "spider" inside a guiding sleeve formed of two halves suitable for clamping onto pipe.

.2 Guided sleeve formed of two parts, suitable to be bolted to supporting structure.

.3 Guide length to be minimum 300 mm.

3. EXECUTION

3.1 Application

.1 Supply and Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation and where indicated on the drawing.

.2 Provide structural work and equipment required to control expansion and contraction of piping, loops, pipe offsets, and swing joints and provide expansion joints where indicated or required. Where deemed necessary by the Contract Administrator the Contractor shall, at his own cost, employ a Professional Engineer to design pipe anchors to control piping expansion and contraction.

.3 Provide pipe guides as required to ensure correct pipe alignment for expansion joints.

3.2 Installation

.1 Install as indicated.

.2 Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end.

.3 Rigidly anchor pipe to building structure at points shown, and where necessary provide pipe guides so that movement takes place along axis of pipe only.

.4 Install flexible connectors and expansion joints in accordance with Manufacturer's instructions.

.5 Do not compress or expand connector during installation.

END OF SECTION

TANKS

1. GENERAL

1.1 Scope

.1 Domestic water expansion tanks.

.2 Blowdown tanks.

.3 Glycol fill tanks.

.4 Accessories and connection to piping system.

.5 Saddles and structural supports.

1.2 Standards

.1 Construct pressure tanks to current ASME Code for Unfired Pressure Vessels.

.2 Comply with current Provincial Government Regulations.

1.3 Submittals

.1 Provide shop drawings for all scheduled tanks.

.2 Submit as part of shop drawings for domestic hot water storage tanks, specifications and installation instructions for tank lining method.

1.4 Inspections

.1 Obtain inspection certificates for pressure vessels from Provincial Authorities.

2. PRODUCTS

2.1 Expansion Tanks, Diaphragm Type

.1 For potable water.

.2 Welded steel, rated for working pressure, supplied with steel support structure.

.3 Precharged air chamber, heavy duty butyl diaphragm bonded with polypropylene liner to steel sheel separating air chamber from water.

.4 Provide with air side charge connection, and water side inlet connection precharged as scheduled.

.5 Accepted Manufacturer: Amtrol, Armstrong, Bell & Gossett.

.6 Performance Data: Refer to Section 15999 – List of Schedules.

2.2 Blowdown Tank

.1 Vertical or horizontal type with welded drop tube connections.

.2 Shell:

.1 ASME code rated welded tank of ASTM A515 black steel plate. Prime coated, safety factor of 5.

.2 Provide certificate of registration required by Provincial Authorities.

.3 Nozzles:

.1 Blow-off inlet

.2 Outlet

.3 Vent connection

.4 Drain connection

.5 Cooling water inlet and outlet

.6 Vacuum breaker connection

.4 Support on vertical legs or saddles.

2.3 Glycol Feed Tank

.1 Glycol feed tank shall include a storage-mixing tank with level gauge; pump suction hose with inlet strainer; pressure pump with fuse protection; integral low fluid cut-out switch; integral check valve; power supply adapter; manual diverter valve for purging air and agitating contents of storage tank; pressure switch with two sets of SPST contacts, each adjustable from 55 kPA (8 psig) to 175 kPa (18 psig) cut-out pressure; 6 mm ($^1/_4$ in.) female NPT connection. Power supply 115 V, 1 phase, 60 Hz to 24 VDC 50 W.

.2 Pressure pump shall be capable of running dry without damage.

.3 Unit shall be completely pre-assembled and certified by a recognized testing agency to CSA standard C22.2 No.68.

.4 Pump and tank capacity: refer to Section 15999 – List of Schedules.

3. EXECUTION

3.1 Installation

.1 Support tanks inside building from building structure as indicated on drawings. Provide 100 mm high housekeeping bases on floor mounted tanks.

.2 Supply and Install 12 mm compressed air line with flexible coiled hose at each expansion tank and charging tank complete with fitting compatible with quick connect on the tank. Extend line and hose down to 1200 mm above floor level.

3.2 Performance

.1 Provide tanks of dimensions and capacities as indicated on the drawings and/or tank schedule in Section 15999 – List of Schedules.

END OF SECTION

STEAM SYSTEMS

1. GENERAL

1.1 Scope

.1 Steam and condensate system with steam pressure below 1035 kPa (150 psi) shall meet the requirements of this section.

1.2 Quality Assurance

.1 The Contractor shall apply for registration and obtain approval prior to construction, for the design of the pressure piping system from the Authority having jurisdiction.

.2 Where required, all fittings used for the boilers and pressure piping system shall be registered with the Authority having jurisdiction.

.3 Where required, the contractor shall register quality control manuals for pressure piping system with the Authority having jurisdiction.

1.3 Standards

.1 ANSI/ASME B31.3 Power Piping Code, for steam systems.

.2 ANSI/ASME Section IX, Welding Qualifications.

.3 ANSI B16.25, Buttweld Ends.

.4 ANSI B16.34, Steel Flange and Buttweld Valves.

.5 ANSI B16.5, Steel Pipe Flanges and Flange Fittings.

.6 ANSI B16.9, Steel Long Radius Buttweld Fittings.

.7 ANSI B16.11, Forged Steel Socket Weld & Threaded Fittings.

.8 ASTM A53, Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

.9 ASTM A105, Forgings, Carbon Steel, for Piping Components.

.10 ASTM A234, Piping Fittings for Wrought Carbon-Steel and Alloy Steel for Moderate and Elevated Temperatures.

1.4 Design Conditions

.1 Pressure and temperature referred to throughout this specification are design conditions; each service class shall only be used within the pressure temperature range specified.

1.5 Corrosion Allowance

.1 Nominal corrosion allowance of 1.6 mm ($^{1}/_{16}$ in) shall be used.

1.6 Submittals

.1 Provide shop drawings for all steam accessories in this Section.

2. PRODUCTS

2.1 Pipe

	Service	Material
.1	Steam and Condensate to 100 kPa (15 psi)	Steel Sch. 40, ASTM A53, Grade B, Seamless or ERW for sizes 15 mm to 40 mm.
		Steel Sch. 40, ASTM A53, Grade B, Seamless or ERW for sizes 50 mm and over.
.2	Chemical Feed	10 gauge 304L Stainless Steel Tubing

2.2 Fittings and Joints

	Service	Material	Joint
.1	Steam and Condensate	Class 150 Malleable iron, ASTM A197, Sizes up to 40 mm	Screwed
		Buttweld Fittings, schedule 40, ASTM A234 Weldolet fittings ASTM A105, Pipe sizes 50 mm and over	Welded
.2	Chemical Feed	Swage-Lok	Compression

.3 The wall thickness of reducing fittings shall equal to the thicker wall of the connecting pipe.

.4 The nominal wall thickness of Buttweld fittings shall be the same as the pipe.

.5 Long radius elbows shall be used for change of direction. Short radius elbows many only be used where the space is limited and with the written consent of the Contract Administrator.

2.3 Flanges

.1 Forged steel weld neck flanges, class 150, as per ANSI B16.5.

.2 Alloy steel stud bolts ASTM A193-B7. Semi-finished heavy hex nuts ASTM A194-2H.

.3 Gaskets shall be spiral wound type. Gasket design temperature shall be same as flange design temperature.

2.4 Steam and Condensate Systems

.1 Gate Valves

.1 Up to 40 mm: Bronze body, rising stem, solid wedge, threaded ends rating 1035 kPa (150 psi) steam.

.2 50 mm and Over: Cast iron body, flanged ends, O.S.&Y, rising stem, bronze trim, solid wedge, rating 1035 kPa (150 psi) steam.

.2 Globe Valves

.1 Up to 40 mm: Bronze body, stainless steel plug and seat ring, rising stem, threaded ends, rating 1035 kPa (150 psi) steam.

.2 50 mm and Over: Cast iron body, flanged ends, O.S.&Y, renewable bronze seat ring, renewable composition disc. Rating 1035 kPa (150 psi) steam.

.3 Swing Check Valves

.1 Up to 50 mm: Bronze body and disc, regrinding swing check, screw-in cap, threaded ends, rating 1035 kPa (150 psi) steam

.2 50 mm and Over: Cast iron body regrind - renew swing check, bolted cover, flanged ends, bronze disc and seat ring, rating 1035 kPa (150 psi) steam

2.5 Valve Operators

.1 Provide suitable handwheel operators for valves.

.2 Provide gear operators for valves 250 mm and over.

.3 Provide valves larger than 100 mm located more than 2100 mm from floor, in equipment rooms, with chain operated sheaves. Extend chains to 1500 mm above floor, and hook to clips to clear walking aisles.

2.6 Strainers

.1 Size to 50 mm: 1720 kPa (250 psi) rating, screwed, cast iron casting, Y-pattern sediment separator with 0.8 mm (20 ga) 304 stainless steel screen. Provide minimum 12 mm drain cock.

.2 Size 50 mm and Over: 1720 kPa (250 psi) flanges, cast iron, Y-pattern, sediment separator with 1.6 mm (14 ga) 304 stainless steel screen. Provide minimum 12 mm drain cock.

2.7 Steam Traps

.1 General:

.1 Trap bodies and components shall have a primary working steam pressure (wsp) rating equal to or in excess of the maximum working steam pressure of the steam system to which applied.

.2 Trap bodies for pressures 860 kPa (125 psi) working steam pressure and shall be cast iron in accordance with ASTM A 278/A 278M, class 30.

.3 Trap shall have permanent external identification of service rating and orifice size.

.2 Float and Thermostatic (F & T) Traps

.1 Float and thermostatic traps shall have AISI 300 series corrosion-resistant steel, heliarc-welded float and operating mechanisms, and hardened, 13 percent chrome corrosion-resistant steel seats and valves.

.2 Thermostatic elements shall be balanced pressure type, with corrosion-resistant allow bellows charged with a fluid that will provide most rapid response to changes in temperature.

.3 Bellows shall be suitable for service with condensate having a pH of 6.0.

.4 Traps shall be designed to permit the removal and replacement of all operating and wearing parts without disturbing piping connections to trap body.

.5 Bodies shall be fitted with drain plugs.

Service	Sizing Safety Factor	Type of Trap
Boiler Header	2:1	Float and Thermostatic
Steam Mains	2:1	Float and Thermostatic
Branch Lines	3:1	Float and Thermostatic

2.8 Steam Drip Pan Elbows

.1 Material: Cast iron

.2 Conform: ASME B31.1 – Power Piping.

.3 Connections: NPT

.4 General: complete with pan to collect condensate.

.5 Standard of Acceptance: Consolidated 1900 series.

2.9 Pipe Insulation

.1 Refer to Section 15085 – Mechanical Thermal Insulation.

2.10 Pipe Hangers and Supports

.1 Refer to Section 15060 – Piping Support Systems.

3. EXECUTION

3.1 Preparation

.1 Ream pipes and tubes. Clean off scale and dirt, inside and outside, before assembly. Remove welding slag or other foreign material from piping.

.2 Protect all steel pipes when stored on site from external conditions and ensure protective coating remains intact. If in the opinion of the Contract Administrator, deterioration of the protective coating has instigated corrosion, all rust must be removed down to bare metal and prime coated with red oxide paint.

3.2 General Piping Layout Practices

.1 Piping shall be arranged for ease of operation, accessibility for maintenance, safety considerations, economy and appearance.

.2 Group piping in pipeways wherever possible for neatness and operability. All piping shall be routed in an orderly manner and to maintain proper grades.

.3 Relative elevations of pipeways shall be set to provide sufficient clearance between lines at intersections, to conserve head room and interfere as little as possible with the use of space.

.4 Flat turns at change in direction shall be avoided.

.5 Dead ends and pockets in piping shall be avoided.

.6 Slope steam piping 0.5% in direction of flow and condensate return piping 0.75%. Provide drip trap assembly at all low points and in front of controls valves. Run condensate lines from traps to nearest condensate receiver. Where condensate lines form a trap, provide vent loop over the trapped section.

.7 Make reductions in condensate and steam pipes with eccentric reducing fittings installed to provide drainage and venting. Top flat for condensate, bottom flat for steam.

.8 Pipe the discharge from steam safety relief valves and vents to the outside.

.9 Pipe discharge from equipment blowdowns, and overflows to the nearest building drain.

.10 Provide clearance for proper installation of insulation, for access of valves, air vents, drains and unions.

3.3 Branch Connections

.1 Make branch connections according to the following schedule.

Legend:

T: Forges tee or reducing tee

S: Socolet

W: Weldolet

HEADER PIPE SIZE (mm)	15	20	25	30	40	50	65	75	100	150	200	250	300
15	T												
20	T	T											
25	T	T	T										
30	T	T	T	T									
40	T	T	T	T	T								
50	S	S	S	T	T	T							
65	S	S	S	S	T	T	T						
75	S	S	S	S	S	T	T	T					
100	S	S	S	S	S	T	T	T	T				
150	S	S	S	S	S	W	T	T	T	T			
200	S	S	S	S	S	W	W	W	T	T	T		
250	S	S	S	S	S	W	W	W	W	T	T	T	
300	S	S	S	S	S	W	W	W	W	W	T	T	T

BRANCH PIPE SIZE (mm)

3.4 Welding

.1 All welds shall have 100% penetration to the root of the joints. Projection of weld metal into pipe shall not exceed 1.5 mm ($^{1}/_{16}$ in). Welds having lack of penetration or excessive projection shall be cut and rewelded.

3.5 Pipe Testing and Inspection

.1 Hydrostatic Testing

.1 All piping shall be hydrostatically tested with water at 1.5 times the design pressure and temperature compensated as per ASNI/ASME B31.1.

3.6 Valves and Strainer Installation

.1 Install valves with stem upright or horizontal, not inverted.

.2 Provide drain valves at low points of piping.

.3 Provide valved drain and hose connection off the bottom of all strainers.

3.7 Steam Trap Installation

.1 Sizing

.1 Size steam traps to handle a minimum of two times the maximum condensate load of the apparatus served.

.2 Assemblies

.1 Install trap with union or flanged connection at both ends.

.2 Provide gate valve and strainer at inlet, gate valve and check valve at discharge.

.3 Provide minimum 250 mm long dirt pocket of same pipe sizes as apparatus return connection.

.4 Do not use thermostatic elements in traps until system has been operated and dirt pockets cleared of sediment and scale. Provide temporary covers for use prior to this time.

END OF SECTION

STEAM SPECIALTIES

1. GENERAL

1.1 Scope

.1 Steam air vents.

.2 Vacuum breakers.

1.2 Quality Assurance

.1 Low pressure steam is steam at 103 kPa (15 psig) or less.

.2 Comply with Provincial Regulations and have CSA approval.

1.3 Submittals

.1 Provide shop drawings and schedules of all equipment in this Section.

2. PRODUCTS

2.1 Steam Air Vents

.1 Provide automatic steam air vents of the thermostatic balanced pressure type, with brass or semi-steel body, renewable stainless steel head and seat.

.2 Fabricate thermostatic liquid filled bellows or phosphor bronze.

2.2 Vacuum Breaker

.1 All brass constructed vacuum breaker with stainless steel spring, 20 mm connection 1033 kPa (150 psi) operating pressure and adjustable operating set point from 0.85 kPa (0.25 in Hg) to 68 kPa (20 in Hg) vacuum.

3. EXECUTION

3.1 Vacuum Breaker

.1 Install on condensate leg of all steam fired equipment.

END OF SECTION

PROCESS PIPING

1. GENERAL

1.1 Scope

.1 This Section covers the supply, installation, testing, cleaning and placing into operation of all process and chemical piping systems including fittings.

1.2 References

.1 The following is a list of standards which may be referenced in this Section and any supplemental Data Sheets:

.1 ANSI:

.1 A21.52, Ductile Iron Pipe, Centrifugally Cast, Gas

.2 B1.20.1, Pipe Threads, General Purpose (Inch)

.3 B16.1, Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

.4 B16.3, Malleable Iron Threaded Fittings

.5 B16.5, Pipe Flanges and Flanged Fittings

.6 B16.9, Factory-Made Wrought Steel Butt-welding Fittings

.7 B16.11, Forged Fittings, Socket-Welding and Threaded

.8 B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250

.9 B16.21, Nonmetallic Flat Gaskets for Pipe Flanges

.10 B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

.11 B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 900, 1500 and 2500

.12 B16.25, Butt Welding Ends

.13 B16.42, Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300

.2 ASME:

.1 Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels

.2 Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators

.3 B31.1, Power Piping

.4 B31.3, Process Piping

.5 B31.9, Building Services Piping

.6 B36.10M, Welded and Seamless Wrought Steel Pipe

.3 ASNT: SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing.

.4 ASTM:

.1 A47, Standard Specification for Ferritic Malleable Iron Castings

.2 A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

.3 A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications

.4 A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

.5 A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

.6 A135, Standard Specification for Electric-Resistance-Welded Steel Pipe

.7 A139, Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

.8 A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

.9 A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping

.10 A182/A182M, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service

.11 A183, Standard Specification for Carbon Steel Track Bolts and Nuts

.12 A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

.13 A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service or Both

.14 A197/A197M, Standard Specification for Cupola Malleable Iron

.15 A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service

.16 A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

.17 A240/A240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels

.18 A276, Standard Specification for Stainless Steel Bars and Shapes

.19 A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

.20 A285/A285M, Standard Specification for Pressure Vessel Plates, Carbon Steel, Low and Intermediate Tensile Strength

.21 A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

.22 A312/A312M, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes

.23 A320/A320M, Standard Specification for Alloy/Steel Bolting Materials for Low-Temperature Service

.24 A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

.25 A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

.26 A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings

.27 A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service

.28 A536, Standard Specification for Ductile Iron Castings

.29 A563, Standard Specification for Carbon and Alloy Steel Nuts

.30 A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry

.31 A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures

.32 A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products

.33 B32, Standard Specification for Solder Metal

.34 B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes

.35 B61, Standard Specification for Steam or Valve Bronze Castings

.36 B62, Standard Specification for Composition Bronze or Ounce Metal Castings

.37 B75, Standard Specification for Seamless Copper Tube

.38 B88, Standard Specification for Seamless Copper Water Tube

.39 B98/B98M, Standard Specification for Copper-Silicone Alloy Rod, Bar and Shapes

.40 C582, Standard Specification for Contact-Molded RTP Laminates for Corrosion-Resistant Equipment

.41 D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension

.42 D413, Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate

.43 D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable

.44 D1330, Standard Specification for Rubber Sheet Gaskets

.45 D1784, Standard Specification for Rigid PVC Compounds and CPVC Compounds

.46 D1785, Standard Specification for PVC Plastic Pipe, Schedules 40, 80, and 120

.47 D2000, Standard Classification System for Rubber Products in Automotive Applications

.48 D2310, Standard Classification for Machine-Made “Fibreglass” (Glass-Fibre-Reinforced Thermosetting-Resin) Pipe

.49 D2464, Standard Specification for Threaded PVC Plastic Pipe Fittings, Schedule 80

.50 D2466, Standard Specification for PVC Plastic Pipe Fittings, Schedule 40

.51 D2467, Standard Specification for PVC Plastic Pipe Fittings, Schedule 80

.52 D2564, Standard Specification for Solvent Cements for PVC Plastic Piping Systems

.53 D2996, Standard Specification for Filament-Wound "Fibreglass" (Glass-Fibre-Reinforced Thermosetting-Resin) Pipe

.54 D3222, Standard Specification for Unmodified Polyvinylidene Fluoride (PVDF) Molding Extrusion and Coating Materials

.55 D3261, Standard Specification for Butt Heat Fusion Polyethylene Plastic Fittings for PE Plastic Pipe and Tubing

.56 D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

.57 D4101, Standard Specification for Propylene Plastic Injection and Extrusion Materials

.58 F714, Standard Specification for Polyethylene Plastic Pipe (SDR-PR) Based on Outside Diameter

.5 AWWA:

.1 C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

.2 C110/A21.10, Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in for Water and Other Liquids

.3 C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

.4 C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges

.5 C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water

.6 C153/A21.53, Ductile-Iron Compact Fittings 3 in through 24 in and 54 inthrough 64 in, for Water Service

.7 C200, Steel Water Pipe - 6 in and Larger

.8 C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in and Larger - Shop Applied

.9 C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 in through 144 in

.10 C208, Dimensions for Fabricated Steel Water Pipe Fittings

.11 C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines

.12 C213, Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines

.13 C214, Tape Coating Systems for the Exterior of Steel Water Pipelines

.14 C217, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Buried/Submerged Steel Water Pipelines

.15 C606, Grooved and Shouldered Type Joints

.16 M11, Steel Pipe - A Guide for Design and Installation

.6 AWS:

.1 A5.8, Specification for Filler Metals for Brazing and Braze Welding

.2 QC 1, Standard for AWS Certification of Welding Inspectors

.7 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP43, Wrought Stainless Steel Butt-Welding Fittings Including Reference to Other Corrosion Resistant Materials

.8 NFPA: 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances

.9 NSF:

.1 60, Drinking Water Treatment Chemicals - Health Effects.

.2 61, Drinking Water System Components - Health Effects.

1.3 Design Requirements

.1 Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

.1 Boiler and Steam Piping: ASME B31.1

.2 Process Piping: ASME B31.3

.3 Building Service Piping: ASME B31.9, as applicable

.4 Natural Gas Piping: CSA B149.1, Natural Gas and Propane Installation Code

.5 Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO Standard Specifications for Highway Bridges, as applicable

.6 Provincial Regulations

1.4 Submittals

.1 General:

.1 Identify process area in the title of all submittal transmittals.

.2 Shop Drawings:

.1 Shop Fabricated Piping:

.1 For epoxy coated steel piping, all sizes, and stainless steel piping, sizes 50 mm and larger, provide detailed pipe fabrication or spool drawings showing fittings and bends, dimensions, field weld locations, coatings, hydrotest information and other pertinent information.

.2 For shop fabricated piping that connects to existing flanges and nozzles, measure and show on the shop drawings the as-built information for the existing flange centrelines, flange faces and any angular misalignment. Adjust design of new piping accordingly so that new piping accurately mates with existing piping.

.3 For embedded piping 100 mm and larger, provide layout drawings showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.

.2 Hydraulic Thrust Restraint for Restrained Joints: details including materials, sizes, assembly ratings, and pipe attachment methods.

.3 Dissimilar Buried Pipe Joints: joint types and assembly drawings.

.3 Quality Control Submittals:

.1 Certificate of Satisfactory Installation, Form 102, as per Section 01650 - Equipment Installation.

.2 Laboratory Testing Equipment: certified calibrations, Manufacturer's product data, and test procedures

.3 Certified welding inspection and test results

.4 Qualifications:

.1 Weld Inspection and Testing Agency: Certification and qualifications

.2 Welding Inspector: certification and qualifications

.3 Welders:

.1 List of qualified welders and welding operators

.2 Current test records for qualified welder(s) and weld type(s) for factory and field welding

.5 Weld Procedures: records in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s)

.6 Nondestructive inspection and testing procedures

.7 Manufacturer's Certification of Compliance:

.1 Pipe and fittings.

.2 Welding electrodes and filler materials.

.3 Factory applied resins and coatings.

.8 Certified weld inspection and test reports

.9 Test logs

.10 Procedures pickling and passivation of stainless steel piping

.11 Pipe coating applicator certification

.12 Bacteriological testing report

1.5 Qualifications

.1 Independent Inspection and Testing Agency:

.1 Ten (10) years experience in field of welding and welded pipe and fittings testing required for this Work.

.2 Calibrated instruments and equipment, and documented standard procedures for performing specified testing.

.3 Certified in accordance with ASNT SNT-TC-1A for testing procedures required for this Work.

.4 Testing Personnel: qualified for non-destructive test methods to be performed.

.5 Inspection Services: qualified welding inspector.

.2 Welding Inspector: AWS certified, AWS QC 1 qualified, with prior inspection experience of welds specified.

.3 Welder and Welding Operator Qualifications:

.1 Qualified by accepted inspection and testing agency before starting Work in accordance with Section IX, Article III of the ASME Boiler and Pressure Vessel Code.

.2 Qualified to perform groove welds in Positions 2G and 5G for each welding process and pipe material specified.

.3 Qualification tests may be waived by the Contract Administrator based on evidence of prior qualification.

1.6 Quality Control

.1 Quality Control: Contractor shall provide services of independent inspection and testing agency for welding operations as approved by Contract Administrator.

.2 Welding materials, fabrication standards and labour qualifications shall conform to ANSI/ASME B31.1, ANSI/ASME B31.3, ANSI B16.25, ASME Boiler and Pressure Vessel Code, Section 9, CSA W59 and the Provincial Board of Labour Regulations.

.3 Use welders fully qualified and licensed by provincial authorities in accordance with CSA W59.

1.7 Delivery, Storage, and Handling

.1 General:

.1 Flanges: securely attach metal, hardboard, or wood protectors over entire gasket surface.

.2 Threaded or Socket Welding Ends: fit with metal, wood, or plastic plugs or caps.

.3 Linings and Coatings: prevent excessive drying.

.4 Cold Weather Storage: locate Products to prevent coating from freezing to ground.

.5 Handling: use heavy canvas or nylon slings to lift pipe and fittings.

2. PRODUCTS

2.1 Piping

.1 As specified on Piping Data Sheets and Piping Schedule located at the end of this Section as Supplement.

.2 Diameters Shown:

.1 Standardized Products: nominal size.

.2 Fabricated Steel Piping (Except Cement-Lined): outside diameter, ASME B36.10M.

.3 Cement-Lined Steel Pipe: lining inside diameter.

2.2 Joints

.1 Grooved End System:

.1 Rigid, except where joints are used to correct misalignment, to provide flexibility, or where shown, Supply and Install flexible type.

.2 Flanges: when required, Supply and Install with grooved type flange adapters of same Manufacturer as grooved end couplings.

.2 Flanged Joints:

.1 Flat-faced carbon steel or alloy flanges when mating with flat-faced cast or ductile iron flanges.

.2 Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.

.3 Threaded Joints: NPT taper pipe threads in accordance with ANSI B1.20.1.

.4 Mechanical Pipe Couplings: Provide Depend-O-Lok pipe couplings where shown on drawings.

.5 Thrust Tie-Rod Assemblies: NFPA 24; tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.

.6 Mechanical Joint Anchor Gland Follower:

.1 Ductile iron anchor type, wedge action, with break off tightening bolts.

.2 Manufacturer and Product: EBAA Iron Inc.; Megalug.

.7 Flexible Mechanical Compression Joint Coupling:

.1 Stainless steel, ASTM A276, Type 305 bands.

.2 Manufacturers:

.1 Pipeline Products Corp.

.2 Fernco Joint Sealer Co.

.8 Mechanical connections of HDPE pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through flanged connections consisting of the following:

.1 A PE stub end thermally butt-fused to end of pipe.

.2 ASTM A240, Type 304 stainless steel backing flange, 863 kPag, ANSI B16.1 standard. Insulating flanges shall be used where shown.

.3 Bolts and nuts of sufficient length to show a minimum of three (3) complete threads when the joint is made and tightened to Manufacturer's standard. Retorque nuts after four (4) hours.

.4 Gaskets as specified on Data Sheet.

2.3 Welding

.1 Welding materials shall be in accordance with CSA W48.

2.4 Gasket Lubricant

.1 Lubricant shall be supplied by pipe manufacturer and no substitute or “or-equal” will be allowed.

2.5 Fabrication

.1 Mark each pipe length on outside:

.1 Size or diameter and class

.2 Manufacturer's identification and pipe serial number

.3 Location number on laying drawing

.4 Date of manufacture

.2 Code markings according to approved Shop Drawings.

.3 Flanged pipe shall be fabricated in the shop, not in the field, and delivered to the Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the Manufacturer.

2.6 Finishes

.1 Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s), Section 09870 - Coating Systems for Steel Tanks and Pipes, Section 15010 - General Mechanical Provisions, and Section 09901 – Painting and Finishing – Process Mechanical.

.2 Galvanizing:

.1 Hot-dip applied, meeting requirements of ASTM A153.

.2 Electroplated zinc or cadmium plating is unacceptable.

.3 Yellow Jacket

.1 HDPE jacket extruded over a mastic base.

.2 Manufacture, test, inspect and report procedures to meet or exceed CAN3-Z299.3 (Quality Assurance Program - Category 3).

.3 Prior to mastic application, sandblast pipe in conformance with requirements or SSPC SP6.

.4 Adhesive consists of a rubberized asphalt mastic, non-hygroscopic, formulated for use with Yellow Jacket. Apply to prepared surfaces in thickness exceeding 0.175 mm.

.5 HDPE has the following minimum properties: Ultimate tensile strength, 21 MPa; Tensile elongation at break, 600%; Shore "D" hardness, 60; and Brittleness temperature -50°C.

.6 Apply HDPE by extruding over adhesive in an even thickness to provide a smooth continuous outer sheath, free of pinholes, bubbles, wrinkles, blisters, cracks, or mechanical damage.

.7 Minimum HDPE thickness will be as follows:

Nominal Pipe Diameter (mm)	**Minimum HDPE Thickness (mm)**
20	0.55
25	0.55
30	0.60
40	0.65
50	0.70
65	0.70
75	0.70
100	0.75
150	0.90
200 and larger	1.00

.8 All flaws (up to 3 per pipe) will be repaired by cutting out each damaged area and applying sealant lined 200 mm diameter patch or heat shrink sleeve not exceeding 400 mm in length. Overlap undamaged area by a minimum of 75 mm around cut out section.

.9 Where the number of flaws or damaged areas per pipe exceeds 3 or any flaw is too large to be repaired with a patch or sleeve, the pipe will be rejected.

.10 Tape Wrap: Shop applied tape wrap may be used as an alternative to Yellow Jacket. Two or three layer methods can be used, meeting or exceeding the application and performance requirements of AWWA C214.

3. EXECUTION

3.1 Piping Material Selection

.1 Select piping material for the various services based on Section 15200-00S – Piping Schedule.

3.2 Examination

.1 Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

.2 When connecting to existing flanges and nozzles, accurately measure pipe/flange locations and any angular misalignment and make appropriate adjustments so that new piping will mate up properly.

.3 Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

.4 Welding Electrodes: verify proper grade and type, free of moisture and dampness, and coating is undamaged.

3.3 Preparation

.1 Notify Contract Administrator at least two (2) weeks prior to field fabrication of pipe or fittings.

.2 Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

.3 Damaged Coatings and Linings: repair using original coating and lining materials in accordance with Manufacturer's instructions.

3.4 Welding

.1 Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.1, B31.3 and B31.9 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting Manufacturer

.2 Weld Identification: mark each weld with symbol identifying welder

.3 Pipe End Preparation:

.1 Machine Shaping: preferred

.2 Oxygen or Arc Cutting: smooth to touch, true, and slag removal by chipping or grinding

.3 Beveled Ends for Butt Welding: ANSI B16.25

.4 Surfaces:

.1 Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.

.2 Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.

.3 Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.

.5 Alignment and Spacing:

.1 Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.

.2 Root Opening of Joint: as stated in qualified welding procedure.

.3 Minimum Spacing of Circumferential Butt Welds: minimum four times pipe wall thickness or 25mm, whichever is greater.

.6 Climatic Conditions:

.1 Do not perform welding if there is impingement of any rain, snow, sleet, or high wind on the weld area, or if the ambient temperature is below 0°C.

.2 Stainless Steel and Alloy Piping: If the ambient is less than 0°C, local preheating to a temperature warm to the hand is required.

.7 Tack Welds: performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.

.8 Surface Defects: chip or grind out those affecting soundness of weld.

.9 Weld Passes: as required in welding procedure.

.10 Weld Quality: free of cracks, incomplete penetration, weld undercutting, excessive weld reinforcement, porosity slag inclusions, and other defects in excess of limits shown in applicable piping code.

3.5 Installation-General

.1 Join pipe and fittings in accordance with Manufacturer's instructions, unless otherwise shown or specified.

.2 Remove foreign objects prior to assembly and installation.

.3 Flanged Joints:

.1 Install perpendicular to pipe centreline.

.2 Bolt Holes: straddle vertical centrelines, aligned with connecting equipment flanges or as shown.

.3 Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.

.4 Plastic Flanges: install annular ring filler gasket at joints of raised-face flange.

.5 Raised-Face Flanges: use flat-face flange when joining with flat-faced ductile or cast iron flange.

.6 Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.

.7 Threaded flanged joints must be shop fabricated and delivered to Site with flanges in-place and properly faced.

.8 Manufacturer:

.1 Same as pipe Manufacturer.

.2 Victaulic flange adapter.

.4 Threaded and Coupled Joints:

.1 Conform to ANSI B1.20.1.

.2 Produce sufficient thread length to ensure full engagement when screwed home in fittings.

.3 Countersink pipe ends, ream and clean chips and burrs after threading.

.4 Make connections with not more than three threads exposed.

.5 Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

.5 Grooved-End Joints:

.1 Type: rigid, except where joints are used to correct misalignment, to provide flexibility, and where shown otherwise, in which case provide flexible type.

.6 Soldered Joints:

.1 Use only solder specified for particular service.

.2 Cut pipe ends square and remove fins and burrs.

.3 After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.

.4 Wipe excess solder from exterior of joint before hardened.

.5 Before soldering, remove stems and washers from solder joint valves.

.7 PVC and CPVC Piping:

.1 Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.

.2 Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.

.3 Do not thread Schedule 40 pipe.

.8 Fibreglass Reinforced Piping:

.1 Cut, fabricate, and install in accordance with Manufacturer's written instructions.

.2 Provide Manufacturer's representative for instructing workers on proper installation and jointing methods.

.3 Installation shall be made by workers experienced in FRP pipe lay-up techniques.

.9 All bolt threads shall be coated with an anti-seize compound prior to being made up with nuts unless otherwise specified in the detail piping system specifications. All bolts for submerged flanges shall be coated with an anti-seize compound that has NSF-61 certification.

3.6 Pipe Coatings

.1 Provide epoxy coating and lining on piping when indicated on the piping data sheet(s) or in Section 15200-00S – Piping Schedule.

.2 Shop apply coating and lining to the greatest extent possible. Touch up coating and linings in the field as required. Minimize the number of field welds and use only where shown on approved shop drawings. Apply coating and lining to field welds and meet the same surface preparation, coating and testing requirements as shop welds.

.3 Before applying coatings and linings to metal piping, grind and round off all sharp edges, maximum radius of edges: 6 mm.

.4 All interior epoxy coatings shall conform to NSF Standard 61 – Drinking Water System Components, suitable for use in potable water applications. Coating materials and application shall be in accordance with Section 09870 - Coating Systems for Steel Tanks and Pipes.

.5 Colour of top coat: As selected by Contract Administrator from a set of standard colours which shall include white.

3.7 Tape Wrap

.1 For welded joints on Yellow jacketed pipe and at other indicated locations apply tape to buried pipe and fittings. Use Polyken, Tec-Tape or Denso tape, consisting of primer and tape applied to minimum thickness of 0.90 mm in accordance with AWWA C209.

.2 For flanged or coupled joints and for fittings use petrolatum primer, mastic and tape; Polyken, Tec-Wrap or Denso, in accordance with AWWA C217.

.3 Shrink Sleeve: As an alternative to tape wrap, shrink sleeves are acceptable if material and method of installation is reviewed and accepted by the Contract Administrator prior to use.

3.8 Installation-Exposed Piping

.1 Piping Runs:

.1 Parallel to building or column lines and perpendicular to floor, unless shown otherwise.

.2 Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

.2 Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

.3 Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

.4 Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other Work.

.5 Piping clearance, unless otherwise shown:

.1 Over Walkway and Stairs: minimum of 2200 mm, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

.2 Between Equipment or Equipment Piping and Adjacent Piping: Minimum 1000 mm, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

.3 From Adjacent Work: minimum 100 mm from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

.4 Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.

.5 Headroom in front of openings, doors, and windows shall not be less than the top of the opening.

.6 Do not install piping containing liquids or liquid vapours in transformer vaults or electrical equipment rooms.

.7 Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical Work.

3.9 Installation-Buried Pipe

.1 Joints:

.1 Dissimilar Buried Pipes: Supply and install flexible mechanical compression joints for pressure pipe.

.2 Concrete Encased or Embedded Pipe: do not encase joints in concrete unless specifically shown.

.2 Placement:

.1 Keep trench dry until pipe laying and joining are completed.

.2 Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.

.3 Measure for grade at pipe invert, not at top of pipe.

.4 Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.

.5 Prevent foreign material from entering pipe during placement.

.6 Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's Work.

.7 Lay pipe upgrade with bell ends pointing in direction of laying.

.8 Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, supply and install:

.1 Shorter pipe lengths.

.2 Special mitered joints.

.3 Standard or special fabricated bends.

.9 After joint has been made, check pipe alignment and grade.

.10 Place sufficient pipe zone material to secure pipe from movement before next joint is installed.

.11 Prevent uplift and floating of pipe prior to backfilling.

.3 PVC, CPVC, or HDPE Pipe Placement:

.1 Lay pipe snaking from one side of trench to other.

.2 Offset: As recommended by Manufacturer for maximum temperature variation between time of solvent welding and during operation.

.3 Do not lay pipe when temperature is below 5°C, or above 32°C when exposed to direct sunlight.

.4 Shield ends to be joined from direct sunlight prior to and during the laying operation.

.4 Tolerances:

.1 Deflection from Horizontal Line, Except PVC, CPVC, or HDPE**:** maximum 2 mm**.**

.2 Deflection From Vertical Grade: maximum 6 mm.

.3 Joint Deflection: maximum of 75% of Manufacturer's recommendation.

.4 Horizontal position of pipe centreline on alignment around curves maximum variation of 500 mm from position shown.

.5 Pipe Cover: minimum 2700 mm, unless otherwise shown.

3.10 Installation – Concrete Encased

.1 Supply and install reinforced concrete pipe encasement where shown on Drawings and where otherwise required. Some piping may be required to be concrete encased for pipe strength requirements that are included in the Specifications. Piping under and within the influence of buildings, utility trenches, vaults, slabs and other structures shall be concrete encased. See details on Drawings for encasement requirements.

.2 Where concrete encased piping crosses structure construction and expansion joints, Supply and Install flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

3.11 Thrust Restraint

.1 Location:

.1 Buried Piping: where shown and where required to restrain force developed at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist due to hydrostatic testing and normal operating pressure.

.2 Exposed Piping: at all joints in piping.

.2 Thrust Ties:

.1 Steel Pipe: attach with fabricated lugs.

.2 Ductile Iron Pipe: attach with socket clamps against a grooved joint coupling or flange.

.3 Flanged Coupling Adapters: for exposed installations, install Manufacturer's anchor studs through the coupling sleeve.

.3 Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: install pipe joint Manufacturer's adapter gland follower and pipe end retainer, or thrust tie-rods and socket clamps.

3.12 Pipe Sleeves

.1 Refer to Section 15010 – General Mechanical Provisions.

3.13 Wall Pipes for Slab, Floor, Wall, and Roof Penetrations

.1 Steel or Stainless Steel Wall Pipe:

.1 Same material and thickness as connecting pipe, except 6 mm minimum thickness.

.2 Lining: same as connecting pipe, factory-applied.

.3 Thrust Collar:

.1 Outside Diameter: unless otherwise shown, 75 mm greater than outside diameter of wall pipe.

.2 Continuously fillet welded on each side all around.

.2 Ductile Iron Wall Pipe:

.1 Diameter and Ends: same as connecting ductile iron pipe.

.2 Thickness: equal to or greater than remainder of pipe in line.

.3 Fittings: in accordance with applicable Pipe Data Sheet.

.4 Thrust Collars:

.1 Rated for thrust load developed at 250 psi.

.2 Safety Factor: 2, minimum.

.3 Material and Construction: ductile iron or cast iron, cast integral with wall pipe wherever possible, or thrust rated, welded attachment to wall pipe.

.5 Manufacturers:

.1 American Cast Iron Pipe Co.

.2 U.S. Pipe and Foundry Co.

3.14 Branch Connections

.1 Do not install branch connections smaller than 13 mm nominal pipe size, including instrument connections, unless shown otherwise.

.2 When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including the first block valve in the line carrying the lower pressure, unless otherwise shown.

.3 Threaded Pipe Tap Connections:

.1 Ductile Iron Piping: connect only with service saddle or at a tapping boss of a fitting, valve body, or equipment casting.

.2 Welded Steel or Alloy Piping: connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.

.3 Limitations: threaded taps in pipe barrel are unacceptable.

3.15 Vents and Drains

.1 Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines at all low and high point locations; except for epoxy coated pipe, install vents and drains only where shown.

3.16 Interim Cleaning

.1 Prevent accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping during fabrication and assembly.

.2 Examine piping to assure removal of foreign objects prior to assembly.

.3 Shop cleaning may employ conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter physical properties of material being cleaned.

3.17 Testing

.1 General:

.1 Conduct hydraulic pressure and leakage tests on newly installed piping.

.2 Supply and install necessary equipment and material and make taps in pipe, as required. Provide blind flanges as required.

.3 Contract Administrator will monitor the tests. Provide advance notice of start of testing.

.4 Test Pressures: As specified.

.5 Test Records: make records of each piping system installation during the test to document the following:

.1 Date of test

.2 Description and identification of piping tested

.3 Test fluid

.4 Test pressure

.5 Remarks, including:

.1 Leaks (type, location)

.2 Repairs made on leaks

.6 Certification by Contractor and signed acknowledgment by Contract Administrator that tests have been satisfactorily completed.

.2 Testing New Pipe Connected to Existing Pipe: isolate new pipe with grooved end pipe caps, spectacle blinds, or blind flanges.

.3 Concrete Encased Piping: Test piping prior to placement of concrete.

.4 Preparation and Execution:

.1 Buried Pressure Piping:

.1 Conduct final hydrostatic acceptance tests after trench has been completely backfilled.

.2 An initial service leak test may be conducted with a partially backfilled trench and the joints left open for inspection, if field conditions permit, as determined by the Contract Administrator.

.3 Expose joints for the acceptance test on buried pressure piping to be pneumatically tested or subjected to an initial service leak test.

.2 Exposed Piping: Conduct tests after piping has been completely installed including supports, hangers, and anchors, but prior to insulation.

.5 Hydrostatic Leak Tests:

.1 Equipment: Supply and install the following:

Amount	Description
2	Graduated containers
2	Pressure gauges
1	Hydraulic force pump
	Suitable hose and suction pipe as required

.2 Procedure:

.1 Use water as the hydrostatic test fluid.

.2 Provide clean test water of such quality as to minimize corrosion of the materials in the piping system.

.3 Open vents at high points of the piping system to purge air pockets while the piping system is filling.

.4 Venting during the filling of the system may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents.

.5 Test piping systems at the test pressure specified in Section 15200-00S - Piping Schedule.

.6 Maintain hydrostatic test pressure continuously for thirty (30) minutes minimum and for such additional time as necessary to conduct examinations for leakage.

.7 Examine joints and connections for leakage.

.8 The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking.

.9 Correct visible leakage and retest to satisfaction of the Contract Administrator.

.3 Gravity Sewers and Drains:

.1 Test by water or air exfiltration tests as prescribed by local or state plumbing codes and visually examine for leaks.

.2 Repair leaks and retest system until no further leakage is evident.

.6 Pneumatic Leak Tests:

.1 Perform on compressed air, instrument air, natural gas, and vacuum piping.

.2 Equipment: Supply and install the following:

Amount	Description
1	Pneumatic compressor separator-dryer system capable of providing oil-free dry air and equipped with one or more full capacity safety relief valves set at a pressure of not more than 105% of the required primary test pressure
1	Calibrated test gauge

.3 Procedure:

.1 Perform pneumatic testing using accurately calibrated instruments and oil-free, dry air.

.2 Perform tests only on exposed piping, after piping has been completely installed, including supports, hangers and anchors, and inspected for proper installation.

.3 Test piping system at the test pressure specified in the Piping Schedule.

.4 Take necessary precautions to protect personnel from hazards associated with air testing.

.5 Secure piping to be tested to prevent damage to adjacent piping and equipment in event of a joint failure.

.6 Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by test.

.7 Apply maximum 172 kPa preliminary pneumatic test to piping system prior to final leak testing, to locate major leaks.

.8 Examine joints and connections for leakage with soap bubbles.

.9 Correct visible leaks and retest to satisfaction of the Contract Administrator.

.10 Gradually increase pressure in the system to not more than one-half of test pressure.

.11 Thereafter increase pressure in steps of approximately one tenth ($^{1}/_{10}$) of maximum test pressure until required test pressure is reached.

.12 Maintain pneumatic test pressure continuously for minimum ten (10) minutes and for such additional time as necessary to conduct a soap bubble examination for leakage.

.13 The piping system, exclusive of possible localized instances at pump or valve packing, shall show no evidence of leakage.

.14 Correct visible leakage retest to satisfaction of the Contract Administrator.

.15 Following pneumatic testing, thoroughly purge, with nitrogen, lines that are to carry flammable gases to assure no explosive mixtures will be present in the system during the filling process.

3.18 Cleaning and Disinfection

.1 Following assembly and testing, and prior to final acceptance, flush piping with water, (except as stated below), and remove accumulated construction debris and other foreign matter.

.2 Insert cone strainers in the connections to attached equipment and leave until cleaning has been accomplished.

.3 Minimum Flushing Velocity: 0.8 m per second.

.4 Blow clean of loose debris plant process air, natural gas, and instrument air-lines with compressed air; do not flush with water.

.5 Remove accumulated debris through drains 50 mm and larger or by removing spools and valves from piping.

.6 Immediately following drainage of flushed lines, dry piping with compressed air.

.7 Plant process air and compressed air piping shall be blown clean of loose debris with compressed air.

.8 Clean all oxygen and ozone piping, including vents and drains, in accordance with Compressed Gas Association Pamphlet 4.1.

.9 Disinfect piping intended to carry potable water before placing in service:

.1 Meet the requirements of AWWA C651, unless otherwise specified.

.2 Disinfecting Mixture:

.1 A chlorine-water solution having a free chlorine residual of 40 mg/L to 50 mg/L.

.2 Prepare by injecting one of the following:

.1 Liquid chlorine gas-water mixture.

.2 Calcium or sodium hypochlorite and water mixture.

.3 Inject mixture into pipeline at a measured rate while freshwater is allowed to flow through the pipeline at a measured rate so the combined mixture of freshwater and chlorine solution is of the specified strength.

.4 Apply liquid chlorine -water mixture by means of a chlorinating device.

.5 Calcium Hypochlorite: If this procedure is used, first mix dry powder with water to make a thick paste, then thin to approximately a 1 percent solution (10,000 mg/L chlorine).

.6 Sodium Hypochlorite: If this procedure is used, dilute liquid with water to obtain a 1 percent solution.

.7 The following proportions of hypochlorite to water will be required:

Product	Quantity	Water
Calcium Hypochlorite [1] (65 – 70% C1)	0.5 kg	28.5 Litres
Sodium Hypochlorite [2] (5.25% C1)	3.8 Litres	16 Litres

1. Comparable to commercial products known as HTH, Perchloron, and Pittchlor.
2. Known as liquid laundry bleach, Clorox, and Purex.

.10 Point of Application:

.1 Inject chlorine mixture into piping to be treated at the beginning of the line through a suitable tap in the piping.

.2 Control clean water from the existing system or another source so it flows slowly into newly installed piping during chlorine application.

.3 Manipulate valves so the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Use check valves if necessary.

.11 Retention Period:

.1 Retain treated water in pipeline for a minimum of 24 hours or long enough to destroy nonspore-forming bacteria.

.2 At the end of the retention period, the disinfecting mixture shall have a strength of at least 10 mg/L of chlorine.

.3 Operate valves, hydrants, and other appurtenances during disinfection to assure disinfecting mixture is dispersed into all parts of the pipeline including dead ends, new services, and similar areas that otherwise may not receive the disinfecting solution.

.4 Do not place concentrated quantities of commercial disinfectants in pipeline before filling with water.

.5 After chlorination, flush the water from the permanent source of supply until water through pipeline is equal chemically and bacteriologically to the permanent source of supply.

.6 Sample water and have bacteriological testing performed by an approved lab. Submit a report to the Contract Administrator.

.12 Disposal of Disinfecting Water:

.1 Dispose of disinfecting water in an acceptable manner that will protect the public and receiving waters from harmful or toxic concentrations of chlorine.

.2 Do not allow disinfecting water to flow into a waterway without adequate dilution or other satisfactory method of reducing chlorine concentrations to a safe level. Dechlorination may be required.

3.19 Pickling and Passivation

.1 All stainless steel piping shall be cleaned and passivated in accordance with ASTM A380.

3.20 Field Finishing

.1 Notify Contract Administrator at least three (3) days prior to start of any surface preparation or coating application work.

.2 As specified in Section 09870 - Coating Systems for Steel Tanks and Pipes.

.3 Paint the exterior of ferrous metal piping, copper piping, iron piping and PVC piping in accordance with Section 09901 – Painting and Finishing – Process Mechanical**.**

.4 Repair any damage to coating and lining on embedded pipes and sleeves.

3.21 Pipe Identification

.1 Refer to Section 15010 – General Mechanical Provisions.

3.22 Field Quality Control

.1 Pressure test piping for leakage. Refer to Section 15200-00S - Piping Schedule for test pressures and test media.

.2 Minimum Duties of Welding Inspector:

.1 Job material verification and storage.

.2 Qualification of welders.

.3 Certify conformance with approved welding procedures.

.4 Maintenance of records and preparation of reports in a timely manner.

.5 Notification to Contract Administrator of unsatisfactory weld performance within twenty four (24) hours of weld test failure.

.3 Required Weld Examinations:

.1 Perform examinations in accordance with Piping Code**:** ASME B31.3. 10% of the circumferential butt welds shall be random radiographed. For concrete encased steel pipes and pipes under foundations, provide radiographic examination of 50% of welds as selected by the Contract Administrator.

.2 Perform examinations for every pipe thickness and for each welding procedure, progressively, for all piping covered by this Section.

.3 Examine at least one (1) of each type and position of weld made by each welder or welding operator.

.4 For each weld found to be defective under the acceptance standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above. Examine, progressively, two (2) additional welds for each tracer examination found to be unsatisfactory.

3.23 Supplements

.1 Piping Schedule – 15200-00S.

.2 Data Sheets.

Number	Title
15200-03	Carbon Steel Pipe and Fittings-General Service
15200-07	Galvanized Steel Pipe and Fittings – General Service
15200-08	Stainless Steel Pipe and Fittings-General Service
15200-09	Stainless Steel Pipe and Fittings-Special Service 1
15200-10	Polyvinyl Chloride (PVC) Pipe and Fittings
15200-12	Fibreglass Reinforced Plastic (FRP) Pipe and Fittings
15200-13	Copper and Copper Alloy Pipe, Tubing, and Fittings
15200-14	High Density Polyethylene (HDPE) Pipe
15200-20	Stainless Steel Pipe and Fittings-Special Service No. 3
15200-21	Carbon Steel Pipe and Fittings-Natural Gas Service

END OF SECTION

PIPING SERVICE LEGEND

SERVICE	
AA	Aqua Ammonia
AGA	Atomizing Air
AHP	Air-High Pressure
ALP	Air-Low Pressure
AS	Air Scour
AV	Acid Vent
AW	Acid Waste
BBD	Boiler Blowdown
BS	Brine Solution
CA	Compressed Air
CCW	Circulating Cooling Water
CO2	Carbon Dioxide
CS	Caustic (Sodium Hydroxide)
CSW	Caustic Waste
DDW	Demineralized Water
DEA	Dilute Acid
DCW	Domestic Cold Water
DHW	Domestic Hot Water
DHWR	Domestic Hot Water Return
DRA	Drainage (Floors)
DRN	Drains (Clean Drains)
DRS	Subdrain
DSW	Distilled Water
ELC	Electrical Conduit
EXP	Expansion Tank Equalizer Line
FC	Ferric Chloride
FCW	Ferric Chloride Waste
GHR	Glycol Heating Return
GHS	Glycol Heating Supply
HCO	Hydraulic Oil

PIPING SERVICE LEGEND

HST	12% Hypochlorite Solution
HYP	0.8% Hypochlorite Solution
LGO	Lubricating Oil
LPC	Low Pressure Condensate
LPS	Low Pressure Steam
LT	Level Transmitter Sleeve Embed
MU	Make-Up Water
NG	Natural Gas
OF	Overflow
PC	Pumped Condensate
PSW	Plant Service Water
PW	Potable Water
RD	Roof Drain
RDIS	Refrigerant Discharge
RS	Refrigerant Suction
SAM	Sample
SAN	Sanitary Drainage
SCA	Sulphuric Acid
SDR	Saturated Recycle Water
SHC	Sodium Hypochlorite
SLO	Seal Oil
ST	Storm
STD	Salt Dry
SW	Seal Water
SWD	Stormwater Drainage
TDW	Tempered Domestic Water
TP	Trap Primer
TRW	Treated Water
TW	Tempered Water
VAC	Vacuum
VTA	Vent Air
WS	Softened Water

PIPING SERVICE LEGEND

EXPOSURE

BUR	Buried
EXP	Exposed
SUB	Submerged
ENC	Concrete Encased

MATERIAL

CI	Cast Iron
CMP	Corrugated Metal Pipe
COP	Copper
CPVC	Chlorinated PVC
CS	Carbon Steel
DI	Ductile Iron
FRP-X	Fiberglass Reinforced Plastic Pipe (X = 1 to 6)
GSP	Galvanized Steel Pipe
HDPE	High Density Polyethylene
PE	Polyethylene
PSTL	PVDF-Lined Steel
PVC	Polyvinyl Chloride
PVDF	Polyvinylidene Fluoride
RSTL	Rubber-Lined Steel
SST	Stainless Steel
STL	Steel
TSTL	TFE – Lined Steel

PRESSURE TEST

H	Hydrostatic
I	In Service
P	Pneumatic
NA	Not Applicable

END OF SECTION

Service	Commodity Abbreviation	Nominal Size(s) (mm)	Exposure[2]	Piping Material[2]	Specification Section	Test Type and Pressure (kPa)[1]	Remarks
ONSITE SODIUM HYPOCHLORITE SYSTEM							
Overflow	OF	100, 150	EXP	PVC	15200-10	N/A	
Vent	VTA	100, 300	EXP	PVC	15200-10	N/A	
Drain	DRN	25, 40, 150	EXP	PVC	15200-10	N/A	
Sodium Hypochlorite	HYP	25, 40, 50, 75, 100	EXP	PVC	15200-10	H, 600	
12% Sodium Hypochlorite	HST	12, 40	EXP	PVC	15200-10	H, 600	
Brine Solution	BS	20, 25, 50	EXP	PVC	15200-10	H, 600	
Softened Water	WS	6, 12, 40, 50	EXP	PVC	15200-10	H, 600	
Stand Pipe	STP	600	EXP	FRP-2	15200-12	H, 150	
Salt Fill Line	STD	100	EXP	SST	15200-08	N/A	
Dust Bag Vent Line	UE	200	EXP	N/A	N/A	N/A	Supplied in Vendor Package
FERRIC CHLORIDE SYSTEM							
Overflow	OF	100	EXP	PVC	15200-10	N/A	
Vent	VTA	200	EXP	PVC	15200-10	N/A	
Ferric Chloride	FC	25, 40, 50, 75, 100	EXP	PVC	15200-10	H, 1050	
Ferric Chloride Waste	FCW	100, 200	BUR	TSTL	15200-03	H, 150	Epoxy Coated / Teflon Lined Steel
Compressed Air	CA	20	EXP	TSTL	15200-03	H, 600	Epoxy Coated / Teflon Lined Steel for purge piping only.
SODIUM HYDROXIDE SYSTEM							
Overflow	OF	100	EXP	PVC	15200-10	N/A	
Vent	VTA	200	EXP	PVC	15200-10	N/A	
Sodium Hydroxide	CS	25, 40, 50, 75, 100	EXP	Expoxy coated / lined Steel	15200-03	H, 1050	
Caustic Waste	CSW	100, 200	BUR	TSTL	15200-03	H, 150	Epoxy Coated / Teflon Lined Steel
Compressed Air	CA	20	EXP	TSTL	15200-03	H, 600	Epoxy Coated / Teflon Lined Steel for purge piping only.
SULPHURIC ACID SYSTEM							
Overflow	OF	100	EXP	SST	15200-09	N/A	
Vent	VTA	200	EXP	PVC	15200-10	N/A	
Sulphuric Acid	SCA	25, 40, 50, 75, 100	EXP	SST	15200-09	H, 1050	
Acid Waste	AW	100,200	BUR	TSTL	15200-03	H, 150	Epoxy Coated / Teflon Lined Steel
Compressed Air	CA	20	EXP	TSTL	15200-03	H, 600	Epoxy Coated / Teflon Lined Steel for purge piping only.
AQUA AMMONIA SYSTEM							
Overflow	OF	100	EXP	SST	15200-09	N/A	
Vent	VTA	150	EXP	PVC	15200-10	N/A	
Aqua Ammonia	AA	25, 40, 50, 75, 100	EXP	SST	15200-09	H, 1050	
Compressed Air	CA	20	EXP	TSTL	15200-03	H, 600	Epoxy Coated / Teflon Lined Steel for purge piping only.

Service	Commodity Abbreviation	Nominal Size(s) (mm)	Exposure[2]	Piping Material[2]	Specification Section	Test Type and Pressure (kPa)[1]	Remarks
BUILDING SERVICES							
Domestic Hot/Cold/Recirculating Water	DHW/DCW/DHWR	15, 20, 25, 30, 40, 50, 75	EXP	COP	15200-13	H, 1050	
Plant Service Cold/Tempered Water	PW/PSW	15, 20, 25, 30, 40, 50, 75	EXP	COP	15200-13	H, 1050	
Sanitary Drainage & Vent	SAN	40, 50, 65, 75, 100, 150	EXP/BUR	PVC	15100-01	to NPC	
Stormwater Drainage	SWD	65, 75, 100, 150, 200	EXP/BUR	PVC	15100-01	to NPC	
Hydronic Heating Supply/Return	GHS/GHR	25, 30, 40, 50, 65, 75, 100, 150	EXP	CS	15200-03	H, 1050	
Refrigerant Suction/Discharge	RS/RDIS	6, 10, 15, 20	EXP	COP	15200-13	to CSA-B52	
Low Pressure Steam/Condensate	LPS/LPC	20, 25, 30, 40, 50, 65, 75, 100, 150, 200	EXP	CS	15160	H, 690	
Natural Gas, Exposed	NG	25, 30, 40, 50, 65, 75	EXP	CS	15200-21	to CAN/CSA-B149.1	
Compressed Air	CA	15, 20, 25, 30, 40, 50	EXP	CS	15200-03	H/P, 1050	Pneumatic pressure testing to be used if hydrauic pressure testing is impractical.

Notes

1) H-Hydraulic; P-Pneumatic
2) For pipe material and service exposure abbreviations, refer to Section 15200-00L.
3) Buried natural gas pipes shall be wrapped with corrosion protection material in accordance with Canadian Gas Code.

DATA SHEET – CARBON STEEL PIPE AND FITTINGS-GENERAL SERVICE

Item	Size	Description
Pipe	550 mm and smaller	Black carbon steel, ASTM A106, Grade B seamless or ASTM A53, Grade B, seamless or ERW. Threaded, butt-welded, grooved end, and flanged joints:
	Screwed:	
	40 mm & smaller	Schedule 80.
	Welded and Grooved:	
	50 mm thru 250 mm	Schedule 40.
Linings (Note 2)	All	Shop-Applied Liquid Epoxy Lining: Apply in strict accordance with manufacturer's instructions and requirements of AWWA C210 and Section 09870, including surface cleaning and preparation. For pipe interior, follow System 1, as specified in Section 09870.
Coatings	All	For exposed piping, follow System 5, as specified in Section 09870.
	All	For immersed piping, follow System 1, as specified in Section 09870.
	All	For buried piping, apply coating in accordance with AWWA C214 consisting of at least four layers: 1. Primer layer. 2. Inner Layer Tape: Corrosion-protective tape, 0.5 mm (20 mils), with black exterior. 3. Outer Layer Tape: Mechanical protective tape, 0.76 mm (30 mils), with gray exterior. 4. Outer Layer Tape: Mechanical protective tape, 0.76 mm (30 mils), with white exterior. Total tape thickness minimum 2.0 mm (80 mils). Hold back minimum of 60 mm from end of pipe for welded joints.
	All	For concrete encased piping, tape wrap as specified above for buried piping; or alternatively, follow System 5, as specified in Section 09870.
Joints	40 mm & smaller	Threaded or flanged at valves and equipment or grooved end meeting the requirements of AWWA C606. See Note 1.
	50 mm & larger	Butt-welded or flanged at valves and equipment, or grooved end meeting the requirements of AWWA C606.

DATA SHEET – CARBON STEEL PIPE AND FITTINGS-GENERAL SERVICE

Item	Size	Description
Fittings	40 mm & smaller	Threaded: 680- or 2070 kPag malleable iron, ASTM A197 or ASTM A47, dimensions in accordance with ANSI B16.3. Grooved End: Malleable iron ASTM A47 or ductile iron ASTM A536, grooved ends to accept couplings without field preparation, EPDM elastomers for potable water service, rigid style coupling or as otherwise noted. Victaulic; Grinnell.
	50 mm & larger	Butt Welded: Wrought carbon steel butt- welding, ASTM A234/A234M, Grade WPB meeting the requirements of ANSI B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise. Grooved End: Malleable iron ASTM A47 or ductile iron ASTM A536, grooved ends to accept couplings without field preparation, EPDM elastomers for potable water service, rigid style coupling or as otherwise noted. Victaulic Style 44; Grinnell. Victaulic Depend-O-Lok, AWWA C221, EPDM elastomer, epoxy coated steel or 316 stainless steel wetted parts, restrained or non-restrained coupling as indicated on Drawings.
Pipe Couplings	75 mm and larger	Victaulic Depend-O-Lok, AWWA C221, EPDM elastomer, epoxy coated steel or 316 stainless steel wetted parts, restrained (FxF) or non-restrained coupling (FxE or ExE) as indicated on Drawings. Bolted type sleeve type couplings, restrained or non-restrained as shown; retrained couplings with harness per AWWA M11 and as indicated on the drawings. See Section 15205 – Piping Specialties.
Branch Connections	40 mm & smaller	Threaded, straight, or reducing tees in conformance with Fittings specified above. See Note 1.
	50 mm & larger	Butt-welding or grooved end tee in conformance with Fittings specified above.
Flanges	40 mm & smaller	Forged carbon steel, ASTM A105/A105M, Grade II, ANSI B16.5 Class 150, socket-weld or threaded, 1.5 mm raised face.
	50 mm to 100	Forged carbon steel, ASTM A105/A105M, ANSI B16.5, welding neck type, bore to match pipe internal diameter, 1.5 mm raised face. Supply and install flat-faced flanges when mating with flat-faced valves and fittings. Grooved End Adapter Flange: Malleable iron ASTM A47 or ductile iron ASTM A536. Victaulic; Grinnell.
	150 to 550	AWWA C207, Class D, slip-on. Supply and install flat-faced flanges when mating with flat-faced valves and fittings.
Blind Flanges	100 mm and smaller	Forged carbon steel, ASTM A105/A105M, Grade II, ANSI B16.5 Class 150, 1.5 mm raised face.
	200 to 550	Steel, AWWA C207, thickness to suit Class D unless otherwise noted.

DATA SHEET – CARBON STEEL PIPE AND FITTINGS-GENERAL SERVICE

Item	Size	Description
Unions	40 mm & smaller	Threaded malleable iron, ASTM A197 or A47, 1035- or 2070 kPag WOG, meeting the requirements of ANSI B16.3.
Couplings	50 mm & larger	Grooved End: Rigid joint malleable iron, ASTM A47 or ductile iron, ASTM A536. Victaulic; Grinnell. Screwed End: Malleable iron, ASTM A197 or A47. See Note 1.
Bolting	Exposed piping	Flanges: Carbon steel ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts. Use 3 mm undersize bolting material for insulating flanges. Grooved End Couplings: Carbon steel, ASTM A183 bolts and nuts, 760 MPa minimum tensile strength.
	Submerged and underground	General Conditions: Type 316, ASTM A193/A193M, Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.
Gaskets	50 mm thru 250 mm	Black neoprene, 2 mm thick, ring type for RF flanges, full face for flat face flanges.
	300 mm and larger	Black neoprene, 3.2 mm thick, ring type for RF flanges, full face for flat face flanges. Grooved Couplings: EPDM per ASTM D2000 for water and air to 110°C.
Thread Lubricant	40 mm & smaller	General Service: Teflon tape.

Notes:
1. Do not use threaded connections on epoxy coated pipe. For small tappings such as vents, drains and gauge connections, supply and install a 50 mm flanged nozzle with a coated blind flange tapped to the size of the required connection.
2. Pipe epoxy lining is required only where indicated on the Piping Schedule 15200-00S.

END OF SECTION

DATA SHEET – GALVANIZED STEEL PIPE AND FITTINGS-GENERAL SERVICE

Item	Size	Description
Pipe	All	Galvanized carbon steel, ASTM A106, Grade B seamless or ASTM A53, Grade B seamless or ERW.
	50 mm & smaller	Schedule 80.
	60 mm to 150 mm	Schedule 40.
	200 mm to 300 mm	Schedule 30.
	350 mm	Standard weight.
Joints	50mm & smaller	Threaded or flanged at valves and equipment, or grooved end meeting requirements of AWWA C606.
	60 mm & larger	Flanged at valves and equipment, or grooved end meeting requirements of AWWA C606.
Fittings		Threaded: 1035- or 2070 kPag malleable iron, ASTM A197 or ASTM A47, dimensions in accordance with ANSI B16.3. Grooved End: Malleable iron ASTM A47 or ductile iron ASTM A536, 1250 kPa working pressure, grooved ends to accept couplings without field preparation. Victaulic; Grinnell.
Branch Connections	50 mm & smaller	Tee or reducing tee in conformance with Fittings above, galvanized 910 kg WOG thredolet or welding boss; galvanize after welding.
	60 mm & larger	Branch Same Size as Run: Grooved end tee in accordance with Fittings above. Branch One or More Sizes Smaller Than Run: grooved end reducing tee in accordance with Fittings above.
Flanges		Galvanized forged carbon steel, ASTM A105/A105M, ANSI B16.5 Class 150 or Class 300, threaded, 1.5 mm raised face. Grooved end adapter flange, malleable iron ASTM A47 or ductile iron ASTM A536. Victaulic; Grinnell.
Unions		Threaded malleable iron, ASTM A197 or A47, 2070kpag WOG, brass to iron seat, meeting the requirements of ANSI B16.3.
Couplings		Grooved End: Rigid joint malleable iron, ASTM A47 or ductile iron, ASTM A536, 1750 kPa working pressure. Victaulic; Grinnell.
Plugs		Forged carbon steel, ASTM A181/A181M, Grade II, round head, threaded, galvanized.

DATA SHEET – GALVANIZED STEEL PIPE AND FITTINGS-GENERAL SERVICE

Item	Size	Description
Bolting		Grooved End Couplings: Carbon steel, ASTM A183 bolts and nuts, 759,000 kPa minimum tensile strength. Flanges: Carbon steel ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts.
Gaskets	All flanges	Flanged, Water and Sewage Service: 3 mm thick, red rubber (SBR), hardness 80 (Shore A), rated to 93 degrees C, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.
	Grooved end couplings	EPDM or chlorinated butyl per ASTM D2000 for water, and air to 110°C, dimensions conforming to AWWA C606.
Thread Lubricant	50 mm & smaller	Teflon tape or joint compound that is insoluble in water.

END OF SECTION

DATA SHEET – STAINLESS STEEL PIPE AND FITTINGS-GENERAL SERVICE

Item	Size	Description
Pipe	50 mm & smaller	Schedule 40S: ASTM A312/A312M, Type 304 seamless, pickled and passivated.
	60 mm to 150 mm	Schedule 10S: ASTM A778, "as-welded" grade, Type 304L.
	200 mm & larger	Schedule 5S: ASTM A778, "as-welded" grade, Type 304L.
Joints	50 mm & smaller	Threaded or flanged at equipment as required or shown.
	60 mm & larger	Butt-welded or flanged at valves and equipment.
Fittings	50 mm & smaller	Threaded Forged: 1,000 CWP, ASTM A182/A182M, Grade F304L.
	60 mm & larger	Butt-Welded: ASTM A774/A774M Grade 304L conforming to MSS SP 43, "as-welded" grade, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
Branch Connections	50 mm & smaller	Tee or reducing tee in conformance with Fittings above.
	60 mm & larger	Butt-welding tee or reducing tee in accordance with Fittings above.
Flanges	25 mm & 40 mm	Forged Stainless Steel: ASTM A182/A182M, Grade F304L, ANSI B16.5 Class 150, socketweld, raised face.
	50 mm and larger	Cast Carbon Steel: ASTM A216/A216M Grade WCA, drilled, ANSI B16.5 Class 150 Van Stone Type with stainless steel stub ends, ASTM A240 Type 304L "as-welded grade", conforming to MSS-SP43, wall thickness same as pipe.
Unions	50 mm & smaller	Threaded Forged: ASTM A182/A182M, Grade F304, 13800 or 20700 kPag WOG, integral ground seats, AAR design meeting the requirements of ANSI B16.11, bore to match pipe.
Bolting	All	Forged Flanges: Type 304 stainless steel, ASTM A320/A320M Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts. Van Stone Flanges: Carbon steel ASTM A307 Grade B hex head bolts and ASTM A563 Grade A hex head nuts. Supply and install same on mating cast iron flange on valve or equipment with flat ring gasket.

DATA SHEET – STAINLESS STEEL PIPE AND FITTINGS-GENERAL SERVICE

Item	Size	Description
Gaskets	All Flanges	Flanged, Water and Sewage Service: 5 mm thick, unless otherwise specified, red rubber (SBR), hardness 80 (Shore A), rated to 93 ^{o}C, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2. Flanged, Hot Air and Fuel Gas Service: 3 mm thick, unless otherwise specified, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 150°C, conforming to ANSI B16.21 and ASTM D1330 Steam Grade. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.
Thread Lubricant	50 mm & smaller	Teflon tape.

END OF SECTION

DATA SHEET – STAINLESS STEEL PIPE AND FITTINGS-SPECIAL SERVICE 1

Item	Size	Description
Pipe	All	ASTM A312/312M Type 316 welded annealed, pickled and passivated. Use Type 316L for welded joints.
	75 mm & smaller	Schedule 40S.
	100 mm to 200 mm	Schedule 10S.
	250 mm & larger	Schedule 10S unless otherwise indicated in the Piping Schedule, Section 15200-00S.
Tubing	19 mm OD & smaller	ASTM A312/A312M Type 316 seamless, soft annealed, 2 mm wall thickness minimum.
Pipe Joints	19 mm & smaller	Threaded or flanged at equipment as required or shown.
	25 mm & 40 mm	Socket weld or flanged at equipment as required or shown.
	50 mm & larger	Butt-welded or flanged at valves and equipment as required or shown.
	100 mm and larger	Grooved end where shown.
Tubing Joints	All	Flareless compression fitting or socket-weld.
Pipe Fittings	19 mm & smaller	Threaded Forged: ASTM A182/A182M, Grade F316, 20700 kPag WOG.
	25 mm and 40 mm	Socket Weld Forged: ASTM A182/A182M, Grade F316L, 13800 kPag WOG.
	50 mm & larger	Butt Welded: ASTM A403/A403M, Grade WP316L conforming to ANSI B16.9 and MSS SP 43, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
	100 mm and larger	Grooved End: Victaulic adapter ring with groove, 316SS, schedule 40, buttwelding connection to adjacent pipe. Rings and coupling specified below shall be supplied by the manufacturer as a package.
Tubing Fittings	All	Flareless Compression Type Forged: ASTM A182/A182M, Grade F304 or F316, Parker-Hannifin Ferulok, Flodar BA Series. Socket Welded: ASTM A182/A182M, Grade F316L, Cajon, Swagelok.
Pipe Couplings	100 mm and larger	Grooved end coupling, ductile iron, EPDM elastomers for potable water and low pressure air service, rigid style coupling. Victaulic Style 44; Grinnell.

DATA SHEET – STAINLESS STEEL PIPE AND FITTINGS-SPECIAL SERVICE 1

Item	Size	Description
	100 mm and larger	Bolted type sleeve type couplings, restrained or non-restrained as shown; retrained couplings with harness per AWWA M11 and as indicated on the drawings. See Section 15205 – Piping Specialties.
	300 mm and larger	Victaulic Depend-O-Lok, AWWA C221, EPDM elastomer, epoxy coated steel or 316 stainless steel wetted parts, restrained (FxF) or non-restrained coupling (FxE or ExE) as indicated on Drawings.
Pipe Branch Connections	19 mm & smaller	Tee or reducing tee in conformance with Fittings above.
	50 mm & smaller	40 mm and smaller branch: Forged Sockolet or half coupling, 13800kPag WOG ASTM A182/A182M, Grade F316L.
	60 mm & larger	Butt-Welded Tee or Reducing Tee: In accordance with Fittings above Forged Weldolet, 13800 kPag WOG ASTM A182/A182M, Grade F316L same inside diameter as branch pipe.
Tubing Branch Connections	All	Compression type or socket-weld tees or reducing tees in accordance with Tubing Fittings above.
Flanges	25 mm & 40 mm	Forged: ASTM A182/A182M Grade F316L, Class 150, socket weld, 1.5 mm raised face, ANSI B16.5 standard.
	50 mm to 100 mm	Forged: ASTM A182/A182M Grade F316L, Class 150, welding neck, 1.5 mm raised face, ANSI B16.5 standard.
	150 mm and larger	Non-Submerged Service: Cast carbon steel, ASTM A216/A216M Grade WCA, drilled, ASME B16.5 Class 150, Van Stone type with stainless steel stub ends, ASTM A240 Type 316L, conforming to MSS SP 43, wall thickness same as pipe. Submerged Service: Forged steel, ASTM A182/A182M Grade F316L, Class 150, welding neck or slip-on type, 1.5 mm raised face, ANSI B16.5 standard.
Unions	19 mm & smaller	Threaded Forged: ASTM A182/A182M, Grade F316, 910 kg- or 1363 kg WOG, integral ground seats, AAR design meeting the requirements of ANSI B16.11, bore to match pipe.
	25 mm & 40 mm	Socket Weld Forged: ASTM A182/A182M Rev C Grade F316L, 910 kg- or 1363 kg WOG, integral ground seats, AAR design meeting the requirements of ANSI B16.11, bore to match pipe.
Bolting	All	Type 316, ASTM A193/A193M, Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.

DATA SHEET – STAINLESS STEEL PIPE AND FITTINGS-SPECIAL SERVICE 1

Item	Size	Description
Gaskets	All Flanges	3.0 mm thick Gore-Tex flat ring type for raised face flanges and full face type for flat face flanges, Garlock, Chesterton. Use 2.0 mm EPDM gaskets for sodium bisulphate service. Grooved Couplings: EPDM per ASTM D2000 for water and air to 110°C.
Thread Lubricant	50 mm & smaller	Teflon tape or Oxyseal; Fleet Supplies, Inc.

END OF SECTION

DATA SHEET – POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

Item	Size	Description
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub type PVC flat face flange in accordance with Fittings above, Class 150 ANSI B16.1 drilling
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts and ASTM A563 Grade A heavy hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 3 mm thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 3 mm ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564, except solvent weld cement for PVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service. Certification shall be submitted.
Thread Lubricant	All	Teflon Tape.

END OF SECTION

DATA SHEET – FIBREGLASS REINFORCED PLASTIC (FRP) PIPE AND FITTINGS

Item	Size	Description
General	All	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Fibreglass reinforced plastic, helically-wound, conforming to ASTM D2310 Type 1, vinyl ester resin, Derakane 411-45 (Dow Chemical Company) or approved equal, Type C glass monofilament surfacing mat and/or Dynel organic fibre synthetic surfacing veil or approved equal. Constructed in conformance with ASTM D2996. UV Protection: Add to the wax coat Cyabsorb UV-9, as manufactured by American Cyanamid Company.
Fabrication		Interior surfacing veil shall be 0.25 to 0.5 mm (10 to 20 mils) thick. Mat layers shall be resin-rich, fully wetted, 1.3 mm (50 mils) minimum thickness.
	FRP-1 (pipe)	1 layer C-Glass veil 2 mat layers bell-and-spigot or flanged
	FRP-2 (pipe)	1 layer Dynel veil 2 mat layers bell-and-spigot or flanged
	FRP-3 (pipe)	1 layer Dynel veil & 2 mat layers flanged
		1 layer C-Glass veil only
		Cut edges of laminates shall be fully wetted and cured with thinned resin, allowed to cure, then coated with surfacing resin to a DFT of 0.25 to 0.27 mm (10 to 15 mils).
Gaskets	All	1.5 mm thick non-asbestos compression type, full-face, Cranite, Johns Manville.
Special Conditions	FRP-3 (pipe)	Interior layer and inner surfaces shall be free of fillers and thixotropic agents. Completed assemblies shall be post-cured for 2 hours @ 93°C, 6 hours @ 88°C or 16 hours @ 71°C. Field welded joints shall be coated with resin paste before joining.
Ratings		Fibreglass reinforced pipe, fittings and flanges shall be rated 690 kPa as specified in ASTM D2310. Minimum continuous strand glass filament (coated with resin) wall thickness for pipe are as follows:
	50 thru 150 mm	4.7 mm
	200 mm	6.4 mm
	250 thru 300 mm	7.9 mm
	350 mm	9.5 mm
	400, 450 mm	11.1 mm
	500 mm	12.7 mm
	600 mm	14.2 mm

DATA SHEET – FIBREGLASS REINFORCED PLASTIC (FRP) PIPE AND FITTINGS

Item	Size	Description
Fittings	All sizes	Fittings: ASTM C582 and D2996. Surface veil and mat layers same as specified above under Ratings. Bends shall be long radius. Structural body of fittings shall be filament wound or built-up with alternate layers of woven roving and chopped stand mat. Filament wound fittings shall be same thickness as specified above under Fabrication.
Flanges		Fibreglass reinforced plastic, faced and drilled 125-pound, ANSI B16.1 standard. Flanges mating with plastic lined steel pipe shall be Van Stone type, ductile iron ASTM A395 or cast steel ASTM A216/A216M Grace WCB, 150-pound standard per ANSI B16.5.
Bolting		Raised Face Flanges: Carbon steel, ASTM A307 Grade B square head bolts and ASTM A563 Grade A heavy hex head nuts. Flat Face Flanges in Corrosive Conditions: Stainless steel Type 316, ASTM A193/A193M, Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.
Gaskets		Flat Face Flanges: Ethylene propylene rubber (EPR), 3 mm thick, full faced. Raised Face Mating Flange: Ring gasket same material as full face, with filler gasket between OD of raised face and flange OD, thickness same as raised face lip. Van Stone Mating Flange: Tetrafluoroethylene (TFE) envelope type, flat ring gasket.
Colour		Add pigment to the final layer only of exterior surfacing resin to lightly tint the surface, but not obliterate laminate quality. Colors are as follows: FRP-1 Red FRP-2 Green FRP-3 Yellow

Notes: 1. FRP1 pipe and fitting materials shall be suitable for float sludge material from a dissolved air flotation process used in potable water treatment with a max temperature of 25°C, addition of ferric chloride and sulphuric acid upstream process resulting in pH range of 5.5 to 7, and system design pressure of 120 kPa.

END OF SECTION

DATA SHEET – COPPER AND COPPER ALLOY PIPE, TUBING AND FITTINGS

Item	Size	Description
General		Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Oxygen Service: Red brass, seamless, standard wall thickness, conforming to ASTM B43.
Tubing	75 mm and smaller	Seamless, conforming to ASTM B88 as follows: Water (buried) .....Type K, soft or hard temper Water (exposed) .....Type L, hard drawn Domestic hot water.....Type L, hard drawn Compressed air service.....Type L, hard drawn P-Trap priming service.....Type L, soft temper P-Trap priming service (buried).....Type K, soft or hard temper Sample line service.....Type L, hard drawn Laboratory gas service .....Type L, hard drawn
Tubing	75 mm and smaller	Seamless, conforming to ASTM B280 as follows: Refrigerant service .....ACR
Tubing	50 mm and smaller	Oxygen service: Seamless, conforming to ASTM B88, Type K, hard drawn.
Fittings	75 mm and smaller	Oxygen Service: Bronze, screwed, 250-pound conforming to ASTM B62, dimensions conforming to ANSI B16.15 or wrought copper, socket joint, conforming to ASTM B75, dimensions conforming to ANSI B16.22. Other Services: Commercially pure wrought copper, socket joint, conforming to ASTM B75, dimensions conforming to ASME B16.22.
Flanges	All	Oxygen Service: Bronze, screwed, conforming to ASTM B61, faced and drilled 150-pound ANSI B16.24 standard. Other Services: Commercially pure wrought copper, socket joint, conforming to ASTM B75, faced and drilled 150-pound ASME B16.24 standard.
Bolting	All	Oxygen Service: ASTM A320/A320M, stainless steel Type 304, Grade B8 bolts with copper silicon hex nuts conforming to ASTM B98 Grade A hard. Other Services: ASTM A307, carbon steel, Grade A hex head bolts, and ASTM A563 Grade A hex head nuts.
Gaskets	All	1.5 mm thick non-asbestos compression type, full-face, Cranite, Johns Manville.
Solder	All 75 mm and smaller	Oxygen Service: Silver brazing alloy, 15 percent silver content, 640 to 700 ^{o}C melting range, conforming to AWS A5.8. Other Services: Wire solder (95% tin), conforming to ASTM B32 Alloy Grade Sn95. Do not use cored solder. Solder joints in accordance with ANSI B16.22.

DATA SHEET – COPPER AND COPPER ALLOY PIPE, TUBING AND FITTINGS

Notes:

1. Refer to Section 15200-000 for special cleaning requirements for oxygen and ozone piping.

END OF SECTION

DATA SHEET – HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

Item	Size	Description
General	All	Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of the same type, grade, and class of polyethylene compound and supplied from the same raw material supplier. Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	ASTM D3350, high density polyethylene, maximum allowable hoop stress 5.5 MPa (800 psi) at 23 ^{o}C. Polyethylene resins shall conform to Type PE 3408 or better. Protection shall be provided against ultraviolet light degradation using carbon black, not less than 2 percent well dispersed in the resin. Pipe wall thickness shall reflect the required SDR* and diameter, as shown in Table 8, ASTM F714. Design Stress Rating: ASTM F714, 5.5 MPa (800 psi) hydrostatic. Pressure Rating / SDR* 200 / 9 160 / 11 130 / 13.5 100 / 17 80 / 21 65 / 26 50 / 32.5 * SDR: standard dimension ratio = OD/thickness
Fittings	150 mm & smaller	Molded fittings, butt fusion joined, conforming to ASTM D3261.
Flanges	All	Van Stone type, cast ASTM A351/A351M, Type 316 stainless steel backing ring, IPP Deltaflex convoluted design or equal for bolting to ASME B16.1, Class 125; ASME B16.5, Class 150; and AWWA C207, Class E. Pressure performance of the backing ring equal to SDR rating of the pipe with safety factor of two. Stub ends same grade HDPE and pressure rating as pipe.
Bolting	All	General Conditions: Carbon steel, ASTM A307 Grade B square head bolts and ASTM A563 Grade A heavy hex head nuts. Washers shall be same material as bolts.
Gaskets	All	Flat ring, 3 mm ethylene propylene rubber (EPR).

END OF SECTION

DATA SHEET – STAINLESS STEEL PIPE AND FITTINGS-SPECIAL SERVICE 3

Item	Size	Description
Pipe	All	Seamless stainless steel mechanical tubing, to ASTM A511 Grade 316 Schedule 40S.
Pipe Joints	All	Cold mandrel drawn seamless to ASTM A511
Pipe Fittings	All	316 stainless steel Swagelok or Parker compression fittings

END OF SECTION

DATA SHEET – CARBON STEEL PIPE AND FITTINGS-NATURAL GAS SERVICE

Item	Size	Description
Pipe	All	Black carbon steel, ASTM A106, Grade B seamless or ASTM A53, Grade B, seamless or ERW. Threaded, butt-welded, and flanged joints.
	50 mm & smaller	Schedule 40
	50 mm thru 150 mm	Schedule 40
Joints	50 mm & smaller	Threaded or flanged at valves and equipment.
	65 mm & larger	Butt-welded or flanged at valves and equipment.
Fittings	50 mm & smaller	Threaded: 680- or 2070 kPag malleable iron, ASTM A197 or ASTM A47, dimensions in accordance with ANSI B16.3.
	65 mm & larger	Butt Welded: Wrought carbon steel butt- welding, ASTM A234/A234M, Grade WPB meeting the requirements of ANSI B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
Flanges	12 mm thru 150 mm smaller	Forged carbon steel, ASTM A105/A105M, Grade II, ANSI B16.5 Class 150 socket-weld or threaded, 1.5 mm raised face.
Unions	50 mm & smaller	Threaded malleable iron, ASTM A197 or A47, 1035- or 2070 kPag WOG, meeting the requirements of ANSI B16.3.
Bolting	All	Alloy steel stud bolts, ASTM A193/A193M, Grade B7 w/2 heavy hex nuts, ASTM A194/A194M, Grade 2H
Gaskets	12 mm thru 150 mm	3mm thick, black synthetic with SBR binder for severe service, ring type, Class 150, ASME B16.5; Garlock Style 3400

Notes:

1. Install natural gas piping in accordance with CSA B149.1, Natural Gas and Propane Installation Code.

END OF SECTION

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 API:

.1 API 600, Steel Valves-Flanged and Buttwelding Ends

.2 API 602, Compact Steel Gate Valves-Flanged, Threaded, Welded and Extended-Body Ends

.3 API 608, Metal Ball Valves-Flanged and Butt-Welding Ends

.4 API 609, Butterfly Valves, Lug Type and Wafer Type.

.5 API 589, Valve Inspection and Testing.

.2 ANSI:

.1 B16.1, Cast Iron Pipe Flanges and Flanged Fittings.

.2 C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.3 ASSE: 1011, Performance Requirements for Hose Connection Vacuum Breakers.

.4 ASTM:

.1 A276, Standard Specification for Stainless Steel Bars and Shapes.

.2 A351, Standard Specification for Castings, Austenitic, Austenitic-Ferric (Duplex), for Pressure-Containing Parts.

.3 A564, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.

.4 B61, Standard Specification for Steam or Valve Bronze Castings.

.5 B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

.6 B98, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

.7 B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.

.8 B139, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.

.9 B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.

.10 B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.

.11 B584, Standard Specification for Copper Alloy Sand Castings for General Applications.

.12 D429, Test Methods for Rubber Property—Adhesion to Rigid Substrates.

.13 D1784, Standard Specification for Rigid PVC Compounds and CPVC Compounds.

.5 AWWA:

.1 C500, Metal-Seated Gate Valves for Water Supply Service.

.2 C504, Rubber-Seated Butterfly Valves.

.3 C508, Swing-Check Valves for Waterworks Service, 2 in. to 24 in. NPS.

.4 C509, Resilient-Seated Gate Valves for Water Supply Service.

.5 C510, Double Check Valve, Backflow-Preventer Assembly.

.6 C511, Reduced-Pressure Principle Backflow Prevention Assembly.

.7 C540, Power-Actuating Devices for Valves and Sluice Gates.

.8 C550, Protective Epoxy Interior Coatings for Valves and Hydrants.

.9 C606, Grooved and Shouldered Joints.

.10 C800, Underground Service Line Valves and Fittings.

.6 Manufacturers Standardization Society:

.1 SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.

.2 SP-88, Diaphragm Type Valves.

1.2 Submittals

.1 General:

.1 Provide valve submittals separated in process areas as per drawing key plan:

.1 J: Onsite hypochlorite generation area

.2 S: Bulk chemical storage area

.2 Identify process area in the title of all submittal transmittals

.2 Shop Drawings:

.1 Product data sheets for make and model.

.2 Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

.3 Furnish Shop Drawings for complete actuator assemblies and accessories prior to delivery.

.4 Provide calculations for sizing, noise, cavitation and actuator torque for open-close/throttle and modulating valves. Provide valve coefficient (Cv) versus percent open curves for each size of valve in each process area.

.5 Power and control wiring diagrams, including terminals and numbers.

.6 Complete motor nameplate data.

.7 Submit a completed Instrumentation, Systems, Automation Society (ISA) S20.50 Instrument Specification Sheet for each device.

.3 Information Submittals:

.1 Certificate of compliance for:

.1 Electric operators; full compliance with AWWA C540.

.2 Butterfly valves; full compliance with AWWA C504.

.3 API ANSI classes 300 and 600 valves; full compliance with API standards.

.2 Factory calibration and testing reports: Handwritten reports will not be accepted.

.3 Operation and Maintenance Manual.

.1 API ANSI classes 300 and 600 valves; full compliance with API standards.

.4 Certification of NSF 61B compliance.

2. PRODUCTS

2.1 General

.1 Provide new material only.

.2 All valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories for a complete operation.

.3 Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

.4 Valve same size as adjoining pipe.

.5 Valve ends to suit adjacent piping.

.6 Size operator to operate valve for the full range of pressures and velocities.

.7 Valve to open by turning counterclockwise.

.8 Factory mount operator, actuator, and accessories.

.9 Provide lubricants of the type recommended by the equipment Manufacturer in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, start-up and operation prior to Substantial Performance. Lubrication systems and lubrications shall be certified to ANSI/NSF Standard 61, to be compatible with potable water use.

2.2 Schedules

.1 Requirements relative to this Section are shown on the valve schedules located at the end of this Section.

.2 Refer to Section 15100-00 – Plumbing Piping for valves related to plumbing systems.

2.3 Materials

.1 Brass and bronze valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.

.1 Approved alloys are of the following ASTM designations: B61, B62, B98 (Alloy UNS No. C65100, C65500, or C66100), B139 (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.

.2 Stainless steel Alloy 18-8 may be substituted for bronze.

2.4 Factory Finishing

.1 Epoxy Lining and Coating:

.1 Use where specified for individual valves described herein.

.2 In accordance with AWWA C550 unless otherwise specified.

.3 Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.

.4 Minimum 0.18 mm dry film thickness except where limited by valve operating tolerances.

.2 Exposed Valves:

.1 In accordance with Division 9 for Painting and Protective Coatings.

.2 Safety isolation valves and lockout valves with handles, handwheels, or chain wheels “safety yellow.”

2.5 Valves

.1 Gate Valves

.1 Type V108 Gate Valve 65 mm and larger:

.1 Iron body, bronze mounted, flanged ends, solid wedge gate, nonrising bronze stem, Class 125 rated 860 kPa SWP, 1380 kPa CWP for 50 mm through 300 mm, and 690 kPa SWP, 1035 kPa CWP for 350 mm through 600 mm.

.2 Acceptable Manufacturers:

.1 Crane; Figure 461.

.2 Stockham; Figure G612.

.2 Ball Valves:

.1 Type V300 Ball Valve 50 mm and Smaller for General Water and Air Service:

.1 Two-piece end entry type, bronze body and end piece, hard chrome-plated bronze or brass ball, RTFE seats and packing, blowout-proof stem, zinc-coated steel hand lever operator with vinyl grip, rated 4140 kPa WOG, 1035 kPa SWP.

.2 Acceptable Manufacturers:

.1 Threaded:

.1 Milwaukee; BA100.

.2 Nibco; T-585-70.

.3 Conbraco Apollo; 70-100.

.2 Soldered:

.1 Milwaukee; BA150

.2 Nibco; S-585-70

.3 Conbraco Apollo; 70-200

.2 Type V305 Ball Valve 65 mm and Smaller for General Water Service:

.1 Two-piece body type, Class 125/150 flanged cast iron or cast steel body, 316 stainless steel ball, full port, RTFE seats and packing, blowout-proof stem, zinc-plated steel hand lever operator with vinyl grip, 860 kPa SWP.

.2 Acceptable Manufacturers:

.1 Kitz #90

.2 Nibco

.3 Conbraco

.3 Type V307 Stainless Steel Ball Valve 25 mm and Smaller:

.1 Three-piece ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end pieces, full port Type 316 stainless steel ball, threaded ends, reinforced PTFE seats, PTFE packing, blowout proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 10350 kPa WOG, 1035 kPa SWP.

.2 Acceptable Manufacturers:

.1 Milwaukee; 20 Series

.2 Nibco; T-580-S6-R-66-LL

.3 Conbraco Apollo; 76-100 Series

.4 Type V308 Stainless Steel Ball Valve 100 mm and Smaller:

.1 ASTM A351/A351M GR CF8M stainless steel body and end pieces, full port Type 316 stainless steel ball, ANSI Class 150 flanged ends, reinforced PTFE or carbon fibre teflon seats, Graphite or PTFE packing, blowout proof stainless steel stem, stainless steel lever operator with vinyl grip.

.2 Acceptable Manufacturers:

.1 Milwaukee; F20 Series

.2 Nibco; F-515-S6-F-66-FS

.3 Conbraco Apollo; 87A-100 Series

.5 Type V309 PVC Ball Valve 100 mm and Smaller:

.1 Rated 1035 kPa at 22.8 ^{o}C, with ASTM D1784, Type I, Grade 1 PVCe body, ball, and stem, end entry, flanged connection, vented ball with relief port on upstream side, Viton or Teflon O-ring stem seals, to block flow in both directions.

.2 Acceptable Manufacturers:

.1 Chemtrol – Bleach Ball Valve

.2 Or approved equal

.6 Type V310 PVC Ball Valve 100 mm and Smaller:

.1 PVC body, ball and end connectors, full port, Teflon PTFE seats, Viton seal, threaded ends, rated at 1590 kPa working pressures.

.2 Acceptable Manufacturers:

.1 Chemline Plastics Ltd. Type 21

.2 Or approved equal

.7 Type V312 PVDF Ball Valve 50 mm and Smaller:

.1 PVDF body, ball and end connectors, full port, Teflon PTFE seats, Viton seal, threaded ends, rated at 1590 kPa working pressures.

.2 Acceptable Manufacturers:

.1 Chemline Plastics Ltd. Type 21

.2 Nibco Tru-Bloc

.8 Type V330 PVC Ball Valve 75 mm and Smaller:

.1 Rated 1035 kPa at 22.8 ^{o}C, with ASTM D1784, Type I, Grade 1 PVC body, ball, and stem, end entry, double union design, solvent-weld socket, threaded or flanged ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions.

.2 Acceptable Manufacturers:

.1 Nibco; Chemtrol Tru-Bloc

.2 ASAHI/America; Duo-Bloc

.3 Spears; True Union

.9 Type V331 PVC Ball Valve 75 mm and 100 mm:

.1 Rated 1035 kPa at 22.8 ^{o}C, with ASTM D1784 Type I, Grade 1 PVC full port body, Teflon seat, Viton O-ring stem, face and carrier seals, end entry design with dual union, solvent-weld socket ends, or single union ball valve with flanged ends drilled to ANSI B16.1.

.2 Acceptable Manufacturers:

.1 Nibco; Chemtrol Tru-Bloc

.2 ASAHI/America; Duo-Bloc

.10 Type V462 Gauge Cock 3 mm-6 mm:

.1 6 mm bronze body, hexagon end pattern, tee head, male ends, rated 862 kPa SWP.

.2 Manufacturer and Product: United Brass Works; Figure 973.

.3 Butterfly Valves:

.1 General:

.1 Valves specified as AWWA C504 to be in full compliance with AWWA C504 and following requirements:

.1 Suitable for throttling operations and infrequent operation after periods of inactivity.

.2 Elastomer seats bonded or vulcanized to body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75 lb pull in accordance with ASTM D429, Method B.

.3 Bubble-tight with rated pressure applied from either side.

.4 No travel stops for disc on interior of body.

.5 Self-adjusting V-type or O-ring shaft seals.

.6 Isolate metal-to-metal thrust bearing surfaces from flowstream.

.7 Stainless steel disc or disc with stainless steel disc edge.

.2 Type V500 Butterfly Valve 75 mm to 1800 mm:

.1 Flanged end, short body type.

.2 AWWA C504, Class 150B.

.3 Cast iron body, cast or ductile iron disc with Type 304 stainless steel shaft, EPDM rubber seat bonded or molded in body only, and stainless steel seating surface.

.4 Painting and Coating

.1 Interior surfaces shall be coated with a protective system in accordance to AWWA Standard C550 – Protective Interior Coatings of Valves and Hydrants, which can be used with the chemicals identified. .

.2 Coating shall be two (2) or more layers (0.13 mm, 5 mils, minimum each coat) Polyamide Epoxy, Amerlock 400, Tnemec Series 140F Pota-Pox Plus or approved equal. Application as per Manufacturer's recommendations.

.3 Coatings shall be holiday free as defined in Section 5.2.3 of AWWA Standard C550.

.4 Exterior surfaces shall be painted consistent with interior surfaces.

.5 Surfaces shall be prepared to NACE SSPC-SP10- Near-White Metal Blast Cleaning

.6 All machined surfaces shall be protected with an approved coating, prior to assembly to prevent rusting. Machined surfaces for valve seats shall have particular attention paid to, as this area if untreated, has proven to support "barnacle growth" which can prevent watertight closure of the valve.

.5 Acceptable Manufacturers:

.1 Pratt

.2 DeZurik

.3 Val-Matic

.3 Type V514 High Performance Butterfly Valve 50 mm to 915 mm:

.1 ANSI Class 150 wafer style, high performance type, Type 316 stainless steel body, Type 316 stainless steel single or double offset disc, Type 316 stainless steel shaft and taper pins, EPDM seat, PTFE stem packing, stainless steel with RTFE thrust washer.

.2 Acceptable Manufacturers:

.1 Tyco/Keystone; K-Lok Figure 360/362/370/372 Series.

.2 DeZurik; BHP Series.

.4 Check and Flap Valve:

.1 Type V602 Check Valve, 50 mm and Smaller:

.1 All bronze, threaded cap, threaded ends, swing type replaceable Teflon disc and bronze disc holder, rated 1035 kPa SWP, 2070 kPa WOG.

.2 Acceptable Manufacturers:

.1 Walworth; Figure 3412

.2 Milwaukee; Figure 510

.2 Type V619 Wafer Style Check Valve 50 mm and smaller:

.1 Rated for aggressive fluids, Class 150 wafer style, 316L stainless steel body, 316L stainless steel disc, 316L stainless steel spring and other internals.

.2 Acceptable Manufacturers:

.1 Gestra; RK16a

.2 Or approved equal

.3 Type V630 PVC Ball Check Valve 100 mm and Smaller:

.1 ASTM D1784, Type I, Grade 1 PVC body, dual union socket welded, threaded or flanged ends, rated 1035 kPa at 22 ^{o}C, and Viton seat and seal.

.2 Acceptable Manufacturers:

.1 Nibco; Chemtrol Tru Union

.2 ASAHI/America

.3 Spears; True Union

.4 Type V694 Check Valve 25 mm to 1200 mm:

.1 Elastomer type flanged or slip-on, round entry area to match pipe, contoured duckbilled shaped exit, valve open with approximately 50 mm of line pressure and return to CLOSED position under zero flow condition, flanged, rated for 345 kPa minimum operating pressure; flanges steel backing flange type, drilled to ANSI B16.1, Class 125, plain-end valve attached with two Type 316 stainless steel adjustable bands, elastomer nylon-reinforced neoprene.

.2 Manufacturer and Product: Red Valve Co.; Tideflex Check Valve Series 35 or TF-2.

.5 Self-Contained Automatic Valves:

.1 Type V717 Back-Pressure Regulating Valve 50 mm and smaller:

.1 Hydraulically operated, diaphragm actuated, 316L SS body, 12mm tube stub ends, 316L SS actuator, SS handle, Teflon/SS diaphragm facing/backing, standard body, 0-700 kPa control range and maintain a constant back pressure upstream of the valve.

.2 Acceptable Manufacturers:

.1 Go Regulator BP-6 Series

.2 Or approved equal

.2 Type V719 PVC or PVDF Pressure-Reducing/Back-Pressure Sustaining Valve 100 mm and smaller:

.1 Hydraulically operated, diaphragm actuated, pilot controlled globe valve, PVC or PVDF body, flanged, threaded or socket weld ends, Viton seat and stem, PVC or PVDF disk, and maintain a constant back pressure upstream of the valve.

.2 Acceptable Manufacturers:

.1 Chemline SB12

.2 Or approved equal

.3 Type V720 Pressure Relief Valve 25 mm and smaller:

.1 Hydraulically operated, 316 SS body, Viton O-ring, 350-1050 kPa adjustable, Male NPT fittings.

.2 Acceptable Manufacturers:

.1 Swagelok

.2 Or approved equal

.4 Type V740 Air and Vacuum Valve 13 mm to 400 mm:

.1 13 mm through 50 mm NPT inlets and outlets, 75 mm and larger ANSI B16.1 Class 125 flanged inlet with plain outlet and protective hoods.

.2 Rated 1035 kPa working pressure, cast iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.

.3 Acceptable Manufacturers:

.1 APCO Valve and Primer Corp.

.2 Val-Matic Valve

.6 Miscellaneous Valves:

.1 Type V940 Solenoid Valve 6 mm to 50 mm:

.1 Three-way internal pilot operated diaphragm type, brass body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA insulation Class F, 120 V AC, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Normal position CLOSED when de-energized as indicated.

.2 Minimum operating pressure differential no greater than 35 kPa (gauge), maximum operating pressure differential not less than 863 kPa (gauge).

.3 Acceptable Manufacturers:

.1 ASCO

.2 Skinner

.7 Miscellaneous Valves:

.1 Type V950 Needle Valve:

.1 Connections: 6 mm NPT.

.2 Body material: brass, bronze or stainless steel.

.3 Acceptable Manufacturers:

.1 ParkerApproved Equal

2.6 Operators

.1 General

.1 Where indicated in the Automated Valve Schedule – Schedule 15202-01, provide valve gear boxes suitable for submersible operation, with NSF approved food grade lubricant. Provide epoxy coating in accordance with Section 09870 – Coating Systems for Steel Tanks and Pipes, or similar coating systems approved by Contract Administrator.

.2 For submerged valves, provide 316 stainless steel extension stems and support brackets.

.2 Manual Operator:

.1 General:

.1 Operator force not to exceed 175 N (40 lb) under any operating condition, including initial breakaway. Gear reduction operator when force exceeds 175 N.

.2 Operator self-locking type or equipped with self-locking device.

.3 Position indicator on quarter-turn valves.

.4 Worm and gear operators one-piece design worm-gears of gear bronze material. Worm hardened alloy steel with thread ground and polished. Traveling nut type operators threader steel reach rods with internally threaded bronze or ductile iron nut.

.2 Exposed Operator:

.1 Galvanized and painted handwheels.

.2 Lever operators allowed on quarter-turn valves 200 mm and smaller.

.3 Cranks on gear type operators.

.4 Chain wheel operator with tiebacks, extension stem, floor stands, and other accessories to permit operation from normal operation level.

.5 Valve handles to take a padlock, and wheels a chain and padlock.

.3 Buried Operator:

.1 Buried service operators on valves larger than 63 mm shall have a 50 mm AWWA operating nut. Buried operators on valves 50 mm and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.

.2 Design buried service operators for quarter-turn valves to withstand 610 Newton-metre of input torque at the FULLY OPEN or FULLY CLOSED positions, grease packed and gasketed to withstand a submersion in water to 69 kPa.

.3 Buried valves shall have extension stems, bonnets, and valve boxes.

.3 Electric Valve Operators:

.1 General:

.1 Provide actuator suitable for full 90-degree rotation of quarter-turn valves or for use on multi-turn valves, as required.

.2 Comply with AWWA C540.

.3 Size for 1-$^{1}/_{2}$ times required valve operating torque. The torque required to stall the motor shall not exceed torque rating of the valve.

.4 Provide controls integral with the actuator and fully equipped as specified in AWWA C540.

.5 Include the following features:

.1 Stem protection for rising stem valves.

.2 Handwheel for manual override control of the valve.

.3 Valve position indication.

.4 Visual indicator for position of positioner.

.5 Built-in motor overload protection.

.6 Two single-pole, double-throw (SPDT) type limit switches, field adjustable cam-operated, with contacts rated for 5 A, 120 VAC, housed in actuator control enclosure, factory installed.

.7 Two SPDT torque limit switches, 10A, 125 VAC. The torque limit switches are to be factory preset and field adjustable, housed in actuator control enclosure, factory installed.

.8 Adjustable mechanical limit stops to prevent over-turning of the valve.

.6 Provide all required actuator mounting hardware and accessories.

.7 Provide control devices and actuator as a matched set from the same Manufacturer wherever possible.

.8 Each actuator shall be capable of operating in any horizontal or vertical orientation.

.9 Unless noted otherwise, the actuator shall fail to the last position when the control function or power fails.

.10 Motors shall be rated at 20% intermittent duty cycle.

.11 The actuator speed shall be field adjustable.

.12 Provide a terminal board for field wiring.

.2 Electric Operators, Open-Close Service – 575 V:

.1 Size motors for one complete OPEN-CLOSE-OPEN cycle no less than once every 10 minutes.

.2 Operators shall be suitable for positioning of valve at intermediate positions.

.3 Integral OPEN-STOP-CLOSE pushbutton controls.

.4 Reversing motor starter.

.5 Integral COMP-OFF-HAND Selector Switch

.6 Minimum monitoring and control signal requirements:

.1 Open Command Input (from a remote dry contact).

.2 Close Command Input (from a remote dry contact).

.3 Open Status (dry contact for remote indication).

.4 Closed Status (dry contact for remote indication).

.5 Computer (Remote) Mode (dry contact for remote indication).

.6 Remote dry contacts will be rated 2 Amps at 120 VAC minimum.

.7 OPEN and CLOSED indicating lights.

.3 Electric Operators, Modulating Service:

.1 Size motors for continuous duty.

.2 Provide feedback potentiometer and integral electronic positioner/comparator circuit to maintain valve position.

.3 Integral OPEN STOP CLOSE pushbutton to control valve in HAND position.

.4 Integral COMP-OFF-HAND Selector Switch

.5 Minimum monitoring and control signal requirements:

.1 COMP-OFF-HAND Selector Switch

.2 Input signal: 4 to 20 mA for position control from PLC when in COMP mode.

.3 Output signal: 4 to 20 mA to PLC for position monitoring

.4 Computer (COMP) Mode (dry Contact for remote indication)

.5 Open Status (dry contact for remote indication)

.6 Closed status (dry contact for remote indication)

.7 Remote dry contacts will be rated 2 Amps at 120 VAC minimum.

.8 OPEN and CLOSED indicating lights.

.9 Valves shall close upon loss of signal unless otherwise indicated.

.10 AC motor with reversing starter or DC motor with solid state reversing controller. Controller capable of 1200 starts per hour.

.11 Duty cycle limit timer and adjustable band width to prevent actuator hunting.

.12 Valve position output converter that generates a 4 to 20 mA dc signal in proportion to valve position, and is capable of driving into loads up to 500 ohm at 24 VDC.

.6 Actuator Power Supply:

.1 575 V three-phase

.2 Provide control power transformer, 120 V secondary, if required.

.7 Enclosure:

.1 Provide actuators with NEMA 4 enclosures, suitable for use in an industrial environment.

.2 Provide 120 V space heaters.

.8 Control Features: Electric actuators with features noted in the Automated Valve Schedule (15202-01).

.9 Acceptable Manufacturers:

.1 Rotork

.2 Limitorque

.4 Electric Operators, Open-Close Service – 120 V:

.1 Standard extended duty cycle induction motor.

.2 F Class insulation and built in thermal motor protection.

.3 Operators shall be suitable for positioning of valve at intermediate positions.

.4 Local control unit (COMP-OFF-HAND)

.5 Valve position indicator and limit switches

.6 Manual override non-clutch design with hand wheel.

.7 High alloy steel gear train for self locking to prevent valve back drive

.8 Enclosures shall be NEMA 4X and suitable for corrosive environments.

.5 Acceptable Manufacturers:

.1 Rotork, ROM 3

.2 Or approved equal.

2.7 Accessories

.1 Tagging: 38 mm diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve, bearing the valve tag number shown on the Valve Schedule and/or Drawings.

.2 T-Handled Operating Wrench:

.1 One each galvanized operating wrench, 1.22 m long.

.2 Acceptable Manufacturers:

.1 Mueller; No. A-24610

.2 Clow No.; F-2520

.3 One each galvanized operating key for cross handled valves.

.3 Extension Bonnet for Valve Operator: Complete with enclosed stem, extension, support brackets, and accessories for valve and operator.

.1 Acceptable Manufacturers:

.1 Pratt

.2 DeZurik

.4 Floor Stand and Extension Stem:

.1 Nonrising, indicating type.

.2 Complete with solid extension stem, coupling, handwheel, stem guide brackets, and yoke attachment.

.3 Stem Guide: Space such that stem L/R ratio does not exceed 200.

.4 Anchor Bolts: Type 304 SST.

.5 Acceptable Manufacturers:

.1 Clow; Figure F-5515

.2 Mueller, Figure A-26426

.5 Floor Box and Extension Stem:

.1 Plain type, for support of nonrising type stem.

.2 Complete with solid extension stem, operating nut, and stem guide brackets.

.3 Stem Guide: Space such that stem L/R ratio does not exceed 200.

.4 Anchor Bolts: Type 304 SST.

.5 Acceptable Manufacturers:

.1 Neenah Foundry; R 7506

.2 Clow; No. F5690

.6 Chain Wheel and Guide:

.1 Handwheel direct-mount type.

.2 Complete with chain.

.3 Galvanized or cadmium-plated.

.4 Acceptable Manufacturers:

.1 Clow Corp.; Figure F-5680

.2 Walworth Co.; Figure 804

.3 DeZurik Corp.; Series W or LWG

3. EXECUTION

3.1 Installation by Contractor

.1 Flange Ends:

.1 Flanged valve boltholes shall straddle vertical centerline of pipe.

.2 Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

.2 Screwed Ends:

.1 Clean threads by wire brushing or swabbing.

.2 Apply joint compound.

.3 PVC and CPVC Valves: Install using solvents approved for valve service conditions.

.4 Valve Orientation:

.1 Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 1476 mm or less above finished floor, unless otherwise shown.

.2 Install operating stem horizontal in horizontal runs of pipe having centerline elevations between 1476 mm and 2057 mm above finish floor, unless otherwise shown.

.3 Orient butterfly valve shaft so that unbalanced flows or eddies are equally divided to each half of the disc, i.e., shaft is in the plane of rotation of the eddy.

.4 If no plug valve seat position is shown, locate as follows:

.1 Horizontal Flow: The flow shall produce an “unseating” pressure, and the plug shall open into the top half of valve.

.2 Vertical Flow: Install seat in the highest portion of the valve.

.5 Install a line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

.6 Install safety isolation valves on compressed air.

.7 Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

.8 Extension Stem for Operator: Where the depth of the valve is such that its centreline is more than 1000 mm below grade, supply an operating extension stem with 50 mm operating nut to bring the operating nut to a point 150 mm below the surface of the ground and/or box cover.

.9 Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of the valve.

.10 Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

.11 Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on all manually operated valves with stem centrelines more than 2000 mm above the operating floor or grade. Chains shall extend to within 1200 mm of the operating floor or grade. Chain wheel and guide assemblies shall also be provided for valves as specified in Section 15202-02, Manual Valve Schedule. Where chains hang in normally travelled areas, use "L" type tie-back anchors.

3.2 Field Finishing by Contractor

.1 Equipment as specified in Section 09901 – Painting and Finishing – Process Mechanical.

3.3 Field Quality Control by Contractor

.1 Demonstration Tests: Conduct position and travel tests on each valve locally and remotely if automated. Provide checklist of functional testing for all valves in 15202-01 and 15202-02.

.2 Performance Test: In accordance with operating conditions indicated in supplemental valve schedules sheets.

.3 Valve may be either tested while testing pipelines, or as a separate step.

.4 Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.

.5 Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.

.6 Count and record number of turns to open and close valve; account for any discrepancies with Manufacturer's data.

.7 Set, verify, and record set pressures for all relief and regulating valves.

.8 Automatic valves to be tested in conjunction with control system testing. Set all opening and closing speeds, limit switches, as required or recommended by the Contract Administrator.

.9 Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 1.24 litre/min/metre of seat periphery.

3.4 Manufacturer's Representative Field Services

.1 The valve(s) as listed below require Manufacturer's field services:

.1 Valves in the Automated Valve Schedule

.2 Valves in the Manual Valve Schedule as follows:

.1 PSVs

.2 Valves with limit switches

.2 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.3 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.4 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.5 The minimum periods of Site attendance as total number of business days for all equipment are identified in the following table along with the form to be completed on each of these trips.

.6 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of business days	Form
1	Equipment Delivery	1	100
2	Installation Assistance	1	101
3	Witnessing of Equipment Installation	6	102
4	Assistance in Equipment Performance Testing	6	103
5	Operator and Maintenance Training	4	T1

3.5 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer’s Representative and as indicated in the Contract Documents.

.2 The Manufacturer’s Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer’s Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.6 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure that each pump, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.7 Training

.1 The Contractor shall provide the services of Manufacturer's Representatives for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.8 Supplements

.1 The supplements listed below, following "End of Section," are part of this Specification.

.1 15202-01 - Automated Valves.

.2 15202-02 - Manual Valves.

END OF SECTION

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Actuator Service	Actuator Type (P - PNEUMATIC, S - SOLENOID, E - ELECTRIC)	Voltage	Comments/ Control Features
Sodium Hypo Chemical Area											
CPG0465-I-01 - 3 of 6	FV - J100A	Ball		PSW	50	Exposed	560	Open/Close	S	120	Vendor Package
CPG0465-I-01 - 3 of 6	FV - J200A	Ball		PSW	50	Exposed	560	Open/Close	S	120	Vendor Package
CPG0465-I-01 - 5 of 6	FV - J500A	Ball	V310	HYP	75	Exposed	170	Open/Close	E	120	
CPG0465-I-01 - 5 of 6	FV - J500B	Ball	V310	HYP	100	Exposed	170	Open/Close	E	120	
CPG0465-I-01 - 6 of 6	FV - J520A	Ball	V310	HYP	75	Exposed	170	Open/Close	E	120	
CPG0465-I-01 - 6 of 6	FV - J520B	Ball	V310	HYP	100	Exposed	170	Open/Close	E	120	
CPG0465-I-01 - 6 of 6	FV - J540A	Ball	V310	HYP	75	Exposed	170	Open/Close	E	120	
CPG0465-I-01 - 6 of 6	FV - J540B	Ball	V310	HYP	100	Exposed	170	Open/Close	E	120	
CPG0465-I-01 - 6 of 6	FV - J560A	Ball	V310	HYP	75	Exposed	170	Open/Close	E	120	
CPG0465-I-01 - 6 of 6	FV - J560B	Ball	V310	HYP	100	Exposed	170	Open/Close	E	120	
WJ - P0006	FV - J600A	Ball	-	HYP	50	Exposed	560	Open/Close	E	120	Vendor Package
WJ - P0006	FV - J620A	Ball	-	HYP	50	Exposed	560	Open/Close	E	120	Vendor Package
WJ - P0006	FV - J640A	Ball	-	HYP	50	Exposed	560	Open/Close	E	120	Vendor Package
WJ - P0006	FV - J660A	Ball	-	HYP	50	Exposed	560	Open/Close	E	120	Vendor Package
WJ - P0006	FV - J665A	Ball	-	HYP	50	Exposed	560	Open/Close	E	120	Vendor Package
Bulk Chemical Building											
WS - P0001	SOL - S200A	Solenoid	V940	AIR	25				S		
WS - P0001	SOL - S204A	Solenoid	V940	AIR	25				S		
WS - P0001	FV - S206A	Butterfly	V500	AW	200	Exposed		Open/Close	E	600	Refer To Drawing WS-A0451 For Instrument Loop Diagram
WS - P0001	FV - S207A	Butterfly	V500	AW	100	Exposed		Open/Close	E	600	Refer To Drawing WS-A0451 For Instrument Loop Diagram
WS - P0001	FV - S210A	Ball	V308	SCA	75	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0001	FV - S210B	Ball	V308	SCA	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0001	FV - S220A	Ball	V308	SCA	75	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0001	FV - S220B	Ball	V308	SCA	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0002	FV - S210C	Ball	V308	SCA	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0002	FV - S220C	Ball	V308	SCA	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0003	FV - S240A	Ball	V307	SCA	25	Exposed		Open/Close	E	120	Skid Mounted; Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0003	FV - S240B	Ball	V307	SCA	25	Exposed		Open/Close	E	120	Skid Mounted; Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0004	SOL - S100A	Solenoid	V940	AIR	25	Exposed		Open/Close	S	120	3-Way
WS - P0004	SOL - S105A	Solenoid	V940	AIR	26	Exposed		Open/Close	S	120	3-Way
WS - P0004	FV - S107A	Butterfly	V500	FCW	100	Exposed		Open/Close	E	600	Refer To Drawing WS-A0451 For Instrument Loop Diagram
WS - P0004	FV - S110A	Ball	V330	FC	75	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0004	FV - S110B	Ball	V330	FC	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0004	FV - S120A	Ball	V330	FC	75	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0004	FV - S120B	Ball	V330	FC	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0004	FV - S130A	Ball	V330	FC	75	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0004	FV - S130B	Ball	V330	FC	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0004	FV - S140A	Ball	V330	FC	75	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0004	FV - S140B	Ball	V330	FC	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0005	FV - S110C	Ball	V330	FC	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0005	FV - S120C	Ball	V330	FC	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0006	FV - S130C	Ball	V330	FC	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0006	FV - S140C	Ball	V330	FC	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0007	FV - S170A	Ball	V330	FC	25	Exposed		Open/Close	E	120	Skid Mounted; Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0008	FV - S170B	Ball	V330	FC	25	Exposed		Open/Close	E	120	Skid Mounted; Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0008	SOL - S300A	Solenoid	V940	AIR	25	Exposed		Open/Close	S	120	3-Way
WS - P0008	SOL - S307A	Solenoid	V940	AIR	25	Exposed		Open/Close	S	120	3-Way
WS - P0008	FV - S309A	Butterfly	V500	CSW	200	Exposed		Open/Close	E	600	Refer To Drawing WS-A0451 For Instrument Loop Diagram
WS - P0008	FV - S310A	Ball	V330	CS	75	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0008	FV - S310B	Ball	V330	CS	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0008	FV - S320A	Ball	V330	CS	75	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0008	FV - S320B	Ball	V330	CS	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0008	FV - S330A	Ball	V330	CS	75	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0008	FV - S330B	Ball	V330	CS	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0008	FV - S340A	Ball	V330	CS	75	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0008	FV - S340B	Ball	V330	CS	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0009	FV - S310C	Ball	V330	CS	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0009	FV - S320C	Ball	V330	CS	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0454 For Instrument Loop Diagram

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Actuator Service	Actuator Type (P - PNEUMATIC, S - SOLENOID, E - ELECTRIC)	Voltage	Comments/ Control Features
WS - P0010	FV - S330C	Ball	V330	CS	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0010	FV - S340C	Ball	V330	CS	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0011	FV - S350A	Ball	V330	CS	25	Exposed		Open/Close	E	120	Skid Mounted; Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0011	FV - S360A	Ball	V330	CS	25	Exposed		Open/Close	E	120	Skid Mounted; Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0011	FV - S370A	Ball	V330	CS	25	Exposed		Open/Close	E	120	Skid Mounted; Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0012	SOL - S400A	Solenoid	V940	AIR	25	Exposed		Open/Close	S	120	3-Way
WS - P0012	FV - S410A	Ball	V308	AA	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0012	FV - S420A	Ball	V308	AA	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0455 For Instrument Loop Diagram
WS - P0013	FV - S410B	Ball	V308	AA	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0013	FV - S410C	Ball	V308	AA	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0013	FV - S420B	Ball	V308	AA	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0013	FV - S420C	Ball	V308	AA	50	Exposed		Open/Close	E	120	Refer To Drawing WS-A0454 For Instrument Loop Diagram
WS - P0014	FV - S440A	Ball	V308	AA	20	Exposed		Open/Close	E	120	Skid Mounted; Refer To Drawing WS-A0454 For Instrument Loop Diagram

Note 1. All valves within vendor packages shall be supplied and installed by the Contractor

MANUAL VALVE SCHEDULE (ALL SIZES)

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Comments/ Control Features
Bulk Chemical Building								
WS - P0001	HV - S200A	Ball	V300	AIR	25	Exposed	560	
WS - P0001	PCV - S200A	Pressure Control	-	AIR	25	Exposed	560	
WS - P0001	PRV - S200A	Pressure Relief	V720	AIR	25	Exposed	560	
WS - P0001	CV - S200A	Check	V602	AIR	25	Exposed	560	
WS - P0001	CV - S200B	Check	V602	AIR	20	Exposed	560	
WS - P0001	HV - S200B	Ball	V312	AIR	20	Exposed	560	
WS - P0001	HV - S200C	Ball	V300	AIR	25	Exposed	560	
WS - P0001	HV - S200D	Ball	V300	AIR	25	Exposed	560	
WS - P0001	HV - S200E	Ball	V300	AIR	15	Exposed	560	
WS - P0001	HV S200F	Ball	V300	AIR	15	Exposed	560	
WS - P0001	HV - S202A	Ball	V308	SCA	75	Exposed	560	
WS - P0001	HV - S202B	Ball	V307	SCA	15	Exposed	560	
WS - P0001	HV - S204A	Ball	V300	AIR	25	Exposed	560	
WS - P0001	PCV - S204A	Pressure Control	-	AIR	25	Exposed	560	
WS - P0001	PRV - S204A	Pressure Relief	V720	AIR	25	Exposed	560	
WS - P0001	CV - S204A	Check	V602	AIR	25	Exposed	560	
WS - P0001	CV - S204B	Check	V602	AIR	20	Exposed	560	
WS - P0001	HV - S204B	Ball	V312	AIR	20	Exposed	560	
WS - P0001	HV - S204C	Ball	V300	AIR	25	Exposed	560	
WS - P0001	HV - S204D	Ball	V300	AIR	25	Exposed	560	
WS - P0001	HV - S204E	Ball	V300	AIR	15	Exposed	560	
WS - P0001	HV - S204F	Ball	V300	AIR	15	Exposed	560	
WS - P0001	HV - S204G	Ball	V312	AIR	20	Exposed	560	
WS - P0001	HV - S205A	Ball	V308	SCA	50	Exposed	560	
WS - P0001	HV - S205B	Ball	V307	SCA	15	Exposed	560	
WS - P0001	HV - S205C	Ball	V308	SCA	50	Exposed	560	
WS - P0001	HV - S205D	Ball	V308	SCA	50	Exposed	560	
WS - P0001	HV - S210A	Ball	V308	SCA	75	Exposed	560	
WS - P0001	HV - S210B	Ball	V308	SCA	50	Exposed	560	
WS - P0001	HV - S220A	Ball	V308	SCA	75	Exposed	560	
WS - P0001	HV - S220B	Ball	V308	SCA	50	Exposed	560	
						Exposed	560	
WS - P0002	SV - S210A	Blind Spectacle	-	SCA	50	Exposed	560	
WS - P0002	SV - S210B	Blind Spectacle	-	SCA	75	Exposed	560	
WS - P0002	CV - S210B	Check	V694	SCA	100	Exposed	560	Duck Bill Check Valve
WS - P0002	HV - S210C	Ball	V308	SCA	50	Exposed	560	
WS - P0002	HV - S210D	Ball	V308	SCA	50	Exposed	560	
WS - P0002	HV - S210E	Ball	V308	SCA	50	Exposed	560	
WS - P0002	HV - S210F	Ball	V307	SCA	15	Exposed	560	
WS - P0002	HV - S210G	Ball	V308	SCA	50	Exposed	560	
WS - P0002	HV - S210H	Ball	V307	SCA	20	Exposed	560	
WS - P0002	HV - S210I	Ball	V307	SCA	20	Exposed	560	
WS - P0002	HV - S210J	Ball	V307	SCA	20	Exposed	560	
WS - P0002	SV - S220A	Blind Spectacle	-	SCA	50	Exposed	560	
WS - P0002	CV - S220A	Check	V619	SCA	50	Exposed	560	
WS - P0002	CV - S220B	Check	V694	SCA	100	Exposed	560	Duck Bill Check Valve
WS - P0002	SV - S220B	Blind Spectacle	-	SCA	75	Exposed	560	
WS - P0002	HV - S220C	Ball	V308	SCA	50	Exposed	560	
WS - P0002	HV - S220D	Ball	V308	SCA	50	Exposed	560	
WS - P0002	HV - S220E	Ball	V308	SCA	50	Exposed	560	
WS - P0002	HV - S220F	Ball	V307	SCA	15	Exposed	560	

MANUAL VALVE SCHEDULE (ALL SIZES)

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Comments/ Control Features
WS - P0002	HV - S220G	Ball	V308	SCA	50	Exposed	560	
WS - P0002	HV - S220H	Ball	V307	SCA	20	Exposed	560	
WS - P0002	HV - S220I	Ball	V307	SCA	20	Exposed	560	
WS - P0002	HV - S220J	Ball	V307	SCA	20	Exposed	560	
						Exposed	560	
WS - P0003	HV - S210K	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S210L	Ball	V307	SCA	20	Exposed	560	Skid Mounted
WS - P0003	HV - S220L	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S220M	Ball	V307	SCA	20	Exposed	560	Skid Mounted
WS - P0003	HV - S230A	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	CV - S230A	Check	V619	SCA	25	Exposed	560	Skid Mounted
WS - P0003	PCV - S230A	Back Pressure	V717	SCA	25	Exposed	560	Skid Mounted
WS - P0003	PRV - S230A	Pressure Relief	-	SCA	-	Exposed	560	Skid Mounted
WS - P0003	HV - S230B	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S230C	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S230D	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S230E	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S230F	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S230G	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S230H	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S240A	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	CV - S240A	Check	V619	SCA	25	Exposed	560	Skid Mounted
WS - P0003	PRV - S240A	Pressure Relief	-	SCA	-	Exposed	560	Skid Mounted
WS - P0003	PCV - S240A	Back Pressure	V717	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S240B	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S240C	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S240D	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S240E	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S240F	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S240G	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S240H	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S240I	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S240J	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S250A	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	CV - S250A	Check	V619	SCA	25	Exposed	560	Skid Mounted
WS - P0003	PRV - S250A	Pressure Relief	-	SCA	-	Exposed	560	Skid Mounted
WS - P0003	PCV - S250A	Back Pressure	V717	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S250B	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S250C	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S250D	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S250E	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S250F	Ball	V307	SCA	25	Exposed	560	Skid Mounted
WS - P0003	HV - S250G	Ball	V307	SCA	25	Exposed	560	
WS - P0003	HV - S250H	Ball	V307	SCA	25	Exposed	560	
						Exposed	560	
WS - P0004	HV - S100A	Ball	V300	AIR	25	Exposed	560	
WS - P0004	PCV - S100A	Pressure Control	-	AIR	25	Exposed	560	
WS - P0004	PRV - S100A	Pressure Relief	V720	AIR	25	Exposed	560	
WS - P0004	CV - S100A	Check	V602	AIR	25	Exposed	560	
WS - P0004	CV - S100B	Check	V602	AIR	20	Exposed	560	
WS - P0004	HV - S100B	Ball	V312	AIR	20	Exposed	560	
WS - P0004	HV - S100C	Ball	V330	FC	75	Exposed	560	
WS - P0004	HV - S100D	Ball	V330	FC	15	Exposed	560	

MANUAL VALVE SCHEDULE (ALL SIZES)

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Comments/ Control Features
WS - P0004	HV - S100E	Ball	V300	AIR	25	Exposed	560	
WS - P0004	HV - S100F	Ball	V300	AIR	15	Exposed	560	
WS - P0004	HV - S100G	Ball	V300	AIR	25	Exposed	560	
WS - P0004	HV - S100H	Ball	V300	AIR	15	Exposed	560	
WS - P0004	HV - S105A	Ball	V300	AIR	25	Exposed	560	
WS - P0004	PCV - S105A	Pressure Control	-	AIR	25	Exposed	560	
WS - P0004	PRV - S105A	Pressure Relief	V720	AIR	25	Exposed	560	
WS - P0004	CV - S105A	Check	V602	AIR	25	Exposed	560	
WS - P0004	CV - S105B	Check	V602	AIR	20	Exposed	560	
WS - P0004	HV - S105B	Ball	V312	AIR	20	Exposed	560	
WS - P0004	CV - S105C	Check	V602	AIR	20	Exposed	560	
WS - P0004	HV - S105C	Ball	V330	FC	50	Exposed	560	
WS - P0004	HV - S105D	Ball	V330	FC	15	Exposed	560	
WS - P0004	HV - S105E	Ball	V300	AIR	25	Exposed	560	
WS - P0004	HV - S105F	Ball	V300	AIR	15	Exposed	560	
WS - P0004	HV - S105G	Ball	V300	AIR	25	Exposed	560	
WS - P0004	HV - S105H	Ball	V300	AIR	15	Exposed	560	
WS - P0004	HV - S105I	Ball	V312	AIR	20	Exposed	560	
WS - P0004	HV - S105J	Ball	V330	FC	50	Exposed	560	
WS - P0004	HV - S105K	Ball	V330	FC	15	Exposed	560	
WS - P0004	HV - S110A	Ball	V330	FC	75	Exposed	560	
WS - P0004	HV - S110B	Ball	V330	FC	50	Exposed	560	
WS - P0004	HV - S120A	Ball	V330	FC	75	Exposed	560	
WS - P0004	HV - S120B	Ball	V330	FC	50	Exposed	560	
WS - P0004	HV - S130A	Ball	V330	FC	75	Exposed	560	
WS - P0004	HV - S130B	Ball	V330	FC	50	Exposed	560	
WS - P0004	HV - S140A	Ball	V330	FC	75	Exposed	560	
WS - P0004	HV - S140B	Ball	V330	FC	50	Exposed	560	
						Exposed	560	
WS - P0005	SV - S110A	Blind Spectacle	-	FC	50	Exposed	560	
WS - P0005	CV - S110A	Check	V630	FC	50	Exposed	560	
WS - P0005	SV - S110B	Blind Spectacle	-	FC	75	Exposed	560	
WS - P0005	CV - S110B	Check	V694	FC	100	Exposed	560	Duckbill Check Valve
WS - P0005	HV - S110C	Ball	V330	FC	50	Exposed	560	
WS - P0005	HV - S110D	Ball	V330	FC	50	Exposed	560	
WS - P0005	HV - S110E	Ball	V330	FC	50	Exposed	560	
WS - P0005	HV - S110F	Ball	V330	FC	15	Exposed	560	
WS - P0005	HV - S110G	Ball	V330	FC	50	Exposed	560	
WS - P0005	HV - S110H	Ball	V330	FC	20	Exposed	560	
WS - P0005	HV - S110I	Ball	V330	FC	20	Exposed	560	
WS - P0005	HV - S110J	Ball	V330	FC	20	Exposed	560	
WS - P0005	SV - S120A	Blind Spectacle	-	FC	50	Exposed	560	
WS - P0005	CV - S120A	Check	V630	FC	50	Exposed	560	
WS - P0005	SV - S120B	Blind Spectacle	-	FC	75	Exposed	560	
WS - P0005	CV - S120B	Check	V694	FC	100	Exposed	560	Duckbill Check Valve
WS - P0005	HV - S120C	Ball	V330	FC	50	Exposed	560	
WS - P0005	HV - S120D	Ball	V330	FC	50	Exposed	560	
WS - P0005	HV - S120E	Ball	V330	FC	50	Exposed	560	
WS - P0005	HV - S120F	Ball	V330	FC	15	Exposed	560	
WS - P0005	HV - S120G	Ball	V330	FC	50	Exposed	560	
WS - P0005	HV - S120H	Ball	V330	FC	20	Exposed	560	
WS - P0005	HV - S120I	Ball	V330	FC	20	Exposed	560	
WS - P0005	HV - S120J	Ball	V330	FC	20	Exposed	560	

MANUAL VALVE SCHEDULE (ALL SIZES)

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Comments/ Control Features
						Exposed	560	
WS - P0006	SV - S130A	Blind Spectacle	-	FC	50	Exposed	560	
WS - P0006	CV - S130A	Check	V630	FC	50	Exposed	560	
WS - P0006	SV - S130B	Blind Spectacle	-	FC	75	Exposed	560	
WS - P0006	CV - S130B	Check	V694	FC	100	Exposed	560	Duckbill Check Valve
WS - P0006	HV - S130C	Ball	V330	FC	50	Exposed	560	
WS - P0006	HV - S130D	Ball	V330	FC	50	Exposed	560	
WS - P0006	HV - S130E	Ball	V330	FC	50	Exposed	560	
WS - P0006	HV - S130F	Ball	V330	FC	15	Exposed	560	
WS - P0006	HV - S130G	Ball	V330	FC	50	Exposed	560	
WS - P0006	HV - S130H	Ball	V330	FC	20	Exposed	560	
WS - P0006	HV - S130I	Ball	V330	FC	20	Exposed	560	
WS - P0006	HV - S130J	Ball	V330	FC	20	Exposed	560	
WS - P0006	SV - S140A	Blind Spectacle	-	FC	50	Exposed	560	
WS - P0006	CV - S140A	Check	V630	FC	50	Exposed	560	
WS - P0006	SV - S140B	Blind Spectacle	-	FC	75	Exposed	560	
WS - P0006	CV - S140B	Check	V694	FC	100	Exposed	560	Duckbill Check Valve
WS - P0006	HV - S140C	Ball	V330	FC	50	Exposed	560	
WS - P0006	HV - S140D	Ball	V330	FC	50	Exposed	560	
WS - P0006	HV - S140E	Ball	V330	FC	50	Exposed	560	
WS - P0006	HV - S140F	Ball	V330	FC	15	Exposed	560	
WS - P0006	HV - S140G	Ball	V330	FC	50	Exposed	560	
WS - P0006	HV - S140H	Ball	V330	FC	20	Exposed	560	
WS - P0006	HV - S140I	Ball	V330	FC	20	Exposed	560	
WS - P0006	HV - S140J	Ball	V330	FC	20	Exposed	560	
						Exposed	560	
WS - P0007	HV - S110K	Ball	V330	FC	20	Exposed	560	
WS - P0007	HV - S110L	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S130K	Ball	V330	FC	20	Exposed	560	
WS - P0007	HV - S130L	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S160A	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	CV - S160A	Check	V630	FC	25	Exposed	560	Skid Mounted
WS - P0007	PRV - S160A	Pressure Relief	-	FC	-	Exposed	560	Skid Mounted
WS - P0007	PCV - S160A	Back Pressure	V719	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S160B	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S160C	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S160D	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S160E	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S160F	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S160G	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S160H	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S170A	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	CV - S170A	Check	V630	FC	25	Exposed	560	Skid Mounted
WS - P0007	PRV - S170A	Pressure Relief	-	FC	-	Exposed	560	Skid Mounted
WS - P0007	PCV - S170A	Back Pressure	V719	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S170B	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S170C	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S170D	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S170E	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S170F	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S170G	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S170H	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S170I	Ball	V330	FC	25	Exposed	560	Skid Mounted

MANUAL VALVE SCHEDULE (ALL SIZES)

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Comments/ Control Features
WS - P0007	HV - S170J	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S180A	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	CV - S180A	Check	V630	FC	25	Exposed	560	Skid Mounted
WS - P0007	PRV - S180A	Pressure Relief	-	FC	-	Exposed	560	Skid Mounted
WS - P0007	PCV - S180A	Back Pressure	V719	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S180B	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S180C	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S180D	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S180E	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S180F	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S180G	Ball	V330	FC	25	Exposed	560	Skid Mounted
WS - P0007	HV - S180H	Ball	V330	FC	25	Exposed	560	Skid Mounted
						Exposed	560	
WS - P0008	HV - S300A	Ball	V300	AIR	25	Exposed	560	
WS - P0008	PCV - S300A	Pressure Control	-	AIR	25	Exposed	560	
WS - P0008	PRV - S300A	Pressure Relief	V720	AIR	25	Exposed	560	
WS - P0008	CV - S300A	Check	V602	AIR	25	Exposed	560	
WS - P0008	CV - S300B	Check	V602	AIR	20	Exposed	560	
WS - P0008	HV - S300B	Ball	V312	AIR	20	Exposed	560	
WS - P0008	HV - S300C	Ball	V300	AIR	25	Exposed	560	
WS - P0008	HV - S300D	Ball	V300	AIR	25	Exposed	560	
WS - P0008	HV - S300E	Ball	V300	AIR	15	Exposed	560	
WS - P0008	HV - S300F	Ball	V300	AIR	15	Exposed	560	
WS - P0008	HV - S302A	Ball	V330	CS	75	Exposed	560	
WS - P0008	HV - S302B	Ball	V330	CS	15	Exposed	560	
WS - P0008	HV - S307A	Ball	V300	AIR	25	Exposed	560	
WS - P0008	PCV - S307A	Pressure Control	-	AIR	25	Exposed	560	
WS - P0008	PRV - S307A	Pressure Relief	V720	AIR	25	Exposed	560	
WS - P0008	CV - S307A	Check	V602	AIR	25	Exposed	560	
WS - P0008	CV - S307B	Check	V602	AIR	20	Exposed	560	
WS - P0008	HV - S307B	Ball	V312	AIR	20	Exposed	560	
WS - P0008	HV - S307C	Ball	V300	AIR	25	Exposed	560	
WS - P0008	CV - S307C	Check	V602	AIR	20	Exposed	560	
WS - P0008	HV - S307D	Ball	V300	AIR	25	Exposed	560	
WS - P0008	HV - S307E	Ball	V300	AIR	15	Exposed	560	
WS - P0008	HV - S307F	Ball	V300	AIR	15	Exposed	560	
WS - P0008	HV - S307G	Ball	V312	AIR	20	Exposed	560	
WS - P0008	HV - S308A	Ball	V330	CS	50	Exposed	560	
WS - P0008	HV - S308B	Ball	V330	CS	15	Exposed	560	
WS - P0008	HV - S310A	Ball	V330	CS	75	Exposed	560	
WS - P0008	HV - S310B	Ball	V330	CS	50	Exposed	560	
WS - P0008	CV - S311A	Check	V694	CS	100	Exposed	560	Duckbill Check Valve
WS - P0008	HV - S320A	Ball	V330	CS	75	Exposed	560	
WS - P0008	HV - S320B	Ball	V330	CS	50	Exposed	560	
WS - P0008	HV - S330A	Ball	V330	CS	75	Exposed	560	
WS - P0008	HV - S330B	Ball	V330	CS	50	Exposed	560	
WS - P0008	HV - S340A	Ball	V330	CS	75	Exposed	560	
WS - P0008	HV - S340B	Ball	V330	CS	50	Exposed	560	
						Exposed	560	
WS - P0009	SV - S310A	Blind Spectacle	-	CS	50	Exposed	560	
WS - P0009	CV - S310A	Check	V630	CS	50	Exposed	560	
WS - P0009	SV - S310B	Blind Spectacle	-	CS	75	Exposed	560	
WS - P0009	CV - S310B	Check	V694	CS	100	Exposed	560	Duckbill Check Valve

MANUAL VALVE SCHEDULE (ALL SIZES)

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Comments/ Control Features
WS - P0009	HV - S310C	Ball	V330	CS	50	Exposed	560	
WS - P0009	HV - S310D	Ball	V330	CS	50	Exposed	560	
WS - P0009	HV - S310E	Ball	V330	CS	50	Exposed	560	
WS - P0009	HV - S310F	Ball	V330	CS	15	Exposed	560	
WS - P0009	HV - S310G	Ball	V330	CS	50	Exposed	560	
WS - P0009	HV - S310H	Ball	V330	CS	20	Exposed	560	
WS - P0009	HV - S310I	Ball	V330	CS	20	Exposed	560	
WS - P0009	HV - S310J	Ball	V330	CS	20	Exposed	560	
WS - P0009	SV - S320A	Blind Spectacle	-	CS	50	Exposed	560	
WS - P0009	CV - S320A	Check	V630	CS	50	Exposed	560	
WS - P0009	CV - S320B	Check	V694	CS	100	Exposed	560	Duckbill Check Valve
WS - P0009	SV - S320B	Blind Spectacle	-	CS	75	Exposed	560	
WS - P0009	HV - S320C	Ball	V330	CS	50	Exposed	560	
WS - P0009	HV - S320D	Ball	V330	CS	50	Exposed	560	
WS - P0009	HV - S320E	Ball	V330	CS	50	Exposed	560	
WS - P0009	HV - S320F	Ball	V330	CS	15	Exposed	560	
WS - P0009	HV - S320G	Ball	V330	CS	50	Exposed	560	
WS - P0009	HV - S320H	Ball	V330	CS	20	Exposed	560	
WS - P0009	HV - S320I	Ball	V330	CS	20	Exposed	560	
WS - P0009	HV - S320J	Ball	V330	CS	50	Exposed	560	
						Exposed	560	
WS - P0010	SV - S330A	Blind Spectacle	-	CS	50	Exposed	560	
WS - P0010	CV - S330A	Check	V630	CS	50	Exposed	560	
WS - P0010	SV - S330B	Blind Spectacle	-	CS	75	Exposed	560	
WS - P0010	CV - S330B	Check	V694	CS	100	Exposed	560	Duckbill Check Valve
WS - P0010	HV - S330C	Ball	V330	CS	50	Exposed	560	
WS - P0010	HV - S330D	Ball	V330	CS	50	Exposed	560	
WS - P0010	HV - S330E	Ball	V330	CS	50	Exposed	560	
WS - P0010	HV - S330F	Ball	V330	CS	15	Exposed	560	
WS - P0010	HV - S330G	Ball	V330	CS	50	Exposed	560	
WS - P0010	HV - S330H	Ball	V330	CS	20	Exposed	560	
WS - P0010	HV - S330I	Ball	V330	CS	20	Exposed	560	
WS - P0010	HV - S330J	Ball	V330	CS	20	Exposed	560	
WS - P0010	SV - S340A	Blind Spectacle	-	CS	50	Exposed	560	
WS - P0010	CV - S340A	Check	V630	CS	50	Exposed	560	
WS - P0010	SV - S340B	Blind Spectacle	-	CS	75	Exposed	560	
WS - P0010	CV - S340B	Check	V694	CS	100	Exposed	560	Duckbill Check Valve
WS - P0010	HV - S340C	Ball	V330	CS	50	Exposed	560	
WS - P0010	HV - S340D	Ball	V330	CS	50	Exposed	560	
WS - P0010	HV - S340E	Ball	V330	CS	50	Exposed	560	
WS - P0010	HV - S340F	Ball	V330	CS	15	Exposed	560	
WS - P0010	HV - S340G	Ball	V330	CS	50	Exposed	560	
WS - P0010	HV - S340H	Ball	V330	CS	20	Exposed	560	
WS - P0010	HV - S340I	Ball	V330	CS	20	Exposed	560	
WS - P0010	HV - S340J	Ball	V330	CS	20	Exposed	560	
						Exposed	560	

MANUAL VALVE SCHEDULE (ALL SIZES)

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Comments/ Control Features
WS - P0011	HV - S350A	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	CV - S350A	Check	V630	CS	25	Exposed	560	Skid Mounted
WS - P0011	PCV - S350A	Back Pressure	V719	CS	25	Exposed	560	Skid Mounted
WS - P0011	PRV - S350A	Pressure Relief	-	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S350B	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S350C	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S350D	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S350E	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S350F	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S350G	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S350H	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S350I	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S350J	Ball	V330	CS	50	Exposed	560	
WS - P0011	HV - S360A	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	CV - S360A	Check	V630	CS	25	Exposed	560	Skid Mounted
WS - P0011	PRV - S360A	Pressure Relief	-	CS	25	Exposed	560	Skid Mounted
WS - P0011	PCV - S360A	Back Pressure	V719	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S360B	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S360C	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S360D	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S360E	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S360F	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S360G	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S360H	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S360I	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S370A	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	CV - S370A	Check	V630	CS	25	Exposed	560	Skid Mounted
WS - P0011	PRV - S370A	Pressure Relief	-	CS	25	Exposed	560	Skid Mounted
WS - P0011	PCV - S370A	Back Pressure	V719	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S370B	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S370C	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S370D	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S370E	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S370F	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S370G	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S370H	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S370I	Ball	V330	CS	25	Exposed	560	Skid Mounted
WS - P0011	HV - S370J	Ball	V330	CS	50	Exposed	560	
						Exposed	560	
WS - P0012	HV - S400A	Ball	V300	AIR	25	Exposed	560	
WS - P0012	PCV - S400A	Pressure Control	-	AIR	25	Exposed	560	
WS - P0012	PRV - S400A	Pressure Relief	V720	AIR	25	Exposed	560	
WS - P0012	CV - S400A	Check	V602	AIR	25	Exposed	560	
WS - P0012	CV - S400B	Check	V602	AIR	20	Exposed	560	
WS - P0012	HV - S400B	Ball	V312	AIR	20	Exposed	560	
WS - P0012	CV - S400C	Check	V602	AIR	20	Exposed	560	
WS - P0012	HV - S400C	Ball	V300	AIR	25	Exposed	560	
WS - P0012	HV - S400D	Ball	V300	AIR	25	Exposed	560	
WS - P0012	HV - S400E	Ball	V300	AIR	15	Exposed	560	
WS - P0012	HV - S400F	Ball	V300	AIR	15	Exposed	560	
WS - P0012	HV - S400G	Ball	V312	AIR	20	Exposed	560	
WS - P0012	HV - S402A	Ball	V308	AA	50	Exposed	560	
WS - P0012	HV - S402B	Ball	V307	AA	15	Exposed	560	

MANUAL VALVE SCHEDULE (ALL SIZES)

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Comments/ Control Features
WS - P0012	HV - S402C	Ball	V308	AA	50	Exposed	560	
WS - P0012	HV - S402D	Ball	V307	AA	15	Exposed	560	
						Exposed	560	
WS - P0013	HV - S240D	Ball	V307	AA	20	Exposed	560	
WS - P0013	SV - S410A	Blind Spectacle	-	AA	50	Exposed	560	
WS - P0013	HV - S410A	Ball	V308	AA	50	Exposed	560	
WS - P0013	CV - S410A	Check	V619	AA	50	Exposed	560	
WS - P0013	PRV - S410A	Pressure Relief	V740	AA	75	Exposed	560	Pressure/Vacuum Relief
WS - P0013	HV - S410B	Ball	V308	AA	50	Exposed	560	
WS - P0013	HV - S410C	Ball	V308	AA	50	Exposed	560	
WS - P0013	HV - S410D	Ball	V308	AA	50	Exposed	560	
WS - P0013	SV - S420A	Blind Spectacle	-	AA	50	Exposed	560	
WS - P0013	HV - S420A	Ball	V308	AA	50	Exposed	560	
WS - P0013	CV - S420A	Check	V619	AA	50	Exposed	560	
WS - P0013	PRV - S420A	Pressure Relief	V740	AA	75	Exposed	560	Pressure/Vacuum Relief
WS - P0013	HV - S420B	Ball	V308	AA	50	Exposed	560	
WS - P0013	HV - S420C	Ball	V308	AA	50	Exposed	560	
						Exposed	560	
WS - P0014	HV - S430A	Ball	V308	AA	50	Exposed	560	
WS - P0014	PRV - S430A	Pressure Relief	-	AA	20	Exposed	560	Skid Mounted
WS - P0014	CV - S430A	Check	V619	AA	20	Exposed	560	Skid Mounted
WS - P0014	PCV - S430A	Back Pressure	V717	AA	20	Exposed	560	Skid Mounted
WS - P0014	HV - S430B	Ball	V308	AA	50	Exposed	560	Skid Mounted
WS - P0014	HV - S430C	Ball	V308	AA	50	Exposed	560	Skid Mounted
WS - P0014	HV - S430D	Ball	V308	AA	50	Exposed	560	Skid Mounted
WS - P0014	HV - S430E	Ball	V307	AA	15	Exposed	560	Skid Mounted
WS - P0014	HV - S430F	Ball	V307	AA	20	Exposed	560	Skid Mounted
WS - P0014	HV - S430G	Ball	V307	AA	20	Exposed	560	Skid Mounted
WS - P0014	HV - S430H	Ball	V307	AA	20	Exposed	560	Skid Mounted
WS - P0014	HV - S430I	Ball	V307	AA	20	Exposed	560	Skid Mounted
WS - P0014	HV - S430J	Ball	V307	AA	20	Exposed	560	Skid Mounted
WS - P0014	HV - S440A	Ball	V307	AA	20	Exposed	560	Skid Mounted
WS - P0014	PRV - S440A	Pressure Relief	-	AA	20	Exposed	560	Skid Mounted
WS - P0014	CV - S440A	Check	V619	AA	20	Exposed	560	Skid Mounted
WS - P0014	PCV - S440A	Back Pressure	V717	AA	20	Exposed	560	Skid Mounted
WS - P0014	HV - S440B	Ball	V307	AA	20	Exposed	560	Skid Mounted
WS - P0014	HV - S440C	Ball	V307	AA	20	Exposed	560	Skid Mounted
WS - P0014	HV - S440D	Ball	V307	AA	20	Exposed	560	Skid Mounted
WS - P0014	HV - S440E	Ball	V307	AA	15	Exposed	560	Skid Mounted
WS - P0014	HV - S440F	Ball	V307	AA	20	Exposed	560	Skid Mounted
WS - P0014	HV - S440G	Ball	V307	AA	20	Exposed	560	Skid Mounted
WS - P0014	HV - S440H	Ball	V307	AA	20	Exposed	560	Skid Mounted
WS - P0014	HV - S440I	Ball	V307	AA	20	Exposed	560	Skid Mounted
WS - P0014	HV - S440J	Ball	V307	AA	20	Exposed	560	Skid Mounted

Note 1. All valves within vendor packages shall be supplied and installed by the Contractor

PIPING SPECIALTIES

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 ASME:

.1 B16.1, Cast Iron Pipe Flanges and Flanged Fittings.

.2 B16.5, Pipe Flanges and Flanged Fittings: NPS 12 mm through NPS 600 mm.

.2 AWWA:

.1 C153/A21.53, Ductile-Iron Compact Fittings, 76 mm through 1,600 mm, for Water Service.

.2 C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

.3 C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.

.4 C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.

.5 Manual M11, Steel Water Pipe—A Guide for Design and Installation.

.3 ASTM:

.1 A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.2 A276, Standard Specification for Stainless Steel Bars and Shapes.

.4 NFPA: 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

.5 NSF: NSF 61, Drinking Water System Components—Health Effects.

1.2 Submittals

.1 General:

.1 Provide coupling submittals separated in process areas as per drawing key plan with lists of quantities of each type of coupling in each area:

.1 F: Filtration area

.2 R: Residuals area

.3 O: Ozone area

.4 C: Chemical area

.5 P: DAF area

.6 A: Administration area

.7 M: Main electrical area

.8 I: Raw water pump station area

.9 Y: Yard piping chambers area

.2 Identify process area in the title of all submittal transmittals.

.2 Action Submittals: Manufacturer's data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).

.3 Informational Submittals:

.1 Coupling Harness:

.1 Details, ratings, calculations and test reports for thrust restraints relying on welded bars or rings.

.2 Weld procedure qualifications.

.3 Load proof-testing report of prototype restraint for any size coupling.

2. PRODUCTS

2.1 General

.1 Provide required piping specialty items, whether shown or not shown on Drawings, as required by applicable codes and standard industry practice.

.2 Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.

2.2 Connectors

.1 Flexible Metal Hose Connector:

.1 Type: Close pitch, annular corrugated with single braided jacket.

.2 Material: Bronze.

.3 End Connections: Female copper solder joint.

.4 Minimum Burst Pressure: 3,500 kPa at 21°C.

.5 Length: Minimum manufacturer recommendation for vibration isolation.

.6 Acceptable Manufacturers:

.1 Senior Flexonics.

.2 Anamet Industrial, Inc.

.3 Unisource Manufacturing, Inc.

.4 Proco Products, Inc.

2.3 Couplings

.1 General:

.1 Coupling linings for use in potable water systems shall be in conformance with NSF 61.

.2 Couplings shall be rated for working pressure not less than indicated in Piping Schedule, Section 15200-00S, for the service and not less than 1,035 kPa.

.3 Couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.

.4 Restrained Couplings: Unless thrust restraint is provided by other means, couplings shall be harnessed in accordance with requirements of AWWA Manual M11, and restrained with retainer bar or ring welded to pipe end, or as shown on Drawings.

.5 Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.

.2 Flexible Sleeve Type Coupling:

.1 Acceptable Manufacturers:

.1 Steel Pipe:

.1 Dresser Piping Specialties; Style 38

.2 Smith-Blair, Inc.; Style 411

.2 Ductile Iron Pipe:

.1 Dresser Piping Specialties; Style 253

.2 Smith-Blair, Inc.; Style 411

.3 Bolted Split Sleeve Type Coupling:

.1 Steel Pipe: Victaulic Depend-O-Lok, AWWA C221, EPDM elastomer, epoxy coated steel or 316 stainless steel wetted parts, restrained (FxF) or non-restrained coupling (FxE or ExE) as indicated on Drawings.

.2 Stainless Steel Air Pipe: Victaulic AirMaster Depend-O-Lok, AWWA C606, EPDM elastomer, 316 stainless steel parts, restrained (FxF) or non-restrained coupling (FxE or ExE) as indicated on Drawings.

.4 Transition Coupling for Steel Pipe:

.1 Acceptable Manufacturers:

.1 Dresser Piping Specialties; Style 162

.2 Smith-Blair, Inc.; Style 413

.5 Flanged Coupling Adapter:

.1 Acceptable Manufacturers:

.1 Steel Pipe:

.1 Dresser Piping Specialties; Style 128

.2 Smith-Blair, Inc.; Style 913

.2 Ductile Iron Pipe:

.1 Dresser Piping Specialties; Style 128

.2 Smith-Blair, Inc.; Style 912

.6 Restrained Flange Adapter:

.1 Pressure Rating:

.1 Minimum Working Pressure Rating: Not less than 1,035 kPa (150 psi).

.2 Safety Factor: Not less than two times working pressure and shall be supported by manufacturer’s proof testing.

.2 Thrust Restraint:

.1 Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.

.2 Products employing set screws that bear directly on pipe will not be acceptable.

.3 Acceptable Manufacturers:

.1 EBAA Iron Sales Co.; Mega-Flange, Victaulic Depend-O-Lok restrained FxF.

.7 Restrained Dismantling Joints:

.1 Pressure Rating:

.1 Minimum working pressure rating shall not be less than rating of the connecting flange.

.2 Proof testing shall conform to requirements of AWWA C219 for bolted couplings.

.2 Acceptable Manufacturers:

.1 Dresser Piping Specialties; Style 131

.2 Viking Johnson

.3 Victaulic, Style 44

2.4 Expansion Joints

.1 Elastomer Bellows:

.1 Type: Reinforced molded wide arch.

.2 End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with split galvanized steel retaining rings.

.3 Washers: Over retaining rings to help provide leak-proof joint under test pressure.

.4 Thrust Protection: Control rods to protect the bellows from overextension.

.5 Bellows Arch Lining: Buna-N, nitrile, or butyl.

.6 Rated Temperature: 250^{o}C.

.7 Rated Deflection and Pressure:

.1 Lateral Deflection: 19 mm, minimum.

.2 Burst Pressure: Four times the working pressure.

.3 Compression deflection and minimum working pressure as follows:

Size (mm)	Deflection (mm)	Pressure (kPa)
65 to 300	26.9	1,035
350	41.9	900
400 to 500	41.9	750

.8 Acceptable Manufacturers:

.1 General Rubber Corp.; Style 1015 Maxijoint**.**

.2 Mercer; Flexmore Style 450.

.3 Goodall Rubber Co.; Specification E-711.

.4 Unisource Manufacturing, Inc.; Series 1500.

.5 Proco Products, Inc.; Series 251.

.2 Teflon Bellows:

.1 Type: Three convolutions, with metal reinforcing bands.

.2 Flanges: Ductile iron, drilled 1,035 kPa ASME B16.5 standard.

.3 Working Pressure Rating: 700 kPa, minimum, at 49^{o}C.

.4 Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.

.5 Acceptable Manufacturers:

.1 Garlock; Style 215

.2 Resistoflex; No. R6905

.3 Unisource Manufacturing, Inc.; Style 113

.4 Proco Products, Inc; Series 443

.3 Metal Bellows for Compressor Pressurized Air Piping (PA) and Air Scour Piping (AS):

.1 Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.

.2 Material: Type 316 stainless steel.

.3 End Connections: ASME 150-pound carbon steel flanges.

.4 Minimum Design Working Pressure: 345 kPa at 200°C.

.5 Length: Minimum of twelve (12) convolutions and minimum manufacturer recommendation for vibration isolation.

.6 Rated minimum deflections:

.1 Axial: 50 mm

.2 Lateral: 15 mm

.3 Angular: 10 degrees

.7 Acceptable Manufacturers:

.1 Hyspan Precision Products, Inc.; Series 1500.

.2 Pathway Bellows, Inc.; Style CT.

.3 Senior Flexonics; Style MCB.

.4 Copper Pipe Expansion Compensator:

.1 Material: Stainless steel bellows with female copper solder joint ends.

.2 Working Pressure Rating: 1200 kPa, minimum.

.3 Accessories: Anti-torque device to protect bellows.

.4 Acceptable Manufacturers:

.1 Senior Flexonics; Model HB

.2 Hyspan; Model 8510

.3 Unisource Manufacturing, Inc.; Style EC-FFS

.5 Galvanized and Black Steel Pipe Expansion Compensator:

.1 Material: Carbon steel with stainless steel bellows

.2 Working Pressure Rating: 1200 kPa, minimum

.3 Accessories: Anti-torque device to protect bellows

.4 Acceptable Manufacturers:

.1 Senior Flexonics; Model H

.2 Hyspan; Model 8503

.3 Unisource Manufacturing, Inc.; Style EC-MMT

.6 Flexible Metal Hose:

.1 Type: Close pitch, annular corrugated with single braided jacket.

.2 Material: Stainless steel, ASTM A276, Type 321.

.3 End Connections:

.1 75 mm and Larger: Shop fabricated flanged ends to match mating flanges.

.2 65 mm and Smaller: Screwed ends with one union end.

.4 Minimum Burst Pressure: 4150 kPa at 21^{o}C for 300 mm and smaller.

.5 Length: Provide hose live-length equal to lengths shown on Drawings.

.6 Manufacturer:

.1 Senior Flexonics; Series 401M

.2 Anamet Industrial, Inc.; BWC21-1

2.5 Service Saddles

.1 Double-Strap Iron:

.1 Pressure Rating: Capable of withstanding 1,035 kPa internal pressure without leakage or over stressing.

.2 Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.

.3 Taps: Iron pipe threads.

.4 Materials:

.1 Body: Malleable or ductile iron.

.2 Straps: Galvanized steel.

.3 Hex Nuts and Washers: Steel.

.5 Seal: Rubber.

.1 Acceptable Manufacturers:

.2 Smith-Blair; Series 313 or 366.

.3 Dresser; Style 91.

.4 Nylon-Coated Iron:

.6 Pressure Rating: Capable of withstanding 1035 kPa internal pressure without leakage or over stressing.

.7 Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.

.8 Materials:

.1 Body: Nylon-coated iron

.2 Seal: Buna-N

.3 Clamps and Nuts: Stainless steel

.9 Manufacturer: Smith-Blair; Style 315 or 317.

2.6 Modular Mechanical Seal:

.1 Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.

.2 Fabrication:

.1 Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.

.2 Pressure plates shall be reinforced nylon polymer.

.3 Size: According to manufacturer's instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening.

.3 Manufacturer: Thunderline Corp., Link-Seal Division.

3. EXECUTION

3.1 General

.1 Provide accessibility to piping specialties for control and maintenance.

3.2 Piping Flexibility Provisions

.1 General:

.1 Thrust restraint shall be provided as specified in Section 15200-000 – Process Piping.

.2 Install flexible couplings to facilitate piping installation, in accordance with approved shop drawings.

.2 Flexible Joints at Concrete Backfill or Encasement: Install within 450 mm or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.

.3 Flexible Joints at Concrete Structures:

.1 Install 450 mm or less from face of structures; joint may be flush with face.

.2 Install a second flexible joint, whether or not shown:

.1 Pipe Diameter 450 mm and Smaller: Within 450 mm of first joint.

.2 Pipe Diameter Larger than 450 mm: Within one pipe diameter of first joint.

.3 Flexible expansion joints shall be provided to compensate for earth settlement at buried piping connections to structure wall pipes.

.4 Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.

.5 Expansion Joints:

.1 Grooved Joint and Flanged Piping Systems: Elastomer bellows expansion joint.

.2 Nonmetallic Pipe: Teflon bellows expansion joint.

.3 Screwed and Soldered Piping Systems: Copper or galvanized and black steel pipe expansion compensator, as applicable.

.4 Air and Water Service above 49^{o}C: Metal bellows expansion joint.

.5 Pipe Run Offset: Flexible metal hose.

3.3 Service Saddles

.1 Ferrous Metal Piping (except stainless steel): Double-strap iron.

.2 Plastic Piping: Nylon-coated iron.

3.4 Couplings

.1 General:

.1 Install in accordance with manufacturer's written instructions.

.2 Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.

.3 Application:

.1 Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.

.2 Concrete Encased Couplings: Flexible coupling.

3.5 Flexible Pipe Connections to Equipment

.1 Install to prevent piping from being supported by equipment, for vibration isolation, and where shown.

.2 Product Applications Unless Shown Otherwise:

.1 Nonmetallic Piping: Teflon bellows connector.

.2 Copper Piping: Flexible metal hose connector.

.3 Compressor Discharge: Metal bellows connector.

.4 Blower Suction and Discharge: Elastomer bellows connector (Vendor Package).

.5 All Other Piping: Elastomer bellows connector.

.3 Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

END OF SECTION

AIR COMPRESSORS

1. GENERAL

1.1 Scope

.1 Oil free scroll air compressors.

.2 Air receiver and accessories.

.3 Aftercooler.

.4 Desiccant air dryer.

.5 Pressure reducing station.

.6 Condensate trap.

.7 Filters.

.8 Controls.

1.2 Quality Assurance

.1 Ensure compressors operate at specified air volume without oil creep, are non-overloading and operate within 10% of peak efficiency.

.2 Air receivers shall meet requirements of ASME Code for Unfired Pressure Vessels and carry ASME approval stamp.

1.3 Submittals

.1 Submit provincial inspector's certificate for air receiver for inclusion in O&M Manuals.

.2 Submit full shop drawings for all equipment and accessories in this Section.

2. PRODUCTS

2.1 Oilless Scroll Compressor

.1 Supply and Install duplex scroll oil free compressor unit consisting of air cooled motor-compressors, aftercooler, sound enclosure and operating controls.

.2 General:

.1 The scroll compressors shall be mounted inside a rigid steel enclosure. The enclosure shall have a powder coated finish, and shall acoustically insulation. Noise levels shall not exceed 58 dBa with all compressor units in operation. System shall include a solid state controller to operate the necessary compressor to maintain the pressure requirement.

.3 Oilless Scroll Compressor:

.1 The compressors shall be belt driven oilless rotary scroll, single stage, air-cooled contruction with absolutely no oil needed for operation. The rotary design shall not require any inlet or exhaust valves and shall be rated for 100% continuous duty. Direct drive compressors shall not be used. Tip seals shall be composite PTFE material and be rated for 10,000 hours operation. Compressor bearings shall be external to the air compression chamber and shall be serviceable from extended compressor life. Bearing maintenance shall not be required until 10,000 run hours. Compressors with bearings that are not accessible for service shall not be accepted. Compressors shall have an integral radial flow fan for cooling and shall require any additional electric cooling fans. Each compressor shall have flexible connectors on intake and discharge and air-cooled aftercooler.

.4 Air-Cooled Aftercooler:

.1 Each compressor shall come complete with air-cooled aftercoolers and shall be sized to provide an approach temperature of 11°C (20°F). Each unit shall be constructed of copper tubing with metal headers and shall be mounted integral to the compressor enclosure.

.5 Controls:

.1 Each compressor assembly shall be supplied with full voltage motor starter with overload protection and shall sequenced with the logic regulator controller with digital display. Unit controller shall display the compressor running status, unit run hours and system pressure. Alarm mode shall indicate high temperature shutdown status, high current draw and failure of temperature switch. Service mode shall inform user when scheduled maintenance interval is reached. Set mode shall allow user to adjust selected parameters of the operational mode such as start/stop pressures. Compressors shall be sequenced on and off based on the air demand of the system.

.2 Supply and install a control panel with system to maintain the air net pressure and to sequence the compressor assemblies.

.3 Refer to P&ID drawing WS-H0521 and Division 17 for system interface requirements.

2.2 Desiccant Air Dryer

.1 Desiccant air dryer to be self-contained complete with desiccant media, automatic controls, moisture removal trap and internal wiring.

.2 Air inlet and air outlet connections to be at same level and factory insulated.

.3 Desiccant air dryer to operate continuously to maintain specified -20°C (-4p°F) dew point. House unit in steel cabinet shall come complete with an access door and panel for maintenance and inspection.

.4 Dryer shall come complete with an air inlet temperature gauge, air inlet pressure gauge, on/off switch, high temperature light, power on light, air outlet temperature gauge, air outlet pressure gauge, coalescing filters.

2.3 Air Receiver

.1 Supply and install vertical receiver built to ASME pressure vessel code section VIII, division 1 for Maximum working pressure of 1,380 kPa (200 psi) at 205°C (400°F). Screw inlet and outlet connections.

.2 Fittings shall include safety valve, pressure gauge, drain cock and automatic condensate trap.

.3 Tank finish shall be shop primed.

2.4 Pressure Reducing Valve

.1 Supply and Install pressure reducing stations complete with automatic reducing valve and bypass, and low pressure side relief valve and gauge.

.2 Valve capacity shall be as noted on drawings suitable to reduce pressure from 1380 kPa to 210 kPa (200 psi to 30 psi). PRV to be adjustable upwards from reduced pressure.

2.5 Condensate Trap

.1 Condensate drain trap shall be of the float type with NPT connections. Body material shall be ductile iron. Valve mechanism shall be stainless steel with viton valve head designed to retain a water seal at all times. All internals are to be renewable and filed serviceable without disturbing the piping connections.

.2 Standard of Acceptance: Spirax Sarco CA14.

3. EXECUTION

3.1 Installation

.1 Supply and Install air cock and drain connection on horizontal casing.

.2 Connect condensate drains to nearest floor drain. Supply and Install isolation ball valve and strainer upstream of condensate trap.

.3 Install valved bypass around air dryer. Factory insulate inlet and outlet connections.

.4 Supply and Install valved drip connections at low points of piping system.

.5 Install take-offs to outlets from top of main, with shut-off valve after take-off.

.6 Supply and install compressed air couplings, 25 mm female speed couplers where outlets are indicated.

3.2 Performance

.1 Refer to 15999 – List of Schedules.

END OF SECTION

PLUMBING FIXTURES AND TRIM

1. GENERAL

1.1 Scope of Work

.1 Supply and install plumbing fixtures.

1.2 References

.1 The following is a list of standards which may be referenced in this Section:

.1 Canadian Gas Association (CGA).

.2 ASME

.3 CSA

.4 ULC

.5 UL

.6 ASSE: 1010, Performance Requirements for Water Hammer Arresters.

.7 Plumbing and Drainage Institute:

.1 Code Guide 302 and Glossary of Industry Terms.

.2 WH-201, Water Hammer Arrester Standard.

1.3 Submittals

.1 Action Submittals:

.1 Shop Drawings: catalogue information and rough-in dimensions for plumbing fixtures, products, and specialties.

1.4 Regulatory Requirements

.1 Comply with the Plumbing Code and the requirements of provincial and local authorities having jurisdiction.

2. PRODUCTS

2.1 General

.1 Fixture Trim: supply and install plumbing fixture trim where applicable on fixtures.

.2 Plumbing Fixtures: indicated by fixture number as shown on Drawings.

.3 Drainage Products: indicated by fixture number as shown on Drawings.

.4 Plumbing Specialties: indicated by fixture number as shown on Drawings.

.5 Exposed fixture connections and piping shall be polished chrome-plated.

2.2 Fixture Trim:

.1 Supply Stop:

.1 Flexible supply with heavy cast brass, loose key, 15 mm IPS by 10 mm OD tubing angle stop to wall with canopy flange; chrome-plated finish.

.2 Provide stop with stuffing box.

.3 Acceptable Manufacturers: McGuire, American Standard, Kohler.

.2 Trap:

.1 Chrome-plated, 1.4 mm thick (17-gauge), semicast P-trap with compression ring cast brass waste and vent connection and cleanout.

.2 40 mm for lavatories and drinking fountains.

.3 40 mm for sinks.

.4 Accepted Manufacturers: McGuire, American Standard, Kohler.

2.3 Lavatories

.1 L-1, Lavatory (Wall Hung, Stainless Steel):

.1 Fixture: 469 mm x 483 mm, 18-gauge Type 304 stainless steel, seamless welded construction with integral backsplash and apron, underside sound deadened, wall clip with integral flange, three-hole punched on 100 mm centers for faucet. Aristaline; Model WHB1819.

.2 Faucet: Chicago Faucet Co., Model 2200 with 0.03 L/s flow restrictor; American Standard.

.3 Trim: McGuire H165LKN3RB 10 mm supply stop with loose key, McGuire 8872C-17T 17-gauge, chrome-plated cast brass P-trap.

.4 Strainer: McGuire Manufacturing Company, Inc.; Model 155A chrome-plated grid strainer with tailpiece.

.5 Carrier: Smith, Series 0800-M2P.

.2 Accepted Manufacturers:

.1 Faucet Fittings: Chicago, American Standard

.2 Lavatories: Chicago, American Standard, Symmons

2.4 Water Closets

.1 WC-1, Water Closet:

.1 Ultra-Low Flush (6 LPF), vitreous china, siphon jet, whirlpool action, fully glazed trapway, close coupled closet combination with elongated rim bowl, self draining jets, bolt caps and insulated vitreous china closet tank complete with fittings. Tank lid shall be secured to tank by bolting down or other approved method.

.1 Standard of Acceptance:

.1 American Standard, Cadet PA.

.2 Crane, Cranada Pro II ULF.

.2 Seat: White with open front, with cover.

.1 Accepted Manufacturers: Centoco 820 STS, Bemis, Olsonite

.3 Provide hand-operated supply shut off valve complete with escutcheon.

2.5 Safety Equipment:

.1 Emergency showers, eyewashes and other similar safety equipment shall be certified by CSA to meet the ANSI Z358.1 Standard for Emergency Eyewash and Shower Equipment.

.2 Emergency Shower/Eyewash Combination, Exterior Enclosed (EES-S750A, EES-S751A):

.1 Provide an insulated all-weather booth with an integral hot water supply and tempered blending system. All tempered water systems incorporate fail-safe features, including anti-scald protection and full flow cold water bypass.

.2 Enclosure Booth: exterior and interior FRP skins with 38 mm (1.5 in) flame retardant insulation to give an appropriate value of RSI 1.9 (R11). Protected with UV inhibitors, the exterior resin skin is bright yellow with Safety Green graphics. Large graphics identify the booth as an emergency shower/eyewash station and assist in guiding the user to the double swing doors. Interior space is heated and illuminated to provide for safe user comfort.

.1 Shower Area: 1500 x 1200.

.2 Floor Grate: fibreglass.

.3 Doors: dual spring-loaded, self-closing with clear 200 mm x 300 mm Lexan windows.

.3 Multiple Drench System:

.1 Shower: 250mm ABS plastic showerhead with integral 1.26 L/s (20 USgpm) flow control in Safety Green.

.2 Eye/Face Wash: 0.32 L/s (5 USgpm) ABS plastic head.

.3 Drench Hose: 0.25 L/s (4 USgpm) hose with flag and ball valve.

.4 Alarm System: standard alarm system is flow switch activated, and provides local audible and visible alarms with dry hermetic relay contacts for remote alarm hook up. System includes silencing circuit with auto reset. Area light flashes and alarm sounds upon activation.

.5 Flow Switch: DPDT, alarm activation at 0.14 L/s (2.2 USgpm).

.6 Water Heater Tank: 119 USgal capacity, 4.0 Kw, 240 Vac copper immersion heater. Dual element thermostat with manual reset hi-limit protection. Tank shall be insulated and jacketed.

.7 Space Heater: Natural convection 2.5 kW.

.8 Lights: 100 Watt, interior clear and exterior green (normally on).

.4 Plumbing

.1 Schedule 40 galvanized piping with brass and stainless steel valves.

.2 Supply: 30 mm IPS.

.3 Waste: 75 mm Caulk.

.5 Tempering System

.1 Tempering system shall provide enough tempered water to for a single 1.26 L/s (20 USgpm) shower for 15 minutes at 25°C (77°F). Recovery time of up to 7 hours.

.6 Electrical System

.1 Standard system requires 208-240/120 VAC, single phase, 3 wire and ground.

.2 NEMA 4 water/dust tight.

.7 Standard of Acceptance: Haws Model 8710 Polar Booth Series.

.3 Emergency Shower/Eyewash Combination, Indoor (EES-S752A, EES-S754A, EES-S755A, EES-S757A):

.1 Shower: 250mm ABS plastic deluge showerhead.

.2 Eyewash: Stainless steel bowl with aerated eye/face wash. Stainless steel dust cover.

.3 Valves: chrome-plated brass stay open ball valve complete with stainless steel ball and stem.

.4 Support: Freestanding, 30 mm galvanized pipe standard, stanchion, and floor flange.

.5 Alarms: Magnetically operated proximity switches.

.6 Standard of Acceptance: Haws; Model 8346.

.4 Emergency Shower, Exterior (ES-S758A, ES-759A)

.1 Freeze-resistant wall-mounted drench shower complete round 250 mm ABS showerhead and stay-open ball valve with extended valve stem activated by a push flag. Shower head shall be capable of providing 76 LPM (20 USgpm) of 25°C (77°F) of tempered water when pressure is between 200 kPa (30 psi) and 620 kPa (90 psi). Ball valve shall be installed on warm side of building envelope to allow for year-round operation. Supply: 25 mm IPS.

.2 Standard of Acceptance: Haws Model 8111FP.

.5 Emergency Eyewash, Exterior (EEW-S758A, EEW–S759A)

.1 Freeze-proof wall-mounted eyewash complete with round 275 mm stainless steel receptor, aluminum wall bracket, and twin ABS plastic anti-surge soft-flow eyewash heads capable of providing 4.5 LPM (1.2 USgpm) of 25°C (77°F) of tempered water when pressure is between 200 kPa (30 psi) and 620 kPa (90 psi). Supply with ball valve with extended valve stem and self-draining valve installed in warm side of building envelope to allow for year-round operation. Supply: 15 mm IPS; Waste: 30 mm IPS.

.2 Standard of Acceptance: Haws Model 7433FP.

.6 Emergency Eyewash, Interior Portable (EEW-H831A)

.1 Gravity-operated eyewash complete with a 60 L capacity FDA high-density green polyethylene tank, yellow pull-down activation arm, threaded wide fill opening and cap, wall bracket and one (1) bottle of bacteriostatic additive to permit storage of water for up to six (6) months. Unit shall provide full pattern flushing at 1.5 L/min for over 15 minutes.

.2 Standard of Acceptance: Haws Model 7500.

.7 Tempering (Mixing) Valve (MV):

.1 Materials: 2.5 L/s (40 USgpm) maximum flowrate.

.2 Inlet and Outlet: 30 mm IPS.

.3 Max Inlet Pressure: 862 kPa (125 psi).

.4 Max Inlet Temperature: 82°C (180°F).

.5 Outlet Temperature: 26°C (79°F).

.6 Constructed of bronze, brass, copper, and stainless steel.

.7 Standard of Acceptance: Haws Model 9202, Western.

.8 Flow Switch for Safety Shower (FS):

.1 General

.1 Function: Sense fluid flow in the pipeline and switch a set of contacts when the flow is positive.

.2 Type: Paddle flow sensor with magnetically coupled switch.

.3 Parts: Unitized assembly by paddle type flow sensor and switch.

.2 Performance

.1 Actuating Flow rate: 0.25 L/s

.2 Maximum Temperature operating: 105°C

.3 Maximum Pressure Rating: 1724 kPa

.3 Process Connections: A 30 mm brass tee

.4 Signal Interface

.1 Output: Single-pole, double-throw (SPDT) switch

.2 Contact: 120 VAC, 5 amps resistive, continuous

.5 Element: Paddle type, size to suit 32 mm pipe, stainless steel wetted parts.

.6 Lower Housing: Brass

.7 Accepted Manufacturers: W. A. Anderson Model V6, MacDonnell.

2.6 Cleanouts

.1 CO, Floor Cleanout (Finished Areas):

.1 Service: floor drainage system – tiled floor

.2 Material: tapered thread, bronze plug with round adjustable scoriated secured nickel bronze top

.3 Manufacturer and Product: Zurn Model ZN1400-NH-HD or Jay R. Smith Mfg. Co.; Model 4103S

.2 CO, Floor Cleanout (Unfinished Areas):

.1 Service: floor drainage system – exposed concrete

.2 Material: tapered thread, bronze plug with round adjustable scoriated secured cast iron top

.3 Manufacturer and Product: Zurn Model Z-1406 or Jay R. Smith Mfg. Co.; Model 4243S

.3 CO, Wall Cleanout:

.1 Material: Stainless steel cover and screw.

.2 Manufacturer and Product: Jay R. Smith Mfg. Co.; Model 4472.

.4 Accepted Manufacturers: Ancon, PPP, Smith, Zurn.

2.7 Floor Drains

.1 FD-1, Floor Drain (Unfinished Areas, General Drainage):

.1 Materials: Dura-coated cast iron body and grate.

.2 305 mm round grate, sediment bucket

.3 Manufacturer and Product: Zurn Model Z415N-P

.2 FD-2, Floor Drain (Finished Areas):

.1 Materials: Dura-coated cast iron body, 134 mm round adjustable nickel bronze strainer, membrane clamp, trap primer connection.

.2 Manufacturer and Product: Zurn Model Z415B-P

.3 FD-3, Floor Drain:

.1 Materials: Dura-coated galvanized cast iron body with white acid-resistant Dura-coated interior complete with adjustable strainer extension, nickel bronze flushing rim top and recessed hinged grate, primer connection.

.2 Manufacturer and Product: Zurn Model Z320.

.4 FFD-1, Funnel Floor Drain:

.1 Materials: cast iron body and nickel bronze grate

.2 Option: oval funnel

.3 Manufacturers: Zurn ZN415-BF-P or Jay R. Smith Mfg. Co., Model 3510 F19-B-P

.5 HD-1, Hub Drain:

.1 Coated cast iron reducing hub adapter with standard cast iron hub

.2 Hub: Two pipe sizes larger than outlet

.3 Manufacturer and Product: Zurn Model Z-415-S-P

.6 Floor Drain Traps:

.1 Supply and install Dura-coated cast iron traps with floor drain fixtures, complete with trap primer connection, as required, Zurn Z1000.

.7 Accepted Manufacturers: Ancon, PPP, Smith, Zurn.

2.8 Roof Drains

.1 RD-1, Roof Drain:

.1 Materials: Cast iron body with combined flashing clamp and gravel stop, and aluminum dome.

.2 Options: Extension collar, sump receiver, underdeck clamp.

.2 Accepted Manufacturers: Smith Model 1010Y-E-R-C, Zurn, Ancon

2.9 Specialties:

.1 HB-1, Hose Bibb:

.1 Material: 20 mm exposed, rough-bronze wall faucet complete with anti-siphon external vacuum breaker, all bronze interior components, vandal-resistant operating stem.

.2 Accepted Manufacturers: Zurn Model Z1341, PPP, Smith, Mifab.

.2 WH-1, Wall Hydrant:

.1 Material: 20 mm bronze encased anti-siphon, automatic draining wall hydrant for flush installation complete with non-freeze integral backflow preventer, copper casing, all-bronze interior parts with ½ turn ceramic disk cartridge, female NPT connection cylinder lock and wall clamp.

.2 Accepted Manufacturer: Zurn Model Z1320, PPP, Smith, Mifab.

.3 Shock Arresters:

.1 Materials: ASSE 1010 certified, Type L copper tube, piston with 2 lubricated EPDM O-rings, FDA approved lubricant, rolled piston stop, wrought copper male thread adapter.

.2 Acceptable Manufacturers:

.1 Sioux Chief Mfg. Co., Inc.; Series 650 and 660

.2 Smith

.3 Precision Plumbing Products

.4 TPD-1, Automatic Trap Priming System:

.1 Materials: Preset 24-hour clock, manual override switch, solenoid valve, 20 mm connection, calibrated water distribution manifold, water hammer arrestor, vacuum breaker, and cabinet.

.2 Power: 120 V, single-phase.

.3 Acceptable Manufacturers: PPP Model PTS, Smith, Zurn.

.5 Pressure/Temperature Relief Valve:

.1 Materials: ASME/AGA rated, bronze body construction, vacuum relief valve vent in drain, backup emergency safety fuse plug, tamper-resistant bonnet screws, test lever, short thermostat, and automatic reseating.

.2 Acceptable Manufacturers:

.1 Watts Industries, Inc.; Series 40

.2 Cash-Acme

.3 Kunkle Valve

.6 Pressure Gauge:

.1 Materials: 90 mm gauge size, 0 to 1100 kPa range, steel case, glass crystal, brass movement, and 8.5 mm NPT lower connection.

.2 Acceptable Manufacturers:

.1 Ashcroft Dresser Instrument Division, Dresser Industries, Inc.; Type 1008

.2 Marsh

.3 Marshalltown

.7 Thermometer:

.1 Materials: Adjustable angle, bi-metal type, 114 mm dial, 0 to 85°C range, 90 mm aluminum stem, and separate NPT brass thermowell.

.2 Acceptable Manufacturers:

.1 H.O. Trerice Co.; Model 80742

.2 Weksler

.8 Flow Switch for Pumps:

.1 General

.1 Function: Sense fluid flow in the pipeline and switch a set of contacts when the flow is positive.

.2 Type: Paddle flow sensor with magnetically coupled switch.

.3 Parts: Unitized assembly by paddle type flow sensor and switch.

.2 Performance

.1 Actuating Flow rate: 0.75 L/s

.2 Maximum Temperature operating: 135°C

.3 Maximum Pressure Rating: 1724 kPa

.3 Process Connections: A 40 mm threadolet

.4 Signal Interface

.1 Output: SPDT switch

.2 Contact: 120 VAC, 5 amps resistive, continuous

.5 Element: Paddle type, size to suit 100 mm pipe, stainless steel wetted parts.

.6 Lower Housing: Stainless steel

.7 Manufacturer

.1 W. A. Anderson: Model V4

.2 MacDonnell

3. EXECUTION

3.1 Preparation

.1 Drawings do not attempt to show exact details of fixtures. Where diagrams show fixture locations, Contractor is cautioned that these diagrams must not be used for obtaining material quantities. Changes in locations of fixtures, advisable in opinion of Contractor, shall be submitted to Contract Administrator for review before proceeding with the Work.

3.2 Installation

.1 Fixture Trim: install fixture trim where applicable on fixtures.

.2 Plumbing Fixtures, Mounting Heights:

.1 Standard rough-in catalogued heights, unless shown otherwise on Drawings.

.2 Caulk fixtures in contact with finished walls with waterproof, white, nonhardening silicone sealant which will not crack, shrink, or change colour with age, GE Silicones or accepted equivalent.

.3 Exact fixture location and mounting arrangement shall be as indicated on toilet room elevations and details as shown on Drawings.

.4 Unless noted otherwise and as a minimum, fixtures shall be supported as indicated in PDI Code Guide 302.

.5 Safety Equipment:

.1 System Shutoff Valves:

.1 Shutoff valves shall give visual indication of position (open or closed).

.2 Shutoff valves shall be lockable valves and locked in open position.

.2 Each safety shower, eyewash, combination safety shower/eyewash shall have red safety signoff tag. After completing requirements listed below, Contractor and the City shall sign red safety signoff tag. Requirements are as follows:

.1 Visually check safety shower/eyewash piping for leaks.

.2 Verify that upon operation, stay-open valves remain open.

.3 Shower heads to be between 2.1 m and 2.5 m above standing surface.

.4 Shower spray pattern, when valve is full open, shall be a minimum 500 mm in diameter at 1500 mm above standing surface.

.5 Water arcs from eyewash spray heads must cross. Test with eyewash gauge; Haws, Model 9015.

.6 Minimum flow rates for safety showers shall be 2 L/s.

.7 Minimum flow rates for eyewashes shall be 0.2 L/s.

.8 Tempered water shall be temperature indicated on Drawings.

.6 Drainage Products:

.1 Floor Drains: set top flush with floor. Supply and install membrane clamps where required.

.2 Cleanouts: install where shown or required for purposes intended. Set cover flush with finished floor.

.7 Plumbing Specialties:

.1 Hose Bibbs and Wall Hydrants: Mount 600 mm above finished floor or grade, unless indicated otherwise on Drawings.

.2 Shock Arresters: Install PDI-certified and rated shock arresters, sized and located in accordance with PDI WH-201 and as shown on Drawings. Shock arresters to have access panels or to be otherwise accessible.

.3 Trap Priming Valves:

.1 Floor drain traps primed with priming valves, 12 mm copper to floor drain.

.2 Two traps maximum primed from one priming valve or as recommended by manufacturer. Locate in mechanical spaces or janitor's rooms and as indicated on Drawings.

.3 Provide shutoff valve ahead of priming valves.

.4 Thermometers and Pressure Gauges:

.1 Arrange devices to facilitate use and observation.

.2 Install in orientation that will allow clear observation from ground level.

.3 Supply and install pressure gauges with block valves.

.4 Install thermometers in thermowells.

.8 Caulk penetrations of exterior walls with weatherproof sealant.

.9 Adjust water flows in domestic water systems for reasonable water flows at each plumbing fixture, terminal device, and recirculation loop. Flush valve fixtures shall be adjusted for proper flush cycle time and water quantity.

3.3 Field Quality Control

.1 Perform visual inspection for physical damage, blocked access, cleanliness, and missing items.

.2 Cover concealed or insulated work only after testing has been successfully completed.

.3 Notify Contract Administrator forty eight (48) hours prior to shower testing. Contract Administrator reserves the right to witness all tempered water and safety shower testing.

.4 Test safety shower and eyewash units. Water flow must be tested at both showerhead and eyewash/face ring.

.1 Shower Flow:

.1 Test with tube-type water gauge (Haws, Model 9010) and 20 L container.

.2 Container shall fill in 10 seconds or less, with a minimum 2 L/s flow.

.2 Eyewash Flow:

.1 Test with tube-type water gauge (Haws, Model 9010) and 4 L container.

.2 Container shall fill in 20 seconds or less.

.3 Contractor shall log, date, and initial inspection upon passing flow tests.

.5 Verify alarm operation both locally and system wide. Notify security prior to test if alarm is connected system wide.

END OF SECTION

PLUMBING EQUIPMENT

1. GENERAL

1.1 Section Includes

.1 This Section specifies the supply, factory testing, delivery, and supervision of installation, testing and performance verification of plumbing equipment.

1.2 Reference Standards

.1 The following is a list of standards which may be referenced in this Section:

.1 Provincial Plumbing Code and the requirements of local authorities having jurisdiction.

.2 Canadian Gas Association (CGA).

.3 CSA/CSA Label on Fixtures and Equipment.

.4 ASHRAE: 90.1, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.

.5 ASME: Boiler and Pressure Vessel Code SEC VIII, D1, Rules for Construction of Pressure Vessels.

.6 ASTM:

.1 A48, Standard Specification for Gray Iron Castings.

.2 A48, Gray Iron Castings

.3 A108, Steel Bars, Carbon Cold Finishes, Standard Quality

.4 A276, Stainless Steel and Heat-Resisting Steel Bars and Shapes

.5 A532, Abrasion Resistant Cast Iron

.6 D4101, Specification for Polypropylene Injection and Extrusion Materials.

.7 AWWA:

.1 C510, Double Check Valve Backflow Prevention Assembly.

.2 C511, Reduced-Pressure Principle Backflow Prevention Assembly.

.3 C550, Protective Epoxy Interior Coatings for Valves and Hydrants.

.8 CSA:

.1 B64.4, Backflow Preventers, Reduced Pressure Principle Type (RP).

.2 B64.5, Backflow Preventers, Double Check Valve Type (DCVA).

.3 C22.1 Canadian Electrical Code, Safety Standard for Electrical Safety Installations

.9 Factory Mutual Engineering and Research Corporation.

.10 NEC.

.11 NEMA: MG 1, Motors and Generators.

.12 NSF.

.13 UL.

.14 ULC.

.15 Hydraulic Institute Standards, Standards of the Hydraulic Institute, 14th Edition

1.3 Design

.1 Design and select plumbing equipment specifically with high efficiency, low energy consumption and innovative technology.

.2 Supply and install totally enclosed fan-cooled type electric motors unless noted otherwise.

1.4 Shop Drawings

.1 Action Submittals: Shop Drawings:

.1 Complete specifications, descriptive drawings, catalog cuts, and descriptive literature that include make, model, capacity, pump curves, dimensions, weight of equipment, and electrical schematics for products specified.

.2 Recommended procedures for protection and handling of equipment and materials prior to installation.

.3 Installation instructions.

.4 Special tools.

.2 Informational Submittals:

.1 O&M Data: As specified in Section 01730 – Operation and Maintenance Manuals.

.2 Complete description of operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogues with complete list of repair and replacement parts with section

drawings, illustrating the connections and the part Manufacturer's identifying numbers.

.3 Certificate of Satisfactory Installation, Form 102, as indicated in Section 01650 – Equipment Installation.

2. PRODUCTS

2.1 Domestic Water Booster Pump System

.1 General: complete packaged triplex (2 duty, 1 standby) booster pump system, including pumps, hydromatic tank, controls, control panel, piping, valves, and appurtenances, factory assembled, skid mounted, prewired, and tested.

.2 Pumps: end suction, closed coupled vertical in-line centrifugal.

.3 Hydromatic Tank:

.1 Prepressurized diaphragm type per data sheet at end of section.

.2 Shell: welded steel, ASME rated and stamped.

.3 Diaphragm: FDA approved, replaceable heavy-duty butyl with polypropylene liner with complete separation between water and shell.

.4 Maximum Operating Pressure: 862 kPa (125 psi).

.5 Maximum Operating Temperature: 52°C (125°F).

.6 Finish: Manufacturer’s standard air-dry enamel.

.7 Accessories: Supports, bladder access flange, drain, air-charging valve, and lifting lug.

.4 Piping:

.1 Material: Schedule 40 stainless steel.

.2 Fittings: Screwed or flanged for 50 mm and smaller, flanged and welded for 65 mm and larger.

.3 Gasket Material: Free from corrosive alkali or acid ingredients and suitable for use in potable water lines.

.4 Isolation Valves: Full port ball or butterfly type.

.5 Pump Check Valves: Combination pressure-reducing and nonslam type, epoxy coated, field adjustable pressure setting.

.6 Pressure Gauges: 115 mm dial, 2 percent accuracy, stainless steel bourdon tube with snubber and gauge cock valve.

.7 Flow Gauge: Pipeline-mounted flow sensor with visual indication.

.5 Controls:

.1 Control Panel: UL listed, NEMA 4 enclosure, single point electrical connection.

.2 Starter: Magnetic, across the line with thermal overload.

.3 Control Switch: ON/OFF/AUTO switch for each pump with indicating lights.

.4 Alarms: Audio and visual as well as auxiliary contacts to Building Automation System as indicated on system schematic.

.5 Pump Alternation: Automatic lead/lag control based on pressure transducer, including automatic transfer on pump failure.

.6 Safety Controls: Thermal resets, low-suction pressure cutout.

.7 Flow Sequencing: Automatic, 5-step control.

.8 Pressure Monitoring and Control System: Completely redundant for failure of primary system.

.6 Capacity: refer to Booster Pump Schedule in Section 15999, List of Schedules.

.7 Accepted Manufacturers: S.A. Armstrong, Bell & Gossett, Paco Pumps.

2.2 Backflow Preventers

.1 Reduced Pressure Backflow Preventers (65 mm through 250 mm):

.1 Description:

.1 Regulatory Compliance: AWWA C511, CSA B64.4, FCCHR of USC Section 10, ASSE 1013.

.2 Valve Body: Ductile or cast iron, Class 125, epoxy-coated (FDA approved).

.3 End Connections: flanged.

.4 Maximum Working Pressure: 1207 kPa (2413 kPa test).

.5 Temperature Range: 0 to 60^{o}C.

.6 Shutoff Valves: non-rising stem, resilient seated gate valves with bronze ball valve test cock.

.7 Inlet Strainer: cast-iron wye strainer, Class 125 flanged, fusion epoxy AWWA C550 coated, perforated stainless steel screen (1.5 mm perforations on 65 mm to 100 mm; 3 mm perforation on 150 mm to 250 mm), threaded cap plug blowout opening.

.8 Accessories: drain line air gap fitting.

.2 Acceptable Manufacturers:

.1 Febco - Model 860.

.2 Watts - Model 909.

.2 Reduced-Pressure Backflow Preventers (20 mm through 50 mm):

.1 Description:

.1 Regulatory Compliance: AWWA C511, CSA B64.4.

.2 Valve Body: bronze.

.3 End Connections: threaded, NPT.

.4 Maximum Working Pressure: 1207 kPa (2413 kPa test).

.5 Temperature Range: 0 to 60^{o}C.

.6 Shutoff Valve: full port, resilient seated, bronze ball valve with bronze ball valve test cock.

.7 Inlet Strainer: Bronze wye strainer, 40-mesh perforated, Type 304 stainless steel.

.2 Accessories: drain line air gap fitting.

.3 Acceptable Manufacturers:

.1 Febco.

.2 Watts.

2.3 Backwater Valve

.1 Valve:

.1 Flapper type backwater valve, lacquered cast iron body, no hub inlet and outlet, sealed bolted cover, automatic bronze flapper which hangs during periods of non-operation.

.2 Accepted Manufacturer and Product: Mifab BV1000.

.2 Housing:

.1 Power epoxy-coated 10-gauge fabricated steel access cover and housing with gasketed, non-skid, reinforced steel cover for deep rough-in.

.2 Accepted Manufacturer and Product: Mifab BV1280.

3. EXECUTION

3.1 Installation

.1 Install, arrange, and connect equipment as shown on Drawings and in accordance with Manufacturer's recommendations.

3.2 Extra Materials

.1 Provide any special tools required for the maintenance of the equipment supplied. Special tools are tools which are not normally available in mechanic's or millwright's tool kit and which are peculiar to the equipment supplied.

END OF SECTION

NATURAL GAS DISTRIBUTION SYSTEM

1. GENERAL

1.1 Scope

.1 Gas Piping.

.2 Valves and Fittings.

.3 Pressure Regulators.

.4 Testing.

.5 Service Connections.

1.2 Utility Service Connections

.1 Supply and Install new natural gas service for this Work complete with regulators.

1.3 Submittals

.1 Submit shop drawings for all equipment and accessories specified in this section.

2. PRODUCTS

.1 Polyethylene coated steel piping manufactured to CSA Z245.1M. High density polyethylene coating shall be to following schedule:

Pipe Size, mm	Thickness (Microns)
Up to 25	686
30	762
40	787
50 and Over	863

.2 Jointing Methods:

.1 Threaded Fittings to ANSI Standard B16.3:

.1 For above ground use, Schedule 80 pipe.

.2 Threaded joints not allowed underground.

.2 Forged Steel Socket Weld ANSI Standard B16.11.

.3 Wrought Steel Butt Welding fitting CSA Z245.10.

2.2 Polyethylene Pipe

.1 Pipe: to CSA B137.4.

.2 Diameter as shown on drawings. Grade PE 2306 or 3406, Series 125.

.3 Jointing Methods: Joint pipe according to manufacturer's recommendations. Threading and gluing not permitted on polyethylene pipe.

.1 Socket fittings: to ASTM D2683.

.2 Butt fusion.

.3 Compression fitted joints: to ASTM D746 with internal tubular stiffener.

.4 Use approved transition fittings when jointing polyethylene pipe to other pipe materials.

2.3 Valves

.1 Conform to CGA Standard 3.16.

.2 Steel plug type gas valve.

2.4 Pressure Regulator

.1 Self operated gas pressure regulator. Cast iron body. Size for full gas load to reduce pressure down from 35 kPa (5 psi) to 2 kPa (8" w.c.). Body rating 1030 kPa (150 psi). Standard of Acceptance: Fisher 66-501.

2.5 Building Pressure Regulator

.1 Self operated gas pressure regulator; malleable iron body. Size for full gas load to reduce gas pressure from 70 kPa to 35 kPa (10 psi to 5 psi). Standard of Acceptance: Fisher FS133h-2.

3. EXECUTION

3.1 Utilities

.1 Maintain, re-route or extend existing lines which remain.

.2 Cap, plug or seal abandoned lines that remain.

3.2 Pipe Installation

.1 Lay pipe to specified alignment, to within tolerance of 200 mm. Survey all routes and show measurements on as-built drawings complete with benchmarked dimensions.

.2 Prevent dirt from entering exposed ends of pipe.

.3 Lay service line pipe on proper grade to drain from building to gas main.

.4 Whenever pipe is to be deflected vertically or horizontally, do not exceed amount of deflection recommended by manufacturer in order to maintain satisfactory piping.

3.3 Valves

.1 Locate valves as indicated.

.2 Set valves on solid bearing. Set plumb and level.

3.4 Pressure and Leakage Tests

.1 Test system in accordance with CAN/CGA B149.1 and requirements of authorities having jurisdiction.

.2 Replace all material found to be defective.

3.5 Purging

.1 Purge after pressure test in accordance with CAN/CGA B149.1.

3.6 Building Regulator Installation

.1 Install service regulator adjacent to building wall in specified location.

.2 Install service regulator and riser pipe in such manner as to prevent undue stress upon service pipe. For plastic service pipe, use steel pipe riser from below ground to regulator.

.3 Ensure regulator vent has rain and insect proof opening and terminates away from building openings.

END OF SECTION

FIRE EXTINGUISHERS

1. GENERAL

1.1 Scope

.1 Fire extinguishers.

.2 Fire extinguisher cabinets and mounting hardware.

1.2 General Requirements

.1 Supply and install portable hand extinguishers where indicated on drawings and specified herein.

1.3 Quality Assurance

.1 Fire protection equipment and installation shall be approved by local Fire Commissioner.

.2 Equipment and installation shall meet the requirements of NFPA 10 Portable Fire Extinguishers.

1.4 Submittals

.1 Submit shop drawings for review. Submit with shop drawings MSDS for each chemical used in the Fire Extinguishers.

2. PRODUCTS

2.1 Portable Hand Fire Extinguishers (FE-H303A)

.1 Multi-Purpose Dry Chemical (Type 1): Pressurised with hose and shut-off nozzle or integral shut-off nozzle and mounting brackets 9.0 kg capacity rating 10A:80BC.

2.2 Fire Extinguisher Brackets.

.1 Fire Extinguishers Bracket: Surface type galvanized steel construction.

3. EXECUTION

3.1 Installation

.1 Install extinguishers so that the bottom of extinguisher is no more than 1200 mm above floor.

END OF SECTION

CAST IRON BOILERS

1. GENERAL

1.1 Scope

.1 Supply and Install hot water boilers, fully modulating burners, trim, control system for installation as specified.

1.2 Quality Assurance

.1 Comply with Provincial Regulations and have CSA approval.

.2 Units shall be approved and labelled by Underwriter's Laboratories.

.3 Field assemble of the ULC packaged boiler/burner to be supervised by factory personnel and include the proper assembly tools that permit accurate assembly in an efficient and timely manner.

.4 The boiler shall be constructed and stamped in accordance with the ASME Code, Section IV for low pressure heating boilers with a maximum water working pressure and bare the proper CRN (Canadian Registration Number) certification.

1.3 Submittals

.1 Submit shop drawings in accordance with Section 01300 – Submittals.

.2 Indicate the following:

.1 General arrangement showing terminal points, instrumentation test connections,

.2 Clearances for operation, maintenance, servicing and installation,

.3 Foundations with loading, anchor bolt arrangements,

.4 Piping hook-ups,

.5 Electrical equipment drawings,

.6 Burners and controls,

.7 Burner firing rate curve (flow versus static pressure),

.8 All miscellaneous equipment, low water cut-offs, flow switches, safety valve, etc.,

.9 Flame safety control system, and

.10 Main gas trains.

.3 Engineering data to include:

.1 Performance data at 25%, 50%, 75% and 100% design capacity.

.2 Radiant heat loss at 100% design capacity.

.4 Provide boiler and burner manufacturer installation instructions.

.5 Submit boiler and burner manufacturer descriptive literature, operating instructions, and maintenance instructions.

.6 Provide operation and maintenance manuals for incorporation into manual specified in Section 01730 – Operation and Maintenance Manuals.

1.4 Maintenance Materials, Special Tools and Spare Parts

.1 Maintenance materials to include:

.1 Special tools for burners, manholes, handholes, and maintenance.

2. PRODUCTS

2.1 Boiler

.1 Type:

.1 Supply and Install natural gas fired hot water cast iron boilers suitable for forced draft with insulated jacket, sectional cast iron heat exchanger, fully modulating gas burner system, controls and boiler trim.

.2 The packaged boilers to be ULC approved.

.3 The packaged boilers to have the ability to withstand low water temperatures of 30°C (85°F) minimum return temperature and a maximum temperature differential of 63°C (113°F).

.2 Construction:

.1 Assemble of cast iron sections conforming to ASME Code requirements and test for maximum working pressure of 470 kPa (68 psig) water.

.2 Permanently seal sections using high temperature rope seal and short draw rods for each pair of sections.

.3 Fuel passages shall be readily accessible without use of special tools. Provide adequate clean-out and access doors, and openings including observation ports and relief openings.

.4 Provide structural steel base with front plate, removable panels and lifting lugs.

.5 Insulate entire boiler with glass fibre and finish with steel cover jacket with factory applied baked enamel.

.6 Supply and Install skim tappings.

.7 The boilers push nipples shall be Bi Spherical ensuring a perfect fit, easier, quicker assembly of sections and higher operating efficiency. The assembly shall use Silicone Thermalcord sandwiched between sections to provide the perfect tightness necessary to prevent leakage of flu gases.

.8 The boilers shall have spring retention for expansion of the cast without the need for constant tightening of the tie rods.

.9 The boilers shall include a channel base and anchor support to assure section alignment. The boiler assemble shall include high quality, removable, full swing doors that only necessitates front/rear access to all flue ways and combustion areas for easy maintenance and cleaning without burner removal.

.10 Boiler Controls:

.1 The boiler control panel shall be easily wired via a cable channel extended from the rear to front of boiler under the top panel enclosure.

.2 The panel shall have a factory mounted temperature indication control, operator, low-high-low and manual reset high limit controls with sensor well opening located in the top front section.

.3 Panel shall allow room for specialized third-party optional features such as energy management systems either in house or telephone modem.

.3 Accepted Manufacturer: De Dietrich Thermique. Refer to Section15999 – List of Schedules for further details.

2.2 Hot Water Boiler Trim

.1 Supply and Install combination water pressure and temperature gauge and ASME rated pressure relief valve set at 414 kPa (60 psig).

.2 Supply and Install low water cut-off with manual reset to automatically prevent burner operation when boiler water falls below safe level.

.3 Supply and Install flow switch with each boiler.

.4 Limit temperature controller shall control burner to prevent boiler water temperature from exceeding safe system temperature.

.5 Manual reset limit.

.6 Supply and Install boiler air vent tapping. Connect air vent tapping to expansion tank to bleed air.

.7 Drain valve.

2.3 Natural Gas Burner

.1 General:

.1 Supply and Install ULC listed forced draft flame retention automatic gas fired type burner.

.2 Burner construction, design, components and installation shall adhere to all applicable code requirements.

.3 The burner shall be mounted to fire on the centerline of the boiler furnace tube.

.4 Burner operation will be full modulation on gas. Burner shall operate with minimal vibration and noise at the specified rate. The burner must operate with 15% to 20% excess air and CO must be less than 15 ppm in the products of combustion.

.5 All components on burner shall have a minimum 24 month warranty from day of turn-over to owner.

.2 Burner Construction:

.1 Burner housing shall be constructed of cast aluminum monobloc type construction. The burner mounting flange must support the burner weight on the boiler independent of any support.

.2 The burner shall be furnished with a stainless steel flame retention type combustion head, capable of withstanding temperatures up to 760°C (1400°F). The combustion head shall incorporate a diffuser and sleeve that is to direct excess air either around the flame or directly through the diffuser vanes. Adjustment to the diffuser insertion shall be made external to the burner and can be made while the burner is in full operation.

.3 Burner shall be equipped with service slide bars that allow for full access to the burner drawer assembly without removing the burner chassis from the boiler.

.4 The burner shall have a flame inspection window positioned at the rear centre of the burner housing. The flame shall be viewed without removing any covers.

.5 The burner shall come complete with a high efficiency, TEFC motor, 120V/1∅/60Hz, and a dynamically balanced reversed incline centrifugal blower wheel.

.6 The sound rating of the burner shall not exceed 83 dBA when measured at 1 m (3 ft) from the burner.

.3 Fuel/Air Ratio Control

.1 The burner shall be outfitted with an integral Camnetic characterized fuel/air metering system. The system shall be capable of providing an adjustable and accurately repeatable constant fuel/air ratio or a linerly adjusted fuel/air ratio throughtout the burner's firing range. Each system shall be complete with nine (9) independently adjustable cam set points. Each set point shall be complete with locking setscrew. The cam follower shall be spring equipped for maximum reliability. All bearings shall require no field lubrication.

.2 The linkage rods on the burner shall be a maximum of two turnbuckles; one used to position an integral burner mounted spring loaded characterized gas butterfly valve that will spring/snap to the closed position if the linkage rod was to be disconnected. The other linkage to control the combustion air damper, located on the suction side of the combustion air intake housing.

.3 A protection screen shall be supplied and installed on the air intake housing.

.4 The metering system shall be controlled by a single servomotor with eight (8) individually adjustable micro switches to enable the service technician to easily set the following positions to control the parameter of the burner. Standard of acceptance: Siemens Model SQM 50. The servomotor shall perform the following functions:

.1 Shutdown position (damper positioned closed at 0° when the call for heat is satisfied)

.2 Ignition position

.3 Low fire gas position

.4 High fire gas position

.5 The servomotor micro switches shall be adjustable to any setting from fully closed to fully open.

.6 The servomotor shall provide visual indication of the motor position and come complete with a disengagement clutch for quick alignment.

.7 The servomotor shall have the capability of receiving the following signals directly from the boiler temperature or pressure controller without the use of an external signal converter:

.1 0 – 10 VDC

.2 4 – 20 mA

.8 The servomotor shall be capable of generating an output signal based on any of the above-mentioned signals with the exception of position proportioning.

.9 When the operating control is satisfied the burner shall execute a controlled shut down and return the air damper to the closed position to reduce stand-by loses. The modulating motor shall come complete with an electrical interlock to insure a guaranteed low fire start.

.4 Ignition and Flame Proving Systems

.1 The burner gas ignition system for the main gas shall utilize natural gas as the fuel source. The gas pilot system components shall include spark ignited pilot assembly, 7000 Volt ignition transformer, pilot safety shut off valve, pilot gas pressure regulator and manual gas shutoff cock.

.5 Burner Mounted Controls

.1 Burner shall be equipped with an integral burner mounted control panel consisting of necessary motor starters, overloads, lights and switches. Burner shall be supplied with an integral HAND/OFF/AUTO switch that incorporates a control toggle that will allow a technician to manually drive the burner servomotor from low fire to high fire or high fire to low fire and the means to stop at any position in between, in a smooth and controlled method.

.2 The burner shall be equipped with an SPDT air pressure switch that will not allow the burner to start if there is insufficient combustion air, which is checked prior to each ignition attempt. Before the burner can start the airflow switch must be in the open position to prove the switch is not giving a false signal of sufficient combustion air pressure.

.6 Flame Safeguard

.1 Burner mounted flame management control shall be a UL/FM approved Siemens LFL1.335 electro-mechanical design control. Digital based flame safeguards shall not be accepted.

.2 The control must perform and include the following:

.1 Should the burner go to a safe lockout position due to ignition or flame failure no attempt at re-ignition will take place without manually resetting the control.

.2 The control shall have an internal fuse to protect again power surges and short circuits. This fuse shall be easily replaced in the field by a qualified service technician. There must be a spare fuse located in control.

.3 The control shall have a built in dial type annunciator, which indicates the position of the burner firing sequence.

.4 The reset switch shall be located on the front of the control. The switch shall illuminate during a lock out condition.

.5 In the event of a power failure the control shall not lock out, and once power is restored the control will perform a safe start-up upon a call for heat.

.7 Main Gas Train

.1 The gas valve train shall contain the following:

.1 Manual Shutoff cock,

.2 Main gas pressure regulator tight shutoff type,

.3 Two automatically operated safety shut-off valves, one with valve seal over-travel and proof of closure switch, Honeywell V4062A 1008 2,

.4 Manual reset low and high gas pressure switches,

.5 Manual leak test cock, and

.6 Burner manifold gas pressure gauge.

.8 Accepted Manutacturer: Riello. Refer to Section 15999 – List of Schedules for further details.

3. EXECUTION

3.1 Installation

.1 Install in accordance with ANSI/ASME Boiler and Pressure Vessels Code Section IV, regulations of the Province of Manitoba, CAN/CGA B149.1 and the Manufacturer's recommendations.

.2 Make all required piping connections to all inlets and outlets recommended by the boiler manufacturer.

.3 Maintain clearances as recommended by the manufacturer for operation, servicing and maintenance without disruption of operation of any equipment/system.

.4 Mount units level on 150 mm housekeeping pads.

.5 Pipe hot water relief valves full size to nearest drain.

.6 Pipe blowdown/drain to nearest floor drain.

3.2 Start-Up and Training

.1 Provide the services of the Manufacturer's Representative to start up unit, test efficiency, carry out performance verification tests, training, etc. as per Section 01650 – Equipment Installation and Section 01664 – Training.

.2 Provide Contract Administrator at least twenty four (24) hours notice prior to inspections, tests and demonstrations. Submit written report of inspections and test results to the Contract Administrator.

3.3 Commissioning

.1 Refer to Section 01670 – Commissioning.

3.4 Performance

.1 Refer to 15999 – List of Schedules.

END OF SECTION

PACKAGED VERTICAL WATERTUBE BOILERS

1. GENERAL

1.1 Scope

.1 Steam boilers complete with burners and economizers.

.2 Automatic blowdown, water softener, and chemical systems.

.3 Controls and boiler trim, including connection to building automation system.

.4 Steam and condenser connections.

.5 Fuel connection with complete gas trains.

.6 Electrical connections.

.7 Chimney connection for forced draft fan.

1.2 Quality Assurance

.1 Comply with Provincial Regulations and have CSA approval.

.2 Units shall be approved and labelled by Underwriter's Laboratories and bear Canadian Registration Number (CRN).

.3 Construct to applicable Section of ASME Code.

.4 Provide factory tests to check construction, controls and operation of unit.

.5 Provide authorised boiler inspection prior to shipment and submit copy of inspection report to the Contract Administrator.

.6 Boilers shall operate at a minimum efficiency of 85% for all firing rates.

1.3 Submittals

.1 Submit shop drawings indicating capacity rating, physical dimensions, wiring diagrams, materials of construction, code compliance, etc.

.2 Provide O&M manuals as indicated in Section 01730 – Operation and Maintenance Manuals, with complete description of installation and operation of boilers.

2. PRODUCTS

2.1 General Design and Construction

.1 Supply and Install factory assembled, factory fire-tested, self-contained, readily transported unit, ready for automatic operation except for connection of water, steam, fuel, electrical and vent services.

.2 The boilers shall be low volume, water tube boiler, capable of achieving full steam pressure in five (5) minutes from a cold start.

.3 Unit shall be a multiple vertical tube, once through, forced flow steam generator. The water tubes shall be straight, vertical construction being swaged at both ends. The water tubes shall conform to ASME SA-106 Grade B specifications. All water tubes shall be welded to a top and bottom header.

.4 Construct to ASME Boiler Code for allowable working pressure of 103 kPa (15 psig) steam, 125°C (260 °F) water operating temperature.

.5 The heat release of the boiler shall not exceed 2235 MJ/m^3 (60,000 BTU/cuft) of furnace volume. Operating radiation losses shall be less than ¼ of 1% of input.

.6 Supply and Install adequate tappings, observation ports, removable panels and access doors for entry, cleaning and inspection. Supply and install lifting lugs on boiler for proper rigging.

.7 Factory paint boiler, base and other components with hard finish silicone enamel.

.8 Accepted Manufacturer: Miura LXL Series. Refer to Section 15999 – List of Schedules for further details.

2.2 Steam Boiler Trim

.1 Supply and Install pressure gauge and ASME rated pressure relief valve set at 103 kPa (15 psig).

.2 Supply and Install water column with cocks, gauge glass set, blowdown valves for gauge glass and column.

.3 Supply and Install float type low water cut-off with manual reset integral with water column to automatically prevent burner operation whenever boiler water falls below safe level. Supply and Install electronic auxiliary low water cut-off as backup.

.4 Boiler condensate return pump control, integral with water column shall automatically maintain water level by controlling pump operation.

.5 The horizontal steam separator provided shall eliminate carry-over due to load swings and provide boiler steam quality of 99+% dry saturated steam.

.6 Operating pressure controller shall control burner to maintain steam pressure setting.

.7 Limit pressure controller shall control burner to prevent steam pressure from exceeding safe system pressure.

2.3 Blowdown System

.1 The boilers shall each be equipped with an automatic blowdown system. The system shall include a separator and tank complete with water level controls, thermometer, gauge glass kit and tank stand, and an automatic surface (solenoid) and manual (manual ball valve) blowdown system on each boiler. The automatic continuous surface blowdown system shall include a sensor, solenoid valve and strainer.

.2 Refer to Section 15130 – Tanks for further tank information.

2.4 Economizer

.1 Economizer shall be completely piped and assembled as part of the boiler package. The economizer shall be floor mounted and attached directly to the boiler flue gas outlet.

.2 Construction:

.1 Gas-tight inner seal welded type steel casing, shop painted.

.2 Waterside design pressure 1380 kPa (200 psi).

.3 Tubes shall be carbon steel with spiral fins, SA- 106-B.

.4 Maximum pitch of fins - 5/25 mm.

.5 Tubes to be made of Schedule 40 pipe.

.6 Drainable and suitable for dry operation in an emergency.

.7 Tube assembly shall be suitably arranged for internal and external cleaning. Provide suitable means of eliminating air pockets during filling.

.8 Inspection port for combustion outlet exhaust and exchanger cleaning if required.

2.5 Fuel Burning System

.1 Forced draft high radiant multi-port power burner integral with front head of boiler designed to burn natural gas.

.2 Burner operation shall be hi-low fire with low fire ignition. Maintain air/fuel ratio with flue gas temperature a minimum of 38°C (100°F) above dew point. Supply and install flue gas thermometer.

.3 Blower shall be statically and dynamically balanced. Blower motor shall be TEFC type.

.4 Burner shall be cast aluminum monobloc construction, dual hinged to allow burner to swing left or right with removable top cover plate for ease of servicing.

.5 All burners shall bear either CSA, CGA or ULC label.

.6 Gas train shall include but not be limited to gas pressure regulator, test valve, shut off valve. Gas pressure supplied to boiler is 35 kPa (5 psig).

.7 Burners shall have characterised valves for precise setting of fuel/air input at all load settings.

.8 Each burner shall come complete with a permanent observation port to allow observation of pilot and main flame.

.9 Servo motor controlling air/fuel input ignition, low fire, high fire, fully open and fully closed micro switches.

.10 Burner shall be manufactured by Weishaupt or Klockner. Refer to Section 15999 – List of Schedules for further details.

2.6 Control Panel

.1 Supply and Install separate control panel for each boiler. Panel with key lock shall contain flame safe guard controls, main disconnect, blower motor starter, switches, indicating lights.

.2 Program relay shall control ignition starting, stopping of burner and provide pre combustion and post combustion purge. Burner shall shut down in the event of ignition pilot or main flame failure or if combustion air pressure in the fan chamber falls below present level, high or low pressure in gas train, high limit or low water condition in boiler.

.3 Burner controller shall have PID logic control, and be fully adjustable and to operate in response to a temperature sensor mounted in the main header.

.4 Control panel shall contain manually adjustable lead/lag operation. Lead boiler shall start on a "call for heat" and be ramped to full fire before second boiler and subsequent boilers shall start. Adjustable time delay between starting of each boiler shall be provided. The boilers shall shut down in reverse order of firing.

.5 Control panel shall contain manual-automatic selector switch. In manual mode firing shall be controlled. A potentiometer set at the desired point between high and low fire. In the auto mode the firing rate shall control in response to the load demand.

.6 Control panel shall annunciate the following alarm points on the symbol indicator:

.1 No Start. No call for heat or safety circuit open.

.2 Controlled shut down.

.3 Lockout due to air pressure drop.

.4 Lockout due to flame fault.

.5 Lockout flame failure after first safety check.

.6 Lockout due to main flame failure.

.7 Lockout after incompletion of program (i.e. extraneous light due to flame not extinguished, UV tube fault or fault in supervision circuit).

.8 An alarm bell shall pulse when an abnormal condition exists.

.7 Supply and Install an hour counter for each burner.

.8 Supply and Install volt free (dry) contacts for burner fault, burner on-off status. These contacts are for connection to the SCADA.

2.7 Free-Standing Multi-Boiler Plant Control and Instrument Panel

.1 Supply and Install a free-standing panel and locate as indicated. The panel shall contain all individual and multi-boiler controls, monitoring system, and panel-mounted instruments specified herein and in the reference specifications, except that flame safeguard system may remain separately mounted in a cabinet at each boiler.

.2 Control Panel Construction:

.1 Construct control panel of not less than 3 mm (11 gauge) reinforced steel for face, top, and sides. The enclosed panel shall be not less than 610 mm (24 in) in depth with inside rigidly welded braces. Design control panel so that all indicating and recording devices and manually operated switches shall be flush mounted in a gasketed removable-top front panel with indicating and recording devices at eye-level. Provide a similar removable-top rear panel located opposite front panel to facilitate wiring, piping, and maintenance. Install other operating controls on a sub-panel within the enclosure. Access to panel enclosure shall be through gasketed, double piano-hinged doors of not less than 1.52 mm (16 gauge) steel. The doors shall be reinforced to prevent sagging and shall come complete with a three point compression type fastener and polished key lock handle. Prime coat complete control panel and finished in baked enamel. Identify flush-mounted devices on panel with engraved lamicore nameplates.

.3 Control Panel Wiring and Piping:

.1 Control panel shall be factory pre-wired in accordance with Canadian Electrical Code. Wire shall be in accordance with Division 16 or UL approved for the intended use, color or number coded, and run in plastic ducts to numbered terminal blocks. Control circuits shall be separately fused with properly rated cartridge type fuses. Power leads to and from magnetic starters and contractors shall terminate at terminal blocks so that field wiring is necessary only from terminal blocks to external equipment. Control leads to and from external control devices shall terminate at separate terminal blocks from power leads. Steam-, draft-, and air-operated devices shall be factory piped to permanently affixed external connections.

3. EXECUTION

3.1 Installation

.1 Maintain Manufacturer's required clearances for operation and maintenance.

3.2 Housekeeping Pads

.1 Mount boilers on 100 mm housekeeping pads.

3.3 Startup and Performance Verification

.1 Refer to Section 01650 – Equipment Installation and Section 01664 – Training.

.2 Provide the services of the Manufacturer's Representative to check the installation, start the boilers, calibrate controls and train the City's operators in the proper Operation and Maintenance of the equipment.

.3 Demonstrate operation of all safety controls to the satisfaction of the Contract Administrator and the City.

.4 Demonstrate operation of the boilers over the entire firing range of the burners. Record water temperature, steam pressure and steam flow if applicable, flue gas temperature, percentage O_2 and other relevant data. Submit written report to the Contract Administrator and City on completion.

.5 The acceptance by the City of the boilers will be contingent upon satisfactory results of tests at time of commissioning to be carried out on the boilers. The object of the testing shall be to prove capacity, efficiency and shall be in form of a report for the customer.

.6 Provide Contract Administrator at least twenty four (24) hours notice prior to inspections, tests and demonstrations. Submit written report of inspections and test results to the Contract Administrator.

3.4 Commissioning

.1 Refer to Section 01670 – Commissioning.

3.5 Performance

.1 Refer to Equipment Schedules.

3.6 Extended Warranty

.1 The boiler shall be covered by a one (1) year parts and labour warranty complete with a boiler inspection package every three (3) months during the warranty period.

.2 The boiler pressure vessel shall be covered by a seven (7) year warranty from the date of shipment from the factory.

.3 The boiler pressure vessel shall be warranted against thermal shock for a period of twenty five (25) years from date of shipment. The warranty shall cover the boiler pressure vessel under all normal operating conditions.

END OF SECTION

STEAM BOILER AUXILIARY EQUIPMENT

1. GENERAL

1.1 Scope

.1 Boiler feed tank and pumps.

.2 Blowdown tanks.

1.2 Quality Assurance

.1 All equipment, controls and accessories to be compatible with system design, and matched to the steam boiler(s) by the boiler Manufacturer.

.2 All components and packages to be factory assembled and piped where called for.

.3 All connections, sizes and capacities to comply with all current applicable codes.

.4 Comply with Provincial Regulations and have CSA approval.

.5 Construct to ASME Section VIII, Rules for Construction of Pressure Vessels.

.6 Obtain all required inspection certificates from Provincial Authorities.

1.3 Shipping

.1 Factory assembled units to be shipped intact unless restricted by transport regulations.

1.4 Shop Drawings

.1 Detailed shop drawings to be submitted for review for all equipment and accessories in this session prior to ordering, indicating physical dimensions, capacities, curves and weights.

2. PRODUCTS

2.1 Blowdown Tanks

.1 Refer to Section 15630 – Packaged Vertical Watertube Boilers.

2.2 Boiler Feed Tank and Pumps

.1 Tank: Supply and Install feed water tank with necessary connections, gauge glass, gauge cocks, thermometer, internal baffle. Support tank on welded structural steel stand assembly. Tank must be elevated to create positive head on feed water pumps.

.2 Standard of Acceptance: Bryan HFS-15-50-100-D.

.3 Make-up Water Assembly: Float operated make-up water feeder, Y strainer with bypass assembly.

.4 Boiler Feed Pumps: One pump shall provide 100% capacity. Motors shall be non overloading, TEFC. Supply and install a multi staged centrifugal type pump sized to suit boiler and for use with 108^{o}C water. The material construction of pump must be stainless steel and having mechanical seals. Minimum NPSH: 1.8 m (6 ft). Control panel shall include the above recommended feed water pump motor control circuit, and overload protection as standard.

.5 Standard of Acceptance: Goulds

.6 Control Panel: Dust proof control panel containing motor starters, selector switch, indicator lights, circuit breakers, pump alternating controls, alarm lights and horn. Provide automatic pump alternating after each cycle.

3. EXECUTION

3.1 General

.1 Vent condensate receivers and boiler feed tanks to outdoors.

.2 Flush and clean condensate tanks and boiler feed tanks prior to delivery to site and keep sealed during construction.

.3 Elevate boiler feed tank to create a positive head on boiler feed water pumps.

.4 Supply and Install suction and discharge valve and a check valve for each boiler feed pump.

.5 When boiler feed tanks are higher than boiler water line, supply and install a spring loaded check valve to prevent boiler from flooding after shutdown.

.6 Supply and Install water meter on make-up water lines.

.7 Supply and Install drain valves on all strainers.

.8 Install steam exhaust heads on blow-off tank vents. Pipe exhaust head drains through roof to sanitary sewer.

3.2 Performance

.1 Refer to Equipment Schedules.

END OF SECTION

HEAT TRACING

1. GENERAL

1.1 Scope

.1 Heat Tape/Trace components, accessories and installation material for a complete operating system.

1.2 General Requirements

.1 Supply and Install heat tape where indicated on Mechanical and Process Drawings and specified herein.

.2 FM Approved constant wattage cable.

1.3 Submittals

.1 Submit Shop Drawing which shall include the following minimum information. Shop Drawings submitted without this information shall be automatically rejected.

.1 Manufacturer's data sheets on each product to be used including:

.1 Preparation instructions and recommendations.

.2 Storage and handling requirements and recommendations.

.3 Installation methods.

.2 Materials of construction: indicate material and wire gauge.

.3 Power consumption and required power supply.

2. PRODUCTS

2.1 Heat Tracing/Tape

.1 Parallel zone system, two conductor stranded copper bus wires covered with FEP Teflon or fluoropolymer inner insulation. Resistance heating cable connection to alternate bus wires covered with extruded FEP Teflon insulating jacket and a stainless steel braided overjacket.

.2 Heating capacity: 20 W/m (6 W/Ft)

.3 For use with 120 V power supply.

.4 Standard of Acceptance:

.1 Delta-Therm PF Series Catalog No. PF-6-SB

2.2 Controls

.1 Heat tracing shall turn on to prevent frost build up on the outside air intakes of the makeup air units.

.1 Heat tape will turn “on” when the O/A temperature sensor reads an air temperature between -5 to 5°C and turned “off” otherwise.

.2 Sequence of Operations: Refer to Sections 15930 – Sodium Hypochlorite Building HVAC Control Sequences and 15940 – Bulk Chemical Building HVAC Control Sequences.

.2 Heat tracing shall turn on to prevent water pipes freezing at outdoor Emergency showers and eyewash stations.

.1 Heat tape will turn “on” when the O/A temperature sensor reads an air temperature below 5°C turned “off” otherwise.

.3 Heat tracing shall turn on to prevent Sodium Hydroxide feed pump discharge piping from freezing.

.1 Heat tape will turn “on” when the O/A temperature sensor reads an air temperature below 5°C turned “off” otherwise

3. EXECUTION

3.1 Installation

.1 Follow Manufacturer’s installation instructions and guidelines for:

.1 General installation, set-up, and preparation of the heat trace and associated components

.2 Proper end termination of cable with proper termination kits

.3 Proper power and control connections

.2 Heat trace shall be installed directly on the bird screen of the intake gravity hood.

.3 Heat trace may be installed above (preferred) or below the screen with stainless steel clamps every 75 mm for the entire perimeter of the intake hood.

3.2 Quality Control

.1 Test continuity of heating cable.

.2 Perform insulation resistance (megger) test on each heater section before, during, and after pavement placement. Minimum acceptable megger reading shall be 10 megohms.

.3 Measure voltage and current at each unit after installation is complete.

.4 Submit to Contract Administrator a written test report showing values measured on each test for each cable.

END OF SECTION

HEAT TRANSFER

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 ANSI.

.2 ASHRAE:

.1 52, Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

.2 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.3 ASME: Code for Unfired Pressure Vessels.

.4 ASTM: D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.

1.2 Submittals

.1 Action Submittals:

.1 Shop Drawings:

.1 Specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of products, and electrical schematics for all products specified.

.2 Manufacturer's standard finish color selection for enclosure finishes.

.2 Informational Submittals:

.1 Recommended procedures for protection and handling of equipment and materials prior to installation.

.2 Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt the arrangement or details shown to the equipment supplied.

.3 O&M Data: As specified in Section 01730 – Operation and Maintenance Manuals.

.4 Extended Warranty.

1.3 Quality Assurance

.1 Heating and Cooling Equipment: Minimum operating efficiencies, defined as COP and EER, specified in Chapter 6 of ASHRAE 90.1.

2. PRODUCTS

2.1 Double-Wall Plate and Frame Heat Exchangers, HEX

.1 General:

.1 Individual and removable double-wall plates and gaskets contained in a carrier assembly.

.2 Designed, constructed, and tested in accordance with the ASME Code for Unfired Pressure Vessels.

.3 ASME pressure vessel labelled.

.1 Working Pressure Rating: 1516 kPag minimum at 82^{o}C.

.2 Relief valve sized to pressure vessel.

.3 Piping Connections: Class 150 ANSI Standard flanged nozzles.

.4 Supply and install units with studded port connections integral with the unit end plate with a Class 150 ANSI Standard flanged pipe spool and gasket for each piping connection, sized to match connection and 300 mm long.

.5 Plates: Type 316 stainless steel.

.6 Gaskets: Viton, EPDM, or Nitrile.

.7 Base Anchor Bolts: 20 mm minimum diameter, Type 316 stainless steel.

.2 Performance: Refer to Section 15999 – List of Schedules.

.3 Acceptable Manufacturers: S.A. Armstrong, Alfa Laval

2.2 Accessories

.1 Equipment Identification Plates: Provide 1.6 mm thick (16-gauge) stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 10mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

.2 Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 45 kg.

3. EXECUTION

3.1 Installation

.1 Heat Exchangers: Support from the concrete base with an angle iron frame and anchor securely in place.

3.2 Extended Warranty

.1 Furnish Manufacturer's extended guarantee or warranty, with the City named as beneficiary, in writing, for a period of five (5) years after the date of Total Performance. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General and Supplemental Conditions.

3.3 Manufacturer's Services

.1 Provide Manufacturer's Representative at Site in accordance with Section 01650 – Equipment Installation, for installation assistance, inspection and certification of proper installation, equipment testing, start-up assistance, and training of City's personnel for specified equipment.

END OF SECTION

AIR HANDLING

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this section:

.1 ARI: 410 Forced-Circulation Air-Cooling and Air-Heating Coils.

.2 AMCA:

.1 Bulletin 300, Setup No. 1.

.2 Standard 99, Standards Handbook, Reverberant Room Method for Sound Testing of Fans.

.3 Standard 210, Laboratory Methods of Testing Fans for Rating.

.3 ASHRAE:

.1 52, Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

.4 ASTM: D4157, Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method), Test Method for.

.5 CSA: C22.1, Canadian Electrical Code

.6 IEEE: 112, Standard Test Procedure for Polyphase Induction Motors and Generators.

.7 NEMA: MG 1-12.53a, Motors and Generators.

.8 NFPA:

.1 70, NEC.

.2 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

.3 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

.9 OSHA.

.10 UL/ULC: Product Directories.

1.2 Submittals

.1 Action Submittals:

.1 Complete specifications, descriptive drawings, catalog cuts, and descriptive literature, which shall include make, model, dimensions, weight of equipment, and electrical schematics for products specified.

.2 Informational Submittals:

.1 Manufacturer's Test Reports for the following:

.1 Hydronic heating coils

.2 Direct Expansion (DX) coils

.3 Heat recovery plates

.4 Noise test results.

.2 Equipment Installation Certificates:

.1 Certificate of Equipment Delivery, Form 100.

.2 Certificate of Readiness to Install, Form 101.

.3 Certificate of Satisfactory Installation, Form 102.

.4 Certificate of Equipment Satisfactory Performance, Form 103.

.3 Recommended procedures for protection and handling of products prior to installation.

.4 O&M Data: As specified in Section 01730, Operation Maintenance Manuals.

1.3 Extra Materials

.1 Provide tag and box for shipment and storage the following spare parts:

Item	Quantity
Filters	Four complete sets per unit
High Efficiency Filters	Two complete sets per unit
Fan Belts	One complete set per unit

.2 Delivery: In accordance with Section 01600 – Materials and Equipment.

2. PRODUCTS

2.1 General

.1 Supply and install non-fused disconnects on each air handling system.

.2 Coat interior surfaces and fan wheel in contact with the air stream with 6-mil minimum thickness of chemical-resistant epoxy coating.

.3 Where spark-proof construction requirements are noted, supply and install equipment in accordance with AMCA Standard 99-0401 for Type B spark-proof construction.

.4 Shafts and Drive Belts:

.1 Provide multiple drive belts where motor horsepower is 1.5 kW or larger.

.2 Belt Guards: Meet federal and Provincial of Manitoba OSHA requirements for safety protection, and be easily removable by one person.

.3 Tachometer Access Holes: Large enough to accept standard tachometer drive shaft.

.4 Center punch fan shaft to accommodate tachometer readings.

.5 Fan Equipment: Rated and tested in accordance with AMCA 210 and AMCA 2401 for Class I service, unless otherwise specified.

.6 Ball Bearings:

.1 For Forward-Curved Fans: Size for minimum life L-10 of over 80,000 hours.

.2 For Airfoil and Backward Inclined Fans: Size for minimum life L-10 of over 40,000 hours, with an average life L-50 of over 200,000 hours.

.7 Drives for Belt-Driven Fans:

.1 Sheaves shall be capable of providing 150% of motor horsepower.

.2 Mount motors on adjustable motor brackets.

.3 Provide motors 75 kW and under with adjustable speed sheaves that allow for 20%speed variation.

.4 Provide belt-driven fans with cast iron or flanged steel sheaves.

.8 Air Filters, Fans, Air Handlers, and Air Conditioners: Meet requirements of NFPA 90A and NFPA 90B.

.9 Acoustical Levels:

.1 Maximum allowable break-out sound pressure measured at 1.2 m away from the air handling equipment shall be limited to 80 dBA

.2 Maximum allowable discharge sound pressure measured at 2.0 m downstream of the unit discharge shall be limited to 85 dBA

2.2 Air Handling Equipment, MAU, AHU

.1 Additional Requirements

.1 Refer to Equipment schedules supplement to this section, Schematic drawings and specification Section 15900 – HVAC Instrumentation and Controls – General, for additional requirement for each Air Handling System.

.2 Unit Construction:

.1 Unit casing shall be of minimum 16 gauge satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two-part acid based etching primer. Finish shall be a 2 part epoxy with polyurethane topcoat, to all exposed surfaces. All unprotected metal and welds shall be factory coated.

.2 Unit shall come complete with 22 gauge solid galvanized metal liner over all insulated areas of sidewalls and roof. Finish side of the liner that is in contact with the airstream shall be a two-part epoxy applied in the same fashion as that on the unit casing.

.3 All units shall be internally insulated with 48 kg per cubic metre density acoustic insulation. Insulation thickness shall match wall thickness of 50mm. Insulation shall be secured with steel angles. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

.4 All walls, roofs and floors shall be of formed construction; with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water-resistant sealant.

.5 Units shall come complete with access doors to all components within the unit. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.

.1 Access doors shall be fully lined, with stainless steel piano hinges and brass pins, in welded steel frames. Doors shall be fully lined with automotive bulb gasket and nylon 6/PA6 lever type handles, operable from both sides for all units over 1.2 m high. Units 1.5 m and above in height to have three handles per door.

.2 Whenever possible, hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. Where space constrictions require the use of outward opening doors to an area of positive pressure, a clear warning label must be affixed.

.3 Hinged access doors shall come complete with tie back clips.

.4 Door directly upstream of cooling coil and all doors downstream of cooling coil shall have thermal breaks to minimize sweating.

.6 Casings shall be supported on structural channel supports, designed and welded for low deflections. Integral lifting lugs shall be provided for hoisting.

.7 Drain pans, where required, shall be an integral part of the floor paneling, a minimum of 50 mm deep, with welded corners. Drain pans shall extend a minimum of 150 mm downstream of coil face and shall come complete with a 40 mm male NPT drain connection. Drain pans must be sloped and pitched such that there is no standing water. Intermediate drain pans shall be provided between cooling coils above 1.6 m. Drain pans shall be Type 316 stainless steel.

.3 Fans:

.1 Fans shall be backward inclined or airfoil design and rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall have a rust inhibiting coating. Fans shall be equipped with greaseable, self-aligning ball or roller type pillow block bearings, supported on a rigid structural steel frame. Fan scroll and wheel shall be aluminum.

.2 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.

.3 Belt guards on all units shall be epoxy coated.

.4 Fan-motor assemblies shall come complete with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be vertical spring type with leveling bolts, bridge bearing waffled pads with minimum 1 in static deflection designed to achieve high isolation efficiency. Fans shall be attached to the discharge panel by a PVC coated polyester woven fabric, with a sealed double locking fabric to metal connection.

.5 Fan motors shall be TEFC high efficiency type, inverter duty where indicated.

.4 Filters:

.1 Filter sections shall come compete with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as shown on the drawings.

.2 Filter media shall meet UL Class 2 standards.

.3 Each filter bank shall come complete with a flush-mounted Magnahelic air filter gauge with adjustable signal flag (Dwyer Series 2000, or approved equal).

.4 Winter-Filters, Summer Filters, Pre-Filters: 50 mm pleated panel disposable filters, non-woven reinforced cotton/poly fabric media with a metal support grid and heavy duty beverage board-enclosing frame. Permanent re-usable metal enclosing frame. The filter media shall have a MERV rating of 6 to ASHRAE Standard 52.1.

.5 Final Filters: Rigid self-supporting extended surface disposable filters consisting of high density synthetic media, media support grid, metal contour stabilizers, metal diagonal support bracing and enclosing frame. Media shall be 3 ply, dual stage synthetic. Pre-filter layer of coarse 7 to 10 µ synthetic fibers; secondary ply of progressively structured spun bonded polypropylene fibers blended with filaments from 1 to 6.7 microns; and final ply of spun bonded polypropylene backing with strength to support filtering stages. The media shall withstand 100 percent humidity and be non-shedding. Media shall have a MERV rating of 13 to ASHRAE 52.1. Media shall be quality certified by ISO-9002.

.5 Motorized Dampers:

.1 Supply and install motorized dampers indicated on drawings and herein described. Motorized dampers shall be of High Performance type as specified under Section 15901 - HVAC Control, Field components, and Instruments.

.2 Motorized dampers and actuators shall be field mounted. Coordinate with HVAC Controls Contractor.

.6 Coils:

.1 Coils shall be constructed of copper tube and aluminum fin with copper headers. Fins constructed of aluminum or copper shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes. The coils shall have a Type 316 stainless steel casing. All coils shall be factory tested with air at 2068 kPa while immersed in an illuminated water tank.

.2 Coils shall be ARI 410 performance rated.

.3 Headers shall be located inside of the air handler unit and arranged for counterflow between air and water. Locate supply and return connections on same side.

.4 Coils shall be removable from the unit at the header end, unless shown otherwise on the drawings. All water coils shall be equipped with a capped vent tapping at the top of the

return header, and a capped drain tapping at the bottom of the supply header. Coils shall be completely drainable.

.5 Water coils shall be circuited to provide adequate tube velocities to meet design requirements. Internal turbulators are not acceptable.

.6 Refrigerant Superfin evaporator type coils shall be equipped with distributors connected to the coil by copper tubes. Hot gas bypass inlet shall be at the refrigerant distributor.

.7 Refrigerant coils shall be alternate tube circuited in order to distribute the cooling effect over the entire coil face at reduced load conditions.

.7 Economizer Mixing Section, where applicable:

.1 Include provisions for mixing dampers on return and outside air inlets.

.2 Position opposed-blade dampers across the long dimension of each air opening, with linkage arranged so corresponding outside and return air dampers move together.

.3 Supply and install either the combination style box, or a two-piece assembly with a vee filter box and high efficiency mixing box bolted together.

.4 Install damper linkage at the factory to provide minimum and maximum damper segments proportional to quantities of minimum and maximum outside air requirements.

.8 Heat Recovery Section, where applicable:

.1 Supply and install an air-to-air plate heat exchanger with minimum performance as shown in the schedule.

.2 Heat exchanger core shall be aluminum. Core shall include flow separators whenever vapour and condensate streams interact limiting the heat transfer capacity.

.3 The supply air side shall be equipped with opposed blade face and bypass dampers with accompanying linkage and operating controls. Dampers and actuators shall be High Performance type as specified under Section 15901 - HVAC Controls, Field Components and Instruments.

.4 HVAC Controls Contractor to supply and install a dedicated solid state controller complete with a control actuator that will effectively modulate the face and bypass damper to achieve the following:

.1 Accurate supply air temperature control

.2 Summer/Winter operation changeover

.5 Frost Control

.1 Unless otherwise noted, the frost prevention control system for the exhaust air side shall be the traversing type, shall be factory-mounted and supplied and installed by the unit manufacturer. Frost control shall be sized such that the total air flow is unchanged in defrost mode.

.2 Where applicable, the frost prevention control system for the exhaust air side shall be the face bypass type, shall be factory-mounted and supplied and installed by the unit manufacturer.

.6 In conditions when the exhaust air could provide more heat than is required, the bypass damper is varied by the controller to limit heat transfer and maintain supply air set point.

.9 DX Cooling Section, where applicable

.1 The DX-Cooling section shall be supplied and installed as an integral part of the air handling unit.

.2 All refrigerant specialties to be supplied, factory installed and tested by the manufacturer.

.3 Free-cooling shall be the first priority before DX-Cooling.

.4 Refer to Section 15730 – Unitary Air Conditioning Equipment.

.10 Factory-Mounted Pre-Wired Controls and Field-Mounted Controls:

.1 Factory-mounted controls shall be pre-wired and certified by CETL. Supply and Install a single-point power connection for entire unit. Refer to Division 16 for Supply and Install of power to unit.

.2 All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.

.3 Unit shall bear an ETL label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electrical Code.

.4 Where indicated, Supply and Install a system of motor speed control, including all necessary terminal blocks, motor starters, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relays. Supply and Install a main non-fused NEMA 4 disconnect switch for each Air Handler System.

.5 Supply and Install a NEMA 4 control cabinet mounted on the outside of the unit casing, which shall be adequately sized to include an allocated 600mm x 600mm space for mounting the Networked DDC controller.

.6 All input and output interfacing points with the Networked DDC controller shall be factory terminalized with proper identification on a control strip mounted adjacent to the space allocated for the Networked DDC controls

.7 Where air-cooled DX-cooling section is required, the field-mounted electronic temperature control system shall have the capability of providing multiple stages of cooling control to maintain supply air temperature. The minimum run and off time for compressors shall be four (4) minutes at full load startup, and may range up to eight (8) minutes under part load conditions. The controller shall incorporate a proportional, integral control algorithm that reduces temperature drop by resetting to the set-point after each stage is cycled on.

.8 Where an Economizer Mixing section is required, upon an Economizer Mode enable signal from the BAS, the Factory-mounted controller shall modulate the mixing dampers to maintain supply air temperature set-point. Additional mechanical cooling shall be enable should the mixing damper is not able to satisfy the supply air temperature set-point.

.9 Where a hydronic heating section is required, a Field-mounted controller shall modulate the control valve output capacity, utilizing proportional and integral control algorithm to maintain supply air temperature set-point with 4 to 20 mA or 0-10 Vdc reset supplied and installed by the Building Automation System (BAS).

.10 Field-mounted controller shall be capable of interfacing with the BAS, all the input/output points and alarms as shown on system schematic drawings and as described in Section 15900 – HVAC Instrumentation and Controls – General.

.11 Supply and Install factory-mounted contacts for emergency shutdown of unit upon activation of fire alarm.

.12 Refer to specification Section 15901 – HVAC Control, Field Components and Instruments for specific requirements of control devices.

.13 Ensure that all interfacing control signals from devices and sensors are compatible with the BAS system.

.14 Supply and Install factory-mounted Hand-Off-Auto (HOA) switch for single speed system, Slow-Off-Fast-Auto (SOFA) switch for two-speed systems. Supply and install variable frequency drives where indicated in accordance with the requirements of Section 16815 – Variable Frequency Drives.

.15 Coordinate factory and field mounted controls with the HVAC Controls Contractor.

.11 Acceptable Manufacturers:

.1 Makeup Air Units: Cicul-aire

.2 Air Handling Units: McQuay

2.3 Accessories

.1 Equipment Identification Plates: Provide 1.6 mm (16-gauge) stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 9.5 mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

.2 Lifting Lugs: Suitably attached for equipment assemblies and components weighing over 45 kg.

2.4 Source Quality Control

.1 Manufacturer's Tests:

.1 Direct expansion cooling coil leak tested underwater with 2068 kPa (300 psi) air.

3. EXECUTION

3.1 Installation

.1 Pipe drain pan connection through a running trap to floor drain.

.2 Isolate sheet metal duct connections from all non-internally spring-isolated fan units or other rotating equipment.

.3 Locate units to provide access spaces required for filter changing; motor, drive, and bearing servicing; and fan shaft and coil removal.

.4 Inspect internal casing insulation, seal all exposed edges, and butt joints with mastic to ensure insulation will not be loosened during operation.

3.2 Adjusting and Cleaning

.1 Air and Water System Balancing: as specified in Section 15950 – HVAC Systems Testing, Adjusting, and Balancing.

.2 Lubricate nonsealed bearings prior to startup.

.3 Do not operate units until filters are installed. If operated without filters, completely clean coils and interior of units.

.4 Vibration:

.1 Statically and dynamically balance all rotating equipment.

.2 Perform field testing on rotating equipment to ensure there is no excessive vibration.

.3 If excessive vibration is experienced, rebalance equipment in-place to the satisfaction of the Contract Administrator.

3.3 Manufacturer's Services

.1 Provide Manufacturer's services in conformance with the requirements of Section 01650, Equipment Installation. Manufacturers Representative shall provide support of equipment installations and field inspection of equipment before startup.

.2 Duration of Training: The training of City's personnel shall be carried out as per Section 01664 - Training.

3.4 Extended Warranty

.1 Provide Manufacturer's extended guarantee or warranty, with the City named as beneficiary, in writing for a period of two (2) years after the date of Total Performance. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in General and Supplemental Conditions.

3.5 Schedules

.1 Refer to Makeup Air and Air Handling Unit schedules in Section 15999 – List of Schedules for further details.

END OF SECTION

UNITARY AIR-CONDITIONING EQUIPMENT

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 ARI: 210/240, Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

.2 AMCA: Bulletin 300, Setup No. 1.

.3 ASHRAE:

.1 52, Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

.2 90.1, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.

.4 ASTM:

.1 B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.

.2 D2370, Standard Test Method for Tensile Properties of Organic Coatings.

.3 D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.

.4 E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.5 G154, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.

.6 A123 / A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.5 CSA:

.1 B52, Mechanical Refrigeration Code.

.6 cETL.

.7 NEMA.

.8 NFPA: 255, Method of Test of Surface Burning Characteristics of Building Materials

.9 UL: UL 94-5V, Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.2 Definitions

.1 The following is a list of abbreviations which may be used in this Section:

.1 EER: Energy Efficiency Ratio.

.2 DX: Direct Expansion.

.3 IR: Infrared.

.4 LED: Light Emitting Diode.

.5 PSC: Permanent Split Capacitor.

.6 SPST: Single Pole, Single Throw.

.7 TXV: Thermostatic Expansion Valve.

1.3 Submittals

.1 Action Submittals:

.1 Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for all products specified.

.2 Manufacturer's standard finish color selection for enclosure finishes.

.3 Complete performance data that will indicate full compliance with the specifications; include fan sound power level data (ref. 10 to 12 watts) at design operating point, based on AMCA Bulletin 300, Setup No. 1.

.2 Informational Submittals:

.1 Manufacturer's Installation Certificates, Certificate of Satisfactory Installation in accordance with Section 01650 - Equipment Installation, for heat pumps, air conditioning units, and motors.

.2 Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement or details shown to equipment furnished.

.3 Sample copy of guarantee.

.4 Test reports.

.5 O&M Data in conformance with Section 01730 - Operation and Maintenance Manuals.

.1 Include wiring and control diagrams for equipment.

.2 Include as-built version of equipment schedules.

1.4 Quality Assurance

.1 Cooling Equipment: minimum operating efficiencies, defined as EER, as specified in ASHRAE 90.1.

.2 Unit shall be rated (when matched with appropriate outdoor unit) per ARI 210/240.

.3 Units shall be certified by UL and CSA, and shall be UL or cETL listed and labeled.

.4 Cooling performance rated in accordance with ARI testing procedures.

1.5 Delivery, Storage and Handling

.1 Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

.2 Protection of Equipment:

.1 Box, crate, or otherwise protect from damage and moisture during shipment, handling, and storage.

.2 Protect from exposure to corrosive fumes and keep thoroughly dry at all times.

.3 Store motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings in weathertight and heated storage facilities prior to installation.

.4 For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

1.6 Extra Materials

.1 Tools: Furnish one complete set of special tools recommended by the Manufacturer for maintenance, dismantling, or repair of each separate type of equipment. Furnish a tool box for storage of the special tools. Identify with the associated equipment number by means of a stainless steel or solid plastic nametag attached to the box.

2. PRODUCTS

2.1 General

.1 Specified components of this Section, including insulation, facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

.2 Multiple Compressor Units:

.1 Supply and Install completely independent refrigeration circuits and controls.

.2 Indoor unit air coils shall have intermingled circuits, unless specified otherwise.

2.2 Split System Heavy Duty AC Outdoor Units

.1 General:

.1 Units shall be completely factory assembled, wired, piped, precharged with R-407 and fully tested in all modes of operation. Non-HFC refrigerant will not be accepted.

.2 Match with associated indoor unit.

.3 Units with multiple compressors shall have completely independent refrigeration circuits and controls to balance heat rejection of each compressor.

.4 Refrigerant pipes shall be copper type "L" and vinyl coated for corrosion prevention.

.5 Factory test reports shall be available on request. Engineer reserves the right to witness factory performance testing.

.6 Manufacturer shall have a minimum of five (5) years experience in the production of dehumidification systems.

.2 Unit Cabinet:

.1 Weatherproof.

.2 Supported on steel full-length mounting rails.

.3 Removable access panels to all internal components and the electrical panel without impairing unit operation.

.4 Knockouts for unit electrical power.

.5 Protective guards on each fan discharge and each coil inlet.

.6 Unit shall be constructed of G-90 galvanized steel with minimum gauge thickness of:

.1 Bases: 16 gauge.

.2 Corner Posts and Tops: 18 gauge.

.3 Access Panels: 20 gauge.

.7 Base:

.1 Unit base pan shall be poured with minimum 6 mm hot asphalt (tar) to prevent rain or condensate from contacting steel on bottom of base pan.

.2 Asphalt shall be poured prior to final factory assembly to assure protection of all steel areas.

.8 Paint Finish:

.1 Painted internally and externally.

.2 Exterior parts shall be thoroughly cleaned chemically, zinc-phosphate coated, and sealed with chromic rinse.

.3 Paint shall be electrically deposited by immersion dipping in a cationic electro-deposition paint system.

.4 Paint shall be baked for a minimum of twenty minutes at 204°C.

.5 MDFT: 1 mil.

.6 Finish shall meet or exceed a 1,000-hour salt spray test per ASTM B117.

.9 Hardware:

.1 Exterior nuts, bolts and washers shall be Type 304 stainless steel.

.2 Exterior screws shall be either Type 304 stainless steel or coated with an epoxy finish that meets or exceeds minimum 4,000 hours Salt Spray Test per ASTM B117.

.3 Compressor:

.1 Compressors shall be hermetic, reciprocating or scroll type complete with crankcase heaters and motors equipped with internal overheat-overload protection.

.2 Provide a five (5)-year compressor warranty.

.4 Condenser Coil:

.1 Coils shall be aluminum plate fins formed on multiple rows of seamless copper tubing arranged in a staggered tube configuration.

.2 Tubes shall be mechanically expanded, firmly bonding tube to shoulder of each fin.

.5 Condenser Fan:

.1 Propeller type, electronically balanced and direct-driven by fan motor.

.2 Motor:

.1 Fan motor(s) and compressor(s) shall be UL/ULC or CSA listed.

.2 Corrosion resistant motor shaft.

.3 Totally enclosed, Class B insulation, sealed ball bearings.

.4 Thermal overload protection.

.3 Outdoor air shall be discharged through a vinyl coated fan guard.

.6 Refrigeration Components:

.1 Spring mounted hermetic compressor.

.2 Crankcase heater.

.3 Liquid line solenoid.

.4 Suction line accumulator.

.5 Condenser coil.

.6 Rubber mounted upflow propeller condenser fans.

.7 Connections for refrigerant piping and specialties.

.8 Filter-drier.

.9 Sight glass-moisture indicator.

.10 Refrigerant pressure service valves.

.7 Controls:

.1 Factory adjusted and preset to design conditions.

.2 Complete with transducers, thermostats, and electrical control circuit factory pre-wired in control panel.

.3 Compressor and fan motor contactors or starters.

.4 Terminal strip for connection of remote controls.

.5 Refrigerant controls shall include a high pressure control (manual-reset), low pressure control (auto-reset), head pressure control, field adjustable refrigerant system lock-out and compressor anti-short cycle timer.

.6 Safeties:

.1 Compressor winding and overheat protection.

.2 Thermal protection (auto-reset) on all inductive loads.

.3 Overload protection in each leg.

.8 Accessories: Supply and Install as follows:

.1 Compressor Cycle Delay: Compressor prevented from restarting for a minimum of five (5) minutes after shutdown.

.2 Hot Gas Bypass: Cooling capacity modulation with hot-gas solenoid valve and bypass piping on both compressors.

.3 Evaporator Freeze Thermostat: SPST temperature activated switch, shuts down unit upon evaporator freeze-up.

.4 Filter Drier: Liquid line mounted, bi-flow type for heat pumps.

.5 Liquid Solenoid Valve: Electric operated shutoff valve, bi-flow for heat pumps, interlocked with compressor operation.

.6 Acceptable Manufacturers: Aaon.

2.3 Electrical

.1 General:

.1 Units shall include high and low voltage terminal block connections.

.2 Control voltage to indoor unit fan shall be 24 V.

.3 Motor Starters/Contactors: Factory installed with unitary equipment, unless otherwise noted.

.4 Disconnects: Factory installed nonfused disconnects or circuit breakers on each unit.

.2 Motors:

.1 Unless otherwise stated, electric motors shall comply with the following:

.1 Voltage, Phase, Horsepower, Synchronous Speed: Refer to Equipment Schedule for motor driven equipment.

.2 Enclosure: ODP, unless specified otherwise.

.3 Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.

.4 Winding Thermal Protection: Manufacturer’s standard.

.5 Space Heater: Manufacturer’s standard.

.6 Multispeed Motors, Synchronous Speed; Number of Windings: Manufacturer’s standard.

.7 Efficiency: In accordance with Section 15010, General Mechanical Provisions.

2.4 Accessories

.1 Lifting Lugs: Suitably attached for equipment assemblies and components weighing over 45 kg.

.2 Equipment Identification Plates: Furnish 1.6 mm (16-gauge) stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 10mm high engraved block type black enamel filled

equipment identification number and letters indicated in this Specification and as shown on drawings.

.3 Anchor Bolts: Type 316 stainless steel, sized by equipment Manufacturer, 12 mm minimum diameter, quantity as recommended by Manufacturer.

2.5 Source Quality Control

.1 Factory Tests:

.1 Direct expansion coils leak tested underwater with 1380 kPa air. Pressure tested to 3100 kPa.

.2 Electric heating coils tested with 2,000 V dielectric test.

2.6 Equipment Schedules

.1 Refer to Section 15999 – List of Schedules.

3. EXECUTION

3.1 Installation

.1 Set and install equipment so that equipment is level and properly supported.

.2 Make certain that piping connections to equipment do not cause any strain on equipment.

.3 Make certain that vibration isolation has been installed per Manufacturer's instructions and isolation devices are performing satisfactorily.

.4 Install equipment in accordance with Section 01650 – Equipment Installation and with the Manufacturer's recommendations.

.5 Install all safety devices as recommended by Manufacturer and/or required by code in these Specifications.

.6 Initial equipment startup shall be performed by the Manufacturer's Representative.

.7 Startup: The Manufacturer's Representative shall perform the following services. Supervision only, of Contractor personnel, will not be acceptable.

.1 Leak test.

.2 Refrigerant pressure test.

.3 Evacuate (if required).

.4 Dehydrate (if required).

.8 Factory Checkout:

.1 Contractor shall secure the services of the Manufacturer's Representative who shall inspect the installation including external interlock, power connections; supervise initial operation, calibration of operating and safety controls and supervise electrical testing including insulation resistance of motors and voltage balance between phases during starting and running.

.2 This Manufacturer's Representative shall forward a report in three copies to the Contract Administrator via the Contractor when the unit is in safe and proper operating condition. This report shall contain all pressure and control settings, meg readings, voltage readings per phase during START and RUN, suction temperature and pressure, liquid temperature and pressure, and shall list minor discrepancies to be corrected which do not affect safe and reliable operation.

.3 One additional copy of report shall be left in unit control panel. One copy of bound installation operation and maintenance service, and parts brochures, including applicable serial numbers, full unit description, parts ordering sources, shall be placed in the unit control panel at the time of starting.

.9 Locate units to provide access for filter changing; motor, drive, and bearing servicing; and fan shaft and coil removal.

.10 Isolate sheet metal duct connections from all portions of the unit not internally spring-isolated from fans, or other vibrating or rotating equipment.

.11 Inspect internal casing insulation, seal all exposed edges, and butt joints with mastic to ensure insulation will not be loosened during operation.

3.2 Adjusting and Cleaning

.1 Air System Balancing: As specified in Section 15950, HVAC Systems Testing, Adjusting, and Balancing.

.2 Lubricate unsealed bearings prior to startup.

.3 Do not operate units until filters are installed. If operated without filters, completely clean ductwork, coils, and interior of units.

3.3 Filters

.1 Supply and Install a complete set of filters in each unit before operating, and leave in place during startup and testing to keep the equipment and ductwork clean.

.2 Supply and Install a complete set of new filters at the time of Commissioning.

3.4 Training

.1 The training of City's personnel shall be carried out as per Section 01664 - Training.

3.5 Warranty

.1 Furnish Manufacturer's extended warranty, with City named as beneficiary, for a period of five (5) years after the date of Total Performance. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.

END OF SECTION

TERMINAL HEAT TRANSFER UNITS

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 CGA

.2 AMCA: Bulletin 300

.3 ASHRAE: 90.1, Energy Standard for Building Except Low-Rise Residential Buildings

.4 ASTM: A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

.5 NFPA:

.1 54, National Fuel Gas Code

.2 70, NEC

.3 90A, Standard for the Installation of Air Conditioning and Ventilating Systems

.6 SMACNA: Ducted Electric Heat Guide for Air Handling Systems.

.7 ULC: Product Directories.

.8 CSA:

.1 B149.1, Natural Gas and Propane Installation Codr

.2 C22.1, Canadian Electrical Code

.9 Provincial Gas Code.

1.2 Submittals

.1 Action Submittals:

.1 Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for products specified.

.2 Manufacturer’s standard finish color selection for cabinet finishes.

.3 Performance Data, including sound power level data (ref. 10 to minus 12 watts) at design operating point, shall be based on AMCA Bulletin 300, Setup No. 1.

.2 Informational Submittals:

.1 Recommended procedures for protection and handling of equipment and materials prior to installation.

.2 O&M Data: As specified in Section 01730 – Operation and Maintenance Manuals.

.3 Certificate of Satisfactory Installation, Form 102, in accordance with Section 01650 – Equipment Installation.

1.3 Quality Assurance

.1 Heating Equipment: Minimum operating efficiencies, specified in Chapter 6 of ASHRAE 90A.

2. PRODUCTS

2.1 Supplements

.1 See supplements to this Section for additional product information.

2.2 Hydronic Unit Heaters, UH

.1 Casing: 18 gauge steel with threaded connections for hanger rods.

.2 Coils: Seamless copper tubing, 0.6 mm (24 ga) minimum wall thickness, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.

.3 Fan: Direct drive propeller type, statically and dynamically balanced. Horizontal models complete with sleeve bearings and fan guard. Vertical model complete with grease lubricated ball bearings.

.4 Air Outlet: Adjustable pattern diffuser on projection models and four-way louvers on horizontal throw models.

2.3 Fan Coil Units, FC

.1 Characteristics:

.1 DWDI forward curve fan wheel

.2 Belt-driven motor

.3 Heating coil

.4 Disposable filters

.2 Cabinet:

.1 18-gauge steel baked enamel paint finished. Color shall be selected by the Contract Administrator from manufacturer's standard color chart.

.2 25 mm Insulation.

.3 Screwed access panel

.4 Adjustable motor mounts

.5 50mm throwaway filters

.6 External vibration isolator

.7 One piece unit construction factory tested prior to shipping.

.3 Hot Water Heating Coil: serpentine type with aluminum fins mechanically bonded to seamless copper tubes.

.4 Controls: unit control shall be DDC based, supplied by the HVAC Control trade, installed and tested at the factory prior to shipping.

.5 Accepted Manufacturers and Products:

.1 Engineered Air, Model JM-700

.2 McQuay

.3 Trane

2.4 Electric Radiant Heaters, ERH

.1 Characteristics:

.1 Electric infrared radiant heater with single tubular element

.2 Extruded aluminum, anodized and chemically brightened reflectors

.3 Swivel bracket and set screw adjustment

.4 Power supply: 600 V, single phase, 60 Hz.

.5 Finish: Manufacturer's standard.

.2 Acceptable Manufacturers:

.1 CCI Thermal Caloritech; OKB Series.

2.5 Electric Unit Heaters, EHU

.1 Housing

.1 Carbon steel

.2 Heating Element

.1 Stainless steel (2-30 kW).

.3 Mounting

.1 Bracket and hardware for ceiling or wall mounting.

.4 Grilles

.1 Adjustable discharge louvers

.5 Guard

.1 Fan guard

.6 Controls

.1 120 V control transformer

.2 Dual manual and auto reset temperature cutout

.3 Fan delay relay

.4 Controlling magnetic contactors

.5 Power Disconnect, 3P, 20A, 600V

.6 Safety contactor

.7 Terminal blocks for field wiring

.8 Motor contactor

.9 Control enclosure to suit

.7 Finish

.1 Standard factory finish

.8 Acceptable Manufacturers:

.1 Chromalox, Type EUH.

.2 Ouellet.

2.6 Electric Convectors, EC

.1 Cabinet and General Arrangement:

.1 Slope top design.

.2 2.0 mm thick (14-gauge) extruded aluminum front and top.

.3 Satin coat steel back and bottom.

.4 Removable endcaps.

.2 Heating Elements

.1 Aluminum finned stainless steel tubular element.

.2 Floating element suspension.

.3 Controls: Built-in thermostat.

.4 Built-in disconnect switch, rated 600 V, 25A

.5 Acceptable Manufacturers:

.1 Chromalox, AS8 Signature II Series.

.2 Ouellet.

2.7 Accessories

.1 Equipment Identification Plates: Furnish 1.6 mm (16-gauge) stainless steel identification plate securely mounted on each piece of equipment in a readily visible location. Plate shall bear 10 mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

.2 Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 45 kg.

3. EXECUTION

3.1 Installation

.1 Hydronic Unit Heaters and Fan Coil Units

.1 Each terminal heat transfer unit shall come complete with shut-off valve on supply and lockshield balancing valve on return piping.

.2 At high points, supply and install for each unit an easily accessible manual air vent. If not easily accessible, extend vent to exterior surface of cabinet for each servicing.

.3 All heating system piping shall be thoroughly cleaned, flushed, drained and refilled before heat transfer units are connected to the system.

.2 Electric Unit Heaters

.1 Install in accordance with Manufacturer's recommendations.

.2 Mount bottom of unit at 2400 mm above the finished floor, except where noted otherwise on Drawings.

3.2 Manufacturer's Services

.1 Provide Manufacturer's Representative at Site in accordance with Section 01650 Equipment Installation, for installation assistance, inspection and certification, equipment testing, startup assistance, and Section 01664 Training for training of City's personnel for specified equipment.

3.3 Equipment Schedules

.1 Refer to Section 15999 – List of Schedules.

.2 Unit heater capacities are based on 15.6°C (60°F) entering air temperature, 82°C (180°F) average water temperature, with an 11°C (20°F) temperature drop.

END OF SECTION

METAL DUCTWORK AND ACCESSORIES

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 AMCA: 500, Test Methods for Louvers, Dampers and Shutters.

.2 ASHRAE Handbook.

.3 INDA: IST 80.6, Water Resistance (Hydrostatic Pressure Test).

.4 ASTM:

.1 A36/A36M, Standard Specification for Carbon Structural Steel.

.2 A90/A90M, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.

.3 A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.4 A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.5 A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

.6 A176, Standard Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip.

.7 A240/A240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.

.8 A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.9 A563/A563M Standard Specification for Carbon and Alloy Steel Nut.

.10 A568/A568M, Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.

.11 A653/A653M, Standard Specifications for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.12 A700, Standard Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment.

.13 A1008/A1008M, Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

.14 A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

.15 B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.16 C916, Standard Specification for Adhesives for Duct Thermal Insulation.

.17 C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

.18 C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.

.19 E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.20 E96, Standard Test Methods for Water Vapour Transmission of Materials.

.5 NFPA:

.1 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

.3 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.

.4 259, Standard Test Method for Potential Heat of Building Materials.

.6 SMACNA:

.1 Duct Construction Standards.

.2 Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.

.3 HVAC Air Duct Leakage Test Manual.

.7 UL:

.1 181, Standard for Safety Factory-Made Air Ducts and Connectors.

.2 555, Standard for Safety Fire Dampers.

.3 555C, Standard for Safety Ceiling Dampers.

.8 ULC.

.9 National Fire Code of Canada.

.10 NBC.

1.2 Submittals

.1 Action Submittals:

.1 Ductwork Accessories:

.1 Manufacturer's product data including details of materials, construction, dimensions of individual components, installation details, and finishes for the following items:

.1 Duct liner.

.2 Sealing materials.

.3 Dampers; include leakage, pressure drop, and maximum back pressure data.

.4 Duct-mounted access panels and doors.

.5 Insulated flexible ducts.

.6 Sheet metal fasteners.

.2 Duct Fabrication Drawings:

.1 Drawn after actual job measurements are obtained.

.2 Drawn to a scale not smaller than 1:50, on drawing sheets same size as Contract Drawings, detailing:

.1 Fabrication, assembly, and installation details including plans, elevations, sections, details of components, and attachments to other work.

.2 Duct layout, indicating pressure classifications, and sizes in plan view.

.3 For materials handling exhaust duct systems, indicate classification of materials handled.

.4 Duct material and thickness.

.5 Fittings and volume control damper installation (both manual and automatic) details.

.6 Reinforcing details and spacing.

.7 Seam and joint construction details.

.8 Penetrations through fire-rated and other partitions.

.9 Duct accessories and control devices such as automatic dampers, airflow monitors, terminal units, smoke detectors, regulators, air distribution devices, etc.

.10 Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

.11 Fire damper installations, including sleeves and duct-mounted access door and panel installation.

.12 Coordination with ceiling suspension members.

.13 Spatial coordination with other systems installed in same space with duct systems.

.14 Coordination of ceiling- and wall-mounted access doors and panels required for access to dampers and other operating devices.

.15 Coordination with ceiling-mounted lighting fixtures, air outlets, and inlets.

.3 Shop Drawings shall indicate the coordination of ductwork with sprinkler piping and other mechanical and electrical services, and equipment installed under Division 15 and Division 16.

1.3 Informational Submittals:

.1 Sound Attenuators Certified Test Data:

.1 Dynamic insertion loss.

.2 Self-noise power levels.

.3 Static pressure loss.

.4 Dimensions and weights.

1.4 Quality Assurance

.1 Industry Standards:

.1 Unless otherwise indicated or specified, sheet metal ductwork shall be constructed and installed in accordance with SMACNA duct construction standard relevant to ductwork

system. These standards are herein referenced as the SMACNA Manual, unless otherwise indicated.

.2 Comply with ASHRAE Fundamentals Handbook recommendations, except as otherwise indicated.

.3 NFPA Compliance: NFPA 90A and NFPA 90B.

.2 Manufacturers: Firms regularly engaged in manufacture of ductwork products of types, materials, and sizes required, whose products have been satisfactorily used in similar service for not less than five (5) years.

.3 The Contractor shall provide on request the following information:

.1 Laboratory performance data for duct, including leakage rate, bursting strength, collapse strength, seam strength, and pressure loss.

.2 Laboratory performance data for fittings, including zero-length dynamic losses.

.4 The Subcontractor shall be a firm with at least 3 years' experience of successful installation on ductwork systems similar to that required for this Work.

.5 Changes or alterations to layout or configuration of duct system shall:

.1 Specifically be approved in writing by Contract Administrator.

.2 Provide original design results, without increasing system total pressure.

1.5 Delivery, Storage and Handling

.1 Protect ductwork from dirt, water, and debris. During storage on Site, keep ends of ductwork covered to prevent foreign objects and water from entering ductwork.

.2 Deliver sealant materials to Site in original unopened containers labelled with manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

.3 Store and handle sealant materials in compliance with manufacturers' recommendations to prevent deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

.4 Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

2. PRODUCTS

2.1 General

.1 Specified components of this ductwork system, including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

.2 Internally Lined Ductwork: Duct sizes indicated for internally lined ducts are the clear inside dimensions, and shall be increased in both dimensions by twice the thickness of the liner.

.3 Ductwork Interior Surfaces:

.1 Smooth.

.2 No sheet metal parts, tabs, angles, screws, or other items may project into air ducts, unless otherwise specified.

.3 Seams and joints shall be external.

2.2 Sheet Metal Materials

.1 Construct metal duct systems from materials as indicated in Section 15999 – List of Schedules.

.2 Where no specific ductwork materials are indicated in Specifications or on Drawings, galvanized steel sheet metal shall be basis of Contract.

.3 Galvanized Steel Ductwork:

.1 Comply with ASTM A653/A653M.

.2 Galvanized steel sheet, lock forming quality, zinc coating designation G90 in conformance with ASTM A90/A90M.

.3 Sheet metal shall bear LFQ and G90 marks.

.4 Provide mill-phosphatized finish for ducts exposed to view and for ducts scheduled to be painted.

.5 Provide sheet metal packaged and marked as specified in ASTM A700.

.4 Aluminum Ductwork:

.1 Comply with ASTM B209.

.2 Aluminum Sheet: Alloy 3003-H14, unless indicated otherwise.

.3 Aluminum Connectors and Bar Stock: Alloy 6061-T6 or approved equal.

.5 Stainless Steel Ductwork:

.1 Comply with ASTM A167, A176, A240/A240M, and ASTM A480.

.2 Stainless Steel Sheet: Type 304, unless indicated otherwise.

.3 Gauge shall comply with SMACNA manual, unless specified otherwise.

.4 Finish: No. 2 B (cold-rolled, bright) finish, except as otherwise noted.

.5 With No.4 finish on exposed surface for ducts exposed to view.

.6 Exposed Ductwork: Where ductwork is exposed to view in occupied spaces, supply and install free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discoloration, and other imperfections, including those which would impair painting.

.7 Reinforcement Shapes and Plates: Unless otherwise indicated, supply and install reinforcements of same material as ductwork.

2.3 Duct Sealing Materials

.1 General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

.2 Adhesives, Cements, Sealant, and Installation Accessories: As recommended by duct manufacturer for application.

.3 Solvent-Based Sealants:

.1 UV light resistant.

.2 Mildew resistant.

.3 Flashpoint: Greater than 21oC, SETA CC.

.4 Acceptable Manufacturers:

.1 Hardcast, Inc.; Versagrip 102.

.2 Rectorseal; AT-33.

2.4 Firestopping

.1 Supply and Install firestopping in accordance with Division 7.

2.5 Ductwork Fasteners

.1 General:

.1 Rivets, bolts, or sheet metal screws.

.2 Ductwork fasteners shall be same metal as duct being supported, unless otherwise noted.

.2 Self-Drilling Screws:

.1 Galvanized Steel Ductwork System:

.1 Sheet metal screws shall be HWH TEKS® self-drilling type, formed from heat-treated carbon steel with zinc electroplated finish.

.2 Aluminum Ductwork System:

.1 Sheet metal screws shall be HWH TEKS® self-drilling type, formed from heat-treated Marutex® stainless steel with strength of Type 410 stainless steel and corrosion resistance of Type 304 stainless steel, complete with bonded metal and fibre washer for dielectric separation.

.2 Manufacturers:

.1 DB Building Fasteners Inc., Santa Fe Springs, CA.

.2 Clark Craft Fasteners, Tonawanda, NY.

.3 UCAN Fastening Products.

.3 Stainless Steel Ductwork System:

.1 Sheet metal screws shall be HWH TEKS® self-drilling type, formed from heat-treated Marutex® stainless steel with strength of Type 410 stainless steel and corrosion resistance of Type 304 stainless steel.

.2 Manufacturers:

.1 DB Building Fasteners Inc., Santa Fe Springs, CA.

.2 Clark Craft Fasteners, Tonawanda, NY.

.3 UCAN Fastening Products.

2.6 Ductwork Pressure Class

.1 Construct duct systems to pressure classifications indicated in as follows:

.1 Supply Ducts: 750 Pa.

.2 Return Ducts: 500 Pa, negative pressure.

.3 Exhaust Ducts: 500 Pa, negative pressure.

.2 Where no specific duct pressure designations are indicated in Specifications or on Drawings, 500 Pa pressure class shall be basis of Contract.

2.7 Rectangular Ductwork

.1 Fabricate rectangular ducts in accordance with SMACNA Rectangular Industrial Duct Construction Standards, unless specified otherwise.

.2 Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 480 mm and larger and are 0.95 mm thick (20-gauge) or less, with more than 1.0 square metre of unbraced panel area, as indicated in SMACNA Manual, unless they are lined or are externally insulated.

.3 Air Handling Unit Discharge Ductwork: Ductwork extending from air handling units up to and including first elbow or terminal tap shall be constructed of 1.6 mm thick (16-gauge), minimum.

2.8 Rectangular Ductwork Fittings

.1 Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA Rectangular Industrial Duct Construction Standards.

.2 Elbows:

.1 Fit square-turn elbows with vane side rails.

.2 Shop fabricate double-blade turning vanes of same material as ductwork.

.3 Fabricate with equal inlet and outlet.

.4 Rectangular radius elbows with inside radius of 3/4 of duct width in direction of turn.

.5 Acceptable Manufacturers:

.1 Elgen; All-Tight.

.2 Duro-Dyne; Type TR.

2.9 Rigid Round Ductwork

.1 Construct rigid round ducts in accordance with SMACNA Round Industrial Duct Construction Standards, unless specified otherwise.

.2 Basic Round Diameter: As used in this Article, is diameter of size of round duct that has circumference equal to perimeter of a given size of flat oval duct.

.3 Where space limitations prevent use of round duct or where shown on Drawings, supply and install ductwork of flat oval construction.

.4 Fabricate round ducts with spiral seam construction, except where diameters exceed 1800 mm. Fabricate ducts having diameters greater than 1800 mm with longitudinal butt-welded seams.

.5 Single Wall Ductwork: Unless otherwise indicated, rigid round shall be of single wall construction.

2.10 Rigid Round Ductwork Fittings

.1 Construct rigid round ductwork fittings in accordance with SMACNA Round Industrial Duct Construction Standards, unless otherwise specified.

.2 90-Degree Tees, Laterals, and Conical Tees: Fabricate to conform to SMACNA manual with metal thicknesses specified for longitudinal seam straight duct.

.3 Diverging Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.

.4 Elbows:

.1 Fabricate in stamped (die-formed), pleated, or segmented (gored) construction 1.5 times elbow diameter. Two piece segment elbows are not allowed, except with turning vanes.

.2 Segmented Elbows: Fabricate with welded construction.

.3 Round Elbows 200 mm and Smaller:

.1 Stamped elbows for 45 and 90 degree elbows and pleated elbows for 30, 45, 60, and 90 degree Configuration.

.2 Fabricate nonstandard bend angle configurations or nonstandard sized (e.g., 90 and 115 mm) elbows with segmented construction.

.4 Round Elbows 225 mm Through 350 mm:

.1 Segmented or pleated elbows for 30, 45, 60, and 90 degrees.

.2 Fabricate nonstandard bend angle configurations or nonstandard sized (e.g., 240 and 265 mm) elbows with segmented construction.

2.11 Insulated Flexible Duct

.1 Fabricate in accordance with:

.1 UL 181, Class 1.

.2 NFPA 90A and NFPA 90B.

.2 Construction:

.1 Outer Jacket: Fire retardant reinforced aluminum vapour barrier jacket with reinforced cross-hatched scrim having a permeance of not greater than 0.1 perm when tested in accordance with ASTM E96, Procedure A.

.2 Inner Liner: Tri-laminate of aluminum foil, fibreglass, and aluminized polyester.

.3 Reinforcing: Galvanized steel wire helix, mechanically locked to and encapsulated by inner liner fabric.

.4 Insulation:

.1 Factory insulated with fibreglass insulation.

.2 RSI – 1.06 minimum at a mean temperature of 24 C.

.5 Internal Working Pressure: Rating shall be minimum 1500 Pa positive and 1000 Pa negative, with bursting pressure of at least 2-1/2 times working pressure.

.6 Air Velocity Rating: 20 m/s, minimum.

.3 Environment: Suitable for continuous operation at temperature range of minus 29^{o}C to plus 121^{o}C.

.4 Acceptable Manufacturers:

.1 Flexmaster; Type T/L-A.

2.12 Ductwork Hangers and Supports

.1 General:

.1 Attachments, hangers, and supports for ductwork shall be in accordance with SMACNA Manual referenced for type of duct system being installed.

.2 Duct hanging system shall be composed of three elements; upper attachment to building, hanger itself, and lower attachment to duct.

.3 Wire hangers are not acceptable.

.4 Hanger Spacing:

.1 Ducts Up to 1500 mm in Largest Dimension: 3.0 m, maximum.

.2 Ducts Over 1525 mm in Largest Dimension: 2.4 m, maximum.

.2 Construction Materials: Supporting devices including, but not limited to, angles used for support and bracing, baseplates, rods, hangers, straps, screws, bolts shall be as follows:

.1 Galvanized Steel Ductwork:

.1 Indoors: Carbon steel, zinc electroplated.

.2 Outdoors: Carbon steel, hot-dipped galvanized after fabrication.

.2 Aluminum Ductwork Indoors and Outdoors: Carbon steel, hot-dipped galvanized after fabrication.

.3 Stainless Steel Ductwork Indoor and Outdoors: Stainless steel, same ASTM Grade as ductwork.

.3 Building Attachments:

.1 Concrete inserts, powder-actuated fasteners, or structural steel fasteners appropriate for building materials.

.2 Do not use powder-actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 100 mm thick.

.3 Upper Attachment (Concrete):

.1 Drive pin fastener and expansion nail anchor may be used for ducts up to 450 mm maximum dimension.

.2 Threaded stud fastener may be used for ducts up to 900 mm maximum dimension.

.3 Concrete attachments shall be made of steel.

.4 Trapeze and Riser Supports: Steel shapes conforming to ASTM A36/A36M, hot-dipped galvanized after fabrication.

2.13 Flexible Connections

.1 Materials:

.1 Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

.2 Outdoor flexible connectors coated with Hypalon for UV protection.

.2 Metal Edged Connectors:

.1 Construct from same material as ductwork, unless otherwise noted.

.2 Fold and crimp metal edge strips onto fabric as illustrated in SMACNA Manual.

.3 Standard Metal Edged Connectors: Factory fabricated with strip of fabric 90 mm wide attached to two strips of 70 mm wide sheet metal.

.4 Extra Wide Metal Edged Connectors: Factory fabricated with strip of fabric 146 mm wide attached to two strips of 70 mm wide sheet metal.

.5 Transverse Metal Edged Connectors: Factory fabricated with strip of fabric 90 mm wide attached to two strips of 111 mm wide sheet metal.

.3 Acceptable Manufacturers:

.1 Duro-Dyne; Durolon

.2 Dynair

.3 Papco Industries Inc.

2.14 Duct Inspection Doors

.1 General:

.1 Insulated, gasketed, and at least 375 mm x 375 mm when duct dimensions are large enough.

.2 On ductwork where largest side dimension is less then 400 mm, supply and install inspection doors at least 200 mm x 200 mm.

.3 Complete with necessary hardware.

.4 Fabricated of same material as ductwork or galvanized steel for fibreglass ductboard.

.2 Round Spin-in Type Access Doors:

.1 Size: 450 mm and 600 mm diameter will be acceptable in lieu of comparable size square or rectangular access doors specified herein.

.2 Complete with insulation, spin-in frame, inner door, attachment cable, gaskets, three latches, and pull ring.

.3 Casing and Plenum Access Doors:

.1 Size: 1425 mm high x 600 mm wide minimum where possible.

.2 Complete with hardware, hinges, seals, and latch handles.

.4 Manufacturers:

.1 Duro-Dyne

.2 Flexmaster

2.15 Manual Dampers

.1 Butterfly Manual Dampers:

.1 Fabricate from two gauges heavier than duct in which installed, of same material as ductwork or galvanized steel in fibreglass ductboard.

.2 Align operating handle with damper blade.

.3 Supply and install 50 mm standoff bracket for insulated duct systems.

.4 Damper Manufacturers:

.1 Ruskin.

.2 American Warming and Ventilating.

.5 Operator Manufacturers:

.1 Accessible Ductwork: Ventlok; Type 620 or 635.

.2 Accessible Insulated Ductwork: Ventlok; Type 639.

.3 Concealed Ductwork: Ventlok; Type 677 with extended operating rod and concealed regulator with plain cover.

.2 Manual Opposed-Blade Balancing Dampers:

.1 Externally operated gang airfoil, damper blades.

.2 Fabricate from same material as ductwork.

.3 Stainless steel or nylon sleeve bearings.

.4 Construction shall have interlocking edges and maximum 250 mm blade width.

.5 Acceptable Manufacturers:

.1 Ruskin; CD102.

.2 American Warming & Ventilating; Model VC-31.

2.16 Back Draft Dampers

.1 General:

.1 Damper pressure drop ratings shall be based on tests and procedures performed in accordance with AMCA 500.

.2 Heavy Duty Aluminum Counterbalanced Back Draft Dampers

.1 Fabrication:

.1 Frame: 57 mm x minimum 3.2 mm 6063-T5 extruded aluminum channel with front flange and rear flange and galvanized steel braces at mitered corners.

.2 Blades:

.1 Style: Single piece, overlap frame.

.2 Action: Parallel.

.3 Orientation: As indicted on drawings.

.4 Material: Minimum 1.8 mm 6063-T5 extruded aluminum.

.5 Width: Maximum 152 mm.

.3 Bearings: Corrosion-resistant, long-life, synthetic, formed as single piece with axles.

.4 Blade Seals: Extruded vinyl, mechanically attached to blade edge.

.5 Linkage: Minimum 13 mm aluminum tie bar with stainless steel pivot pins mounted on blades.

.6 Axles: Corrosion-resistant, long-life, synthetic, locked to blade and formed as single piece with bearings.

.7 Counterbalances: Adjustable zinc plated steel weights mechanically attached to blade enabling damper to operate over wide range of pressures.

.8 Mounting:

.1 Suitable for mounting in vertical, horizontal airflow up, and horizontal airflow down positions.

.2 Configured for positions as shown on Drawings.

.9 Finish: Mill aluminum.

.2 Performance Data:

.1 Temperature Rating: Withstand minus 40 to 93°C.

.2 Maximum Back Pressure: 4 kPa.

.3 Maximum Air Velocity: 12.7 m/s.

.4 Operation of Blades:

.1 Start to Open: 2.5 Pa.

.2 Fully Open: 12.5 Pa.

.2 Pressure Drop: Maximum 38 Pa at 7.6 m/s through 600 mm by 600 mm damper.

.3 Accessories:

.1 Duct Transition Connection: Rectangular.

.2 Factory Sleeve: Minimum 0.95 mm thick (20-gauge) thickness, minimum 305 mm length.

.4 Manufacturer and Product: Ruskin; Model CBD6.

2.17 Fire Dampers

.1 Duct Mounted Fire Dampers in Fire Walls with Rating of 2 Hours or Less:

.1 NFPA 90A rated for 1 ½ hour service.

.2 Blades, frame, and mounting angles same material as ductwork.

.3 Accordion style folded blades.

.4 74°C fusible link.

.5 Approved for installation with 2 hour fire rating.

.6 Rated, manufactured, tested, and approved in accordance with UL 555.

.7 Blades out of airstream when open (Type B).

.8 Supply and install sleeved frame for duct connections.

.9 Labeled for use in dynamic mode.

.10 Supply and Install dynamic and horizontal mounted dampers with springs for proper closure.

.11 Acceptable Manufacturers:

.1 Nailor-Hart; Model 0130, Type B.

.2 Ruskin; IBD20, Type B.

.2 Duct Mounted Fire Dampers in Walls with 3 Hour or Greater Fire Rating:

.1 NFPA 90A rated for 3 hour service.

.2 Blades, frame, and mounting angles.

.3 Accordion style folding blades.

.4 74 ^{o}C fusible link.

.5 Approved for installation in 4 hour wall.

.6 Rated, manufactured, tested, and approved in accordance with UL 555.

.7 Blades out of airstream when open (Type B).

.8 Supply and install sleeved frame for duct connection.

.9 Labeled for use in dynamic mode.

.10 Supply and install dynamic and horizontal mounted dampers with springs for proper closure.

.11 Corrosive Service Dampers: Type 316 stainless steel.

.12 Acceptable Manufacturers:

.1 Nailor-Hart; Model 0530, Type B.

.2 Ruskin; IBD23, Type B.

.3 Ceiling Grille and Diffuser Fire Dampers:

.1 UL Listed assembly with frame.

.2 Butterfly type blades.

.3 74^{o}C fusible link.

.4 Radiation type damper.

.5 Acceptable Manufacturers:

.1 Nailor-Hart; Model 0722 or 0716

.2 Ruskin; Type CFD Series

.4 Door Grille Fire Dampers:

.1 UL Listed assembly with frame for use in fire doors up to 1½ hour rating.

.2 16 gauge CRS frame and louvre blades complete with fusible link.

.3 Standard of Acceptance:

.1 Air Louvers; Model 1900-A.

2.18 Control Dampers

.1 Refer to Section 15901 - HVAC Controls, Field Components and Instruments for requirements.

2.19 External Duct Insulation

.1 Refer to Section 15085 - Mechanical Thermal Insulation.

2.20 Miscellaneous Accessories

.1 Sheet Metal Plenums:

.1 Fabricate from minimum 1.3 mm thick (18-gauge) metal of same material as ductwork.

.2 Brace with frame of same material for rigidity.

.3 Line with sound attenuation material where indicated.

.2 Louver and Grille Blank-off Sections:

.1 Fabricate from 20-gauge sheets of same material as louver/grille.

.2 Line with sound attenuation/insulating material.

.3 Shop-prime and paint outside face of blank-off section with two coats of flat black exterior paint.

.3 Auxiliary Drain Pans:

.1 Dimensions: Minimum 152 mm larger in both dimensions than equipment it is serving and 51 mm high, minimum.

.2 Construction: 16 gauge galvanized steel with brazed joints. Pans shall be watertight and have hemmed edges.

.3 Drain Connection:

.1 Minimum 25 mm IPS or as shown on Drawings.

.2 Locate at lowest point of drain pan.

.4 Prefabricated Roof Curb:

.1 Supply and install prefabricated roof curbs, flashing and counterflashing constructed of minimum 2.0 mm thick aluminum.

.2 Internal Insulation:

.1 Minimum of 38 mm thick, 48 kg/m^3 density, glass fibre insulation.

.2 Insulation seams sealed to prevent condensation.

.3 Welded or tabbed and riveted construction will be acceptable. Both types of construction shall be manufactured and sealed as required to be watertight and weatherproof.

.4 Lower section of roof curb that will be integrated with roofing system shall be constructed to accommodate roofing system.

.5 Top surface of curb shall have rubber weather-seal pad. Supply and install wooden nailer sections as required for installation.

.6 Sheet metal counterflashing shall be constructed to accommodate rectangular or round ductwork.

.7 Sheet metal screws and rivets shall be stainless steel or coated with corrosion-resistant material.

.8 Height of roof curb shall be 305 mm, unless otherwise indicated herein or on Drawings.

.9 Length and width of roof curb shall be sized by Contractor for particular application.

.10 Accepted Manufacturer:

.1 Factory fabricated by equipment manufacturer.

.5 Accessories Hardware:

.1 Instrument Test Holes:

.1 Cast metal, material to suit duct material, including screw cap and gasket and flat mounting gasket.

.2 Size to allow insertion of pitot tube and other testing instruments.

.3 Supply and install in length to suit duct insulation thickness.

.2 Flexible Duct Clamps:

.1 Stainless steel band with cadmium-plated hex screw to tighten band with worm-gear action.

.2 Supply and install in sizes from 75 mm to 450 mm to suit duct size.

.3 Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline, and grease.

3. EXECUTION

3.1 General Installation

.1 Miscellaneous:

.1 Install sheet metal ductwork and flexible ductwork in accordance with SMACNA Manual, NFPA 90A, and NFPA 90B.

.2 Install ductwork using Manufacturer's recommended adhesives, cement, sealant, and insulation accessories.

.3 Align ductwork accurately at connections, within 3.2 mm misalignment tolerance and with internal surfaces smooth.

.4 Interface Between Ductwork and Louvers: At locations where ductwork is connected to louver for either intake or exhaust purposes, ductwork shall be installed, sloped, and connected to louver so water entering ductwork system positively drains back to and out of louver.

.2 Ductwork Location:

.1 Locate ductwork runs vertically and horizontally, unless otherwise indicated.

.2 Avoid diagonal runs wherever possible.

.3 As indicated by diagrams, details, and notations or, if not otherwise indicated, run ductwork in shortest route that does not obstruct usable space or block access for servicing building and equipment.

.4 In general, install as close to bottom of structure as possible.

.5 For ductwork run above ceiling, maximize clearance between bottom of ductwork and top of ceiling construction.

.6 Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

.7 Ductwork that must transition and drop below piping or other ductwork shall be transitioned back to bottom of structure immediately adjacent to obstruction.

.3 Penetrations:

.1 Supply and install duct sleeves or prepared openings for duct mains, duct branches, and ducts passing through roofs, walls and ceilings.

.2 Clearances:

.1 For uninsulated ducts, allow 25 mm clearance between duct and sleeve, except at grilles, registers, and diffusers.

.2 For insulated ducts, allow 25 mm clearance between insulation and sleeve, except at grilles, registers, and diffusers.

.3 Closure Collars:

.1 Minimum 100 mm wide on each side of walls or floors where sleeves or prepared openings are installed.

.2 Fit collars snugly around ducts and insulation.

.3 Same gauge and material as duct.

.4 Grind edges of collar smooth to preclude tearing or puncturing insulation covering or vapor barrier.

.5 Use fasteners with maximum 150 mm centers on collars.

.4 Packing: Mineral fibre in spaces between sleeve or opening and duct or duct insulation.

.4 Concealment:

.1 Wherever possible in finished and occupied spaces, conceal ductwork from view by locating in mechanical shafts, hollow wall construction, or above suspended ceiling.

.2 Do not encase horizontal runs in solid partitions, except as specifically shown.

.3 Limit clearance to 25 mm where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any.

.5 Coordination with Other Trades:

.1 Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of ductwork system.

.2 Ductwork shall be configured, positioned, and installed to permit installation of light fixtures as indicated on Drawings.

.3 Coordinate ductwork layout with suspended ceiling, lighting and sprinkler head layouts and similar finished work.

.4 Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures.

3.2 Rectangular Ductwork

.1 Where possible, install ductwork so seams and joints will not be cut for installation of grilles, registers, or ceiling outlets.

.2 If cutting of seams or joints is unavoidable, reinforce cut portion to original strength.

3.3 Rectangular Ductwork Fittings

.1 Use bell-mouth or conical tee fittings for round duct takeoffs from rectangular mains.

.2 Use 45 degree entry fittings conforming to SMACNA requirements for rectangular takeoffs from rectangular or round mains.

.3 Make offsets with maximum angle of 45 degrees.

.4 Use fabricated fittings for changes in directions, changes in size and shape, and connections.

3.4 Rectangular Ductwork Transverse Joints

.1 Install each run with a minimum of joints.

.2 Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

.3 Mechanical Joint Option:

.1 Construct transverse joints with Ductmate 25/35 duct connector systems, W.D.C.I. Heavy/Lite duct connector systems, or Ductlok J/E duct connector system.

.2 When using W.D.C.I. Heavy/Lite system, construct ductwork in accordance to the W.D.C.I. Heavy J and Light H Assembly Manual and Duct Construction Standards.

.3 When using Ductlok J/E duct connector system, construct ductwork in accordance with Ductlok's Rectangular Duct Construction Manual for Low, Medium, and High Pressure.

.4 For longitudinal seams, use Pittsburgh lock seam sealed internally with permanently elastic sealer such as Ductmate 5511M mastic.

.5 Conform to SMACNA Class A sealing requirements.

3.5 Rigid Round Ductwork

.1 Except where interrupted by fittings, install round ducts in lengths not less than 3.6 m.

3.6 Rigid Round Ductwork Joints

.1 Rigid round ductwork joints shall be in accordance with SMACNA Round Industrial Duct Construction Standards, unless otherwise specified.

.2 Supply and Return System Joints:

.1 Less than 900 mm: Slip coupling.

.2 Larger than 900 mm: Flanged connector, Van Stone, or welded companion flange type.

.3 Exhaust and Return System Joints:

.1 All Sizes, Spiral Seam Duct: Welded flanged connector.

.2 All Sizes, Longitudinal Seam Duct: Van Stone flange connector.

3.7 Insulated Flexible Duct

.1 Installation:

.1 Where shown, between branch duct and ceiling diffusers and grilles.

.2 Without sags, kinks, sharp offsets, or elbows.

.3 As straight and taut as possible.

.2 Connection: Connect flexible ductwork to round collars, air distribution devices, and terminal units in accordance with flexible duct manufacturer's recommendations.

.3 Length:

.1 Maximum length of low-pressure flexible duct (construction pressure class up to 500 Pa) to be 2400 mm.

.2 Maximum length of medium pressure flexible duct (construction pressure class up to 1000 Pa) to be 1200 mm.

.4 Flexible ductwork shall not pass through wall, floor, or fire resistant rated assembly.

3.8 Ductwork Hangers and Supports

.1 Install ductwork with support systems in accordance with SMACNA Manual, unless otherwise noted.

.2 Support ducts rigidly with suitable ties, braces, hangers, and anchors of type, which will hold ducts true-to-shape and to prevent buckling.

.3 Install additional bracing on ductwork as required, to prevent ballooning or breathing.

.4 Support horizontal ducts within 610 mm of each elbow and within 1220 mm of each branch intersection.

.5 Support vertical ducts at maximum interval of 4900 mm and at each floor.

.6 Upper attachments to structures shall have allowable load not exceeding $^{1}/_{4}$ of failure (proof test) load, but are not limited to specific methods indicated.

.7 In new construction, install concrete insert prior to placing concrete.

3.9 Flexible Connections

.1 Flexible Collars and Connections:

.1 Use between fans and ducts.

.2 For round ducts, securely fasten flexible connections by zinc-coated steel clinch-type draw bands.

.3 For rectangular ducts, lock flexible connections to metal collars.

.4 Supply and install flexible connections between heat pump units and their associated supply and return ductwork

3.10 Dampers

.1 General:

.1 Inspection:

.1 Inspect areas to receive dampers.

.2 Notify Contract Administrator of conditions that would adversely affect installation or subsequent utilization of dampers.

.3 Do not proceed with installation until unsatisfactory conditions are corrected.

.2 Install dampers at locations indicated on Drawings and in accordance with Manufacturer's installation instructions.

.3 Install square and level.

.4 Handle damper using sleeve or frame. Do not lift damper using blades or jack-shaft.

.5 Damper blades and hardware shall operate freely without obstruction.

.6 Damper blades and hardware that bind within frame or obstructed by adjacent construction will not be acceptable.

.7 When installed, damper frames shall be gasketed or caulked to eliminate leakage between duct and damper frames.

.8 Head and sill shall have stops.

.9 Suitable for installation in mounting arrangement shown.

.10 Do not compress or stretch damper frame into duct or opening.

.2 Manual Dampers:

.1 Supply and install balancing dampers for grilles and diffusers in branch duct as near main as possible.

.2 Add or remove balancing dampers as requested by air balancing firm for necessary control of air.

.3 Back Draft Dampers:

.1 Install dampers square and free from racking with blades running horizontally.

.2 Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

.4 Fire Dampers:

.1 At ceiling grille and diffuser fire dampers, supply and install thermal blankets where required by local authorities.

.2 Install 1 ½ hour rated, unless otherwise indicated, at locations shown and in accordance with SMACNA Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.

3.11 Access Doors

.1 Ductwork: Install access doors in ductwork, in accordance with manufacturer's instructions, at each:

.1 Duct mounted fire damper.

.2 Duct mounted smoke or ionization detector.

.3 Motorized damper.

.4 Sail switch.

.5 Turning vane.

.6 Volume damper.

.7 Automatic damper.

.8 Temperature controller.

3.12 Sound Attenuators

.1 Install where shown and in accordance with applicable SMACNA Manual and manufacturer's recommendations.

.2 Supply and install dielectric separation where attenuator material differs from connected duct system.

3.13 External Duct Insulation

.1 Refer to Section 15085 - Mechanical Thermal Insulation.

3.14 Miscellaneous Accessories

.1 Auxiliary Drain Pans:

.1 Route drain lines to nearest floor or hub drain independent of any other drain.

.2 Slope drain pans toward drain connection to promote drainage.

.2 Louver and Grille Blank-off Sections:

.1 Attach airtight to louver or grille and install to allow for easy removal.

.3 Prefabricated Roof Curb:

.1 Supply and install for ductwork roof penetrations.

.2 Roof curb installation, including flashing and counterflashing, shall provide watertight weatherproof enclosure.

.3 Attach counterflashing to ductwork via rubber gasketed sheet metal screws.

.4 Fill space between counterflashing and ductwork with silicon-based sealant. Sealant shall also be applied at all sheet metal screw locations.

.4 Inspection Plates and Test Holes:

.1 Where required in ductwork for balance measurements.

.2 Test holes shall be, airtight and noncorrosive with screw cap and gasket.

.3 Extend cap through insulation.

3.15 Duct Sealing

.1 Seal duct seams and joints as follows:

.1 In accordance with SMACNA requirements.

.2 In addition to other requirements, provide the following duct sealing:

.1 For interior ductwork, tape joints with Hardcast Lag-Rite tape and bonder or Ray-Chem shrink tape.

.2 For exterior ductwork, tape joints with Hardcast outdoor tape and rosin.

.2 If no specific duct sealing requirements are specified, requirements of SMACNA manual shall govern.

.3 Seal externally insulated ducts prior to insulation installation.

.4 Provide additional duct sealing as required to comply with Article - Ductwork Leakage Testing.

3.16 Balancing and Testing of Air Systems

.1 Perform testing in accordance with the requirements of Section 15950 - HVAC Systems Testing, Adjusting, and Balancing.

3.17 Cleaning

.1 Ductwork shall be cleaned of rust, dust, and debris, both internally and externally, before placing in operation.

.2 Before installing air outlets, use air handler to blow dry air through entire system at maximum attainable velocity. Provide temporary air filters for this operation.

3.18 Schedules

.1 Refer to ductwork schedule in Section 15999 – List of Schedules.

END OF SECTION

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 ARI.

.2 AMCA:

.1 99, Standards Handbook.

.2 201, Fans and Systems.

.3 203, Field Performance Measurement of Fan Systems.

.4 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.5 300, Reverberant Room Method for Sound Testing of Fans.

.6 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.3 ABMA: 9, Load Ratings and Fatigue Life for Ball Bearings.

.4 ANSI: S2.19, Mechanical Vibration—Balance Quality Requirements of Rigid Rotors—Part 1, Determination of Permissible Residual Unbalance.

.5 ASHRAE: HVAC Applications Manual.

.6 ASTM:

.1 B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.

.2 D2247, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.

.3 D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

.4 D3363, Standard Test Method for Film Hardness by Pencil Test.

.5 D4167, Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.

.6 E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.7 NEMA: MG 1, Motors and Generators.

.8 NFPA: 45, Fire Protection for Laboratories Using Chemicals.

.9 OSHA.

.10 SSPC:

.1 SP 3, Power Tool Cleaning.

.2 SP 5, Joint Surface Preparation Standard White Metal Blast Cleaning.

.3 SP 6, Joint Surface Preparation Standard Commercial Blast Cleaning.

.4 SP 10, Joint Surface Preparation Standard Near-White Blast Cleaning.

.11 UL/ULC: 507, Electric Fans.

1.2 Definitions

.1 The following is a list of abbreviations which may be used in this Section:

.1 DWDI: Double Width, Double Inlet.

.2 SWSI: Single Width, Single Inlet.

1.3 Submittals

.1 Action Submittals:

.1 Provide for all products specified, as follows:

.1 Identification as referenced in Contract Documents.

.2 Manufacturer’s name and model number.

.3 Descriptive specifications, literature and drawings.

.4 Dimensions and weights.

.5 Fan sound power level data (reference 10 to power minus 12 Watts) at design operating point.

.6 Fan Curves:

.1 Performance Curves Indicating:

.1 Relationship of flow rate to static pressure for various fan speeds.

.2 Brake horsepower curves.

.3 Acceptable selection range (surge curves, maximum revolutions per minute, etc).

.4 Static pressure, capacity, horsepower demand and overall efficiency required at the duty point, including drive losses.

.2 For variable air volume applications, indicate operating points at 100, 80, 60 and 40% of design capacity on fan curves including data to indicate effect of capacity control devices such as inlet vanes on flow, pressure and brake horsepower.

.7 Capacities and ratings.

.8 Construction materials.

.9 Fan type, size, class, drive arrangement, discharge, rotation and bearings.

.10 Wheel type, diameter, revolutions per minute, and tip speed.

.11 Motor data.

.12 Power and control wiring diagrams, including terminals and numbers.

.13 Vibration isolation.

.14 Factory finish system.

.15 Color selection charts where applicable.

.16 Corrosion protection coating product data.

.2 "Or Equal" Equipment:

.1 Where submitted equipment results in change to fan inlet or outlet ductwork configuration shown on drawings, submit system effect factor calculations indicating increased static pressure requirements as described in AMCA 201.

.2 Where accepted equivalent equipment results in change to ductwork and equipment configuration shown on drawings, submit detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement to supplied equipment.

.2 Informational Submittals:

.1 Recommended procedures for protection and handling of products prior to installation.

.2 Manufacturer's installation instructions.

.3 Certificate of Equipment Delivery, Satisfactory Installation, Satisfactory Performance in accordance with Section 01650 – Equipment Installation.

.4 Test reports.

.5 O&M data in conformance with Section 01730, Operation and Maintenance Manuals. Include as-built version of equipment schedules.

1.4 Quality Assurance

.1 Performance Ratings: Tested in accordance with AMCA 210.

.2 Sound Ratings: Tested in accordance with AMCA 300.

.3 Fabrication: In accordance with AMCA 99.

1.5 Extra Materials

.1 Provide tag and box for shipment and storage the following spare parts and materials:

Item	Quantity
Vee Belts	One complete set per belt driven unit

.2 Delivery: In accordance with Section 01600 – Material and Equipment.

2. PRODUCTS

2.1 Equipment Schedules

.1 Some specific equipment requirements are listed in Equipment Schedules. Refer to Supplements.

2.2 Nameplates

.1 All units shall include factory installed permanently attached nameplate displaying unit model and serial number.

2.3 Operating Limits

.1 Fans designated to meet a specified fan class shall comply with requirements of AMCA 99-2408-69.

2.4 Acoustical Levels

.1 Equipment selections shall produce sound power levels in each octave band no greater than those generated by base-case equipment listed in the Equipment Schedule.

.2 In no case shall the sound power level be greater than 80 dBA at a distance of 1.5 m from the equipment.

2.5 Drives

.1 Supply and Install multiple drive belts where motor horsepower is 1.5 kW or larger.

.2 Drive assembly shall be sized for a minimum 140% of fan motor horsepower rating.

.3 Sheaves shall be capable of providing 150% of motor horsepower.

.4 Fan Shafts: First critical speed of at least 125% of fan maximum operating speed.

.5 Provide motors for V-belt drives with adjustable rails or bases.

.6 Unless otherwise noted, provide belt-driven fans with cast iron or flanged steel sheaves.

.7 Motors 15 kW or Smaller:

.1 Variable pitch V-belt sheaves allowing at least 20% speed variation.

.2 Final operating point shall be at approximate sheave midpoint.

.8 Motors Larger than 15 kW: Fixed-pitch sheaves.

.9 Drive Adjustment:

.1 When fixed-pitch sheaves are supplied, accomplish system air balancing by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves.

.2 Provide trial and final sheaves, as well as drive belts, as required.

.10 Weather Cover: For outdoor applications, factory fabricated drive assembly of same material as fan housing, unless specified otherwise.

.11 Belt and Shaft Guards:

.1 Easily removable and to enclose entire drive assembly, meeting federal, OSHA and Province of Manitoba requirements.

.2 Guard faces of expanded metal having minimum 60% free area for ventilation.

.3 Bright yellow finish.

.12 Provide speed test openings at shaft locations.

2.6 Finishes

.1 Carbon Steel Parts: Factory finish as follows, unless indicated otherwise.

.1 Parts cleaned and chemically pretreated with a phosphatizing process.

.2 Alkyd enamel primer.

.3 Air-dry enamel topcoat.

.2 Aluminum Parts: Finished smooth and left unpainted, unless stated otherwise.

.3 Stainless Steel Parts: Finished smooth and left unpainted.

2.7 Cabinet Ceiling Fan

.1 General:

.1 Factory-assembled, ceiling, wall or inline mounted, centrifugal cabinet fan; including housing, fan wheel, drive assembly, motor and accessories.

.2 Bearing AMCA Certified Ratings Seal for sound and air performance.

.2 Housing:

.1 Material: Minimum 0.95 mm thick (20 gauge) galvanized steel.

.2 Construction:

.1 Minimum 2.0 mm thick (14 gauge) blower and motor support frame.

.2 Lined with minimum 12 mm acoustical insulation.

.3 Outlet duct collar with integral reinforced aluminum backdraft damper, with nylon bushings.

.4 Motor mounted on resilient vibration isolators.

.5 Motor and blower removable from unit without cabinet disassembly.

.6 Removable cabinet access panels.

.7 Air Inlet: Field convertible for bottom or end air inlet configuration.

.8 Predrilled universal mounting brackets, adjustable.

.3 Wheel: Centrifugal forward curved type, galvanized steel or plastic construction.

.4 Shaft, Bearings, Drive:

.1 Shafts: Turned, ground and polished carbon steel.

.2 Bearings: Grease lubricated, precision antifriction ball, sealed type.

.3 Drives:

.1 In accordance with Article, Drives.

.2 Factory set to the specified fan revolutions per minute.

.3 Type: Direct.

.5 Electrical:

.1 Integral wiring box.

.2 Factory-installed disconnect switch.

.6 Accessories: Supply and install as follows:

.1 Ceiling Grille: Factory fabricated, aluminum construction, white baked enamel finish.

.2 Speed Controller:

.1 Mounted and wired internally.

.2 Solid state electronics.

.3 Dial type combination ON/OFF switch and SPEED selector.

.4 Time delay switch, 1 to 60 minute asjustment.

.5 Isolation kit.

.6 Motor with thermal overload.

.7 UL/ULC-507 “Electric Fan”.

.7 Acceptable Manufacturers:

.1 Broan Losone Select Series

.2 Greenheck SP Series

.3 Loren Cook Gemini Series.

.4 Penn.

2.8 Inline Fan, Centrifugal, Square

.1 General:

.1 Factory-assembled, centrifugal, inline fan, square housing configuration; including housing, fan wheel, drive assembly, motor and accessories.

.2 Bearing AMCA Certified Ratings Seal for sound and air performance.

.2 Housing:

.1 Construction: All aluminum.

.2 Integral duct collars.

.3 Removable side panels, for ease of service.

.4 Field convertible for side air discharge configuration.

.5 Predrilled universal mounting brackets for vertical or horizontal installation.

.6 Inlets: Aerodynamic aluminum venturi.

.7 Corrosion-resistant fasteners.

.8 Drive belt and bearings separated from air stream by enclosure.

.3 Wheel:

.1 Centrifugal backward inclined, 100% aluminum construction.

.2 Precision machined cast aluminum hub.

.3 Die-formed airfoil or backward inclined blades.

.4 Matched to inlet venturi.

.5 Attached to fan shaft with split taper lock bushing.

.4 Shaft, Bearings, Drive:

.1 Shafts:

.1 Turned, ground and polished carbon steel.

.2 Keyed for sheave installation.

.2 Bearings:

.1 Grease lubricated, precision antifriction ball, self-aligning, pillow block style, relubricable or sealed type.

.2 Selected for average life (ABMA 9 L10) of not less than 200,000 hours operation at maximum cataloged operating speed.

.3 Motors and Drives:

.1 In accordance with Article, Drives.

.2 Motor enclosure shall be TEFC.

.3 Arrangement: Arrangement 9 for belt-driven.

.4 Belts: Oil and heat resistant, non-static type.

.5 Accessories: Supply and install as follows:

.1 Belt Guard: Sheet metal construction, OSHA type.

.2 Aluminum inlet safety screen where inlet side is not ducted.

.3 Motor and Drive Cover:

.1 Factory fabricated, OSHA type.

.2 Sheet metal construction, same material as fan housing.

.3 Vented, openings sufficient size for proper motor cooling.

.4 Insulated Housing: Fibreglass insulation, 25 mm-thick, neoprene coated, on interior of housing.

.5 Disconnect: Factory installed, nonfused, NEMA 4.

.6 Single Side Discharge (where shown on drawing): Package consisting of side duct connection collar and rear-discharge blank-off panel.

.7 Bearing Lubrication Lines:

.1 Extended to outside of fan housing.

.2 Terminate with zerk fittings.

.8 Corrosion Protection Coating:

.1 Provide factory-applied corrosion protection coating on these fan components:

.1 Wheel.

.2 Housing.

.3 Accessories.

.4 Interior surfaces in contact with airstream.

.2 Coating system shall be baked polyester.

.6 Accepted Manufacturers: Greenheck; Loren Cook, Penn.

2.9 Roof Exhauster, Vaneaxial Upblast

.1 General:

.1 Factory-assembled vaneaxial upblast roof fan; including housing, fan wheel, drive assembly, motor and accessories.

.2 Bearing AMCA Certified Ratings Seal for sound and air performance.

.2 Housing:

.1 Construction: Rugged heavy gauge all-welded steel housing.

.2 Motor outside of exhaust air stream.

.3 Motor: TEFC.

.4 Integral conduit chase for wiring.

.5 Drain trough at lowest point of housing.

.3 Wheel:

.1 Heavy gauge steel construction, vaneaxial.

.2 Machined, steel hub.

.3 Matched to deep spun inlet venturi.

.4 Shaft, Bearings, Drive:

.1 Shaft:

.1 Turned, ground and polished carbon steel.

.2 Keyed for sheave installation.

.3 Zinc-phosphate coated and oil emulsion-dipped.

.2 Bearings:

.1 Grease lubricated, precision antifriction ball, self-aligning, pillow block style.

.2 Selected for average life (ABMA 9 L_{10}) of not less than 200,000 hours operation at maximum cataloged operating speed.

.3 Terminate with zerk fittings.

.3 Drives:

.1 Factory set to specified fan revolutions per minute.

.2 Belts: Oil and heat resistant, nonstatic type.

.5 Accessories: Supply and install as follows:

.1 Hinged Backdraft Damper, where shown on Drawings: Gravity operation, adjustable counterweight, and steel construction.

.2 Roof Curb:

.1 Height Above Finished Roof: 300 mm.

.2 Refer to item Prefabricated Roof Curb as specified in Section 15810, Metal Ductwork and Accessories for additional requirement.

.3 Disconnect: Factory installed, nonfused, NEMA 4.

.4 Bearing Lubrication Lines:

.1 Extended to outside of fan housing.

.2 Type 316 stainless steel construction.

.3 Terminate with zerk fittings.

.5 Corrosion Protection Coating:

.1 Provide factory-applied corrosion protection coating on these fan components:

.1 Wheel.

.2 Housing.

.3 Accessories.

.4 Interior surfaces in contact with airstream.

.2 Coating system shall be baked polyester.

.6 Accepted Manufacturers: Chicago, Northern Blower, Twin City.

2.10 Utility Blower, Centrifugal SWSI, Heavy Duty

.1 General:

.1 Factory-assembled utility blower; including housing, fan wheel, drive assembly, motor, and accessories.

.2 Suitable to convey air at temperatures up to 121 ^{o}C.

.3 Fan Performance: AMCA 99-2408 Class I.

.4 Bearing AMCA Certified Ratings Seal for sound and air performance.

.2 Housing:

.1 Material: Steel, unless as per scheduled.

.2 Construction:

.1 Curved scroll configuration, with continuous seam welding and side angle reinforcement.

.2 Lifting lugs welded to housing.

.3 Flanged and drilled outlet to permit duct connection.

.4 Drain connection located at lowest point of fan housing.

.5 Inlet: Spun-formed aerodynamic bell mouth.

.3 Base/Pedestal: All-welded heavy gauge steel.

.3 Wheel:

.1 Centrifugal, one-piece, nonoverloading, backward inclined airfoil blade type.

.2 Material: Steel, unless as per schedule.

.3 Attached to fan shaft with split taper lock bushing.

.4 Shaft, Bearings, Drive:

.1 Shafts:

.1 Turned, ground and polished steel.

.2 Ends drilled and countersunk for tachometer readings.

.3 Keyed for sheave installation.

.2 Bearings:

.1 Grease lubricated, precision antifriction ball, self-aligning type.

.2 Mounted in cast iron pillow block housing.

.3 Selected for average life (ABMA 9 L_{10}) of not less than 200,000 hours operation at maximum cataloged operating speed.

.3 Drives:

.1 Factory set to specified fan revolutions per minute.

.2 Arrangement: Arrangement 10.

.3 Belts: Oil and heat resistant, nonstatic type.

.5 Accessories: Supply and install as follows:

.1 Housing Access Doors: Bolted and gasketed.

.2 Disconnect: Factory installed, nonfused, NEMA 4.

.3 Flanged Inlet: Heavy gauge construction, factory drilled and flanged.

.4 Shaft Seal: Viton construction, located at shaft penetration of housing.

.5 Belt Guard: OSHA type, sheet metal construction same material as fan housing, for complete coverage of belts and sheaves.

.6 Shaft and Bearing Guard: Sheet metal construction same material as fan housing, for complete coverage of shaft and bearings.

.7 Motor and Drive Cover:

.1 Motor Enclosure shall be TEFC

.2 Factory fabricated, OSHA type.

.3 Sheet metal construction, same material as fan housing.

.4 Vented, openings sufficient size for proper motor cooling.

.8 Inlet Guard: Spiral wire type, OSHA approved, removable, same material as fan housing.

.9 Unitary Subbase:

.1 Structural metal subbase, same material as fan housing housed spring isolator with 25 mm deflection.

.2 Bolted to bottom of fan base/pedestal.

.3 Drilled for field installation of vibration isolators.

.10 Corrosion Protection Coating:

.1 Provide factory-applied corrosion protection coating on these fan components:

.1 Wheel.

.2 Housing.

.3 Accessories.

.4 Interior surfaces in contact with airstream.

.2 Coating system shall be baked polyester.

.6 Accepted Manufacturers:

.1 Greenheck

.2 Buffalo

.3 Twin City

.4 Chicago

.5 Barry Blower

.6 Northern Blower

2.11 Industrial Ceiling Fan

.1 Construction:

.1 Heavy Duty construction

.2 Cast iron yoke

.3 Cast iron motor housing

.4 Triple neoprene sealed

.5 Thermo-protected

.6 Superior moisture resistance

.7 1524mm Aerodynamically curved aluminum blades

.8 460 mm length, 25 mm diameter downrod.

.2 Finished:

.1 Electrostatic epoxy

.3 Performance:

.1 Perfectly balanced smooth quiet operation

.2 220 squared meters coverage area

.3 Airflow capacity 20,518 L/s.

.4 Electrical Power:

.1 120 V, single phase, 60 Hz power.

.5 Warranty

.1 5 years parts and labour

.6 Approval

.1 UL listed, CSA Approved.

.7 Manufacturer and Model

.1 EnvironFan, Model 190-7

2.12 Corrosion Protection Coating

.1 Baked Polyester:

.1 Material: Polyester.

.2 Surface Preparation: Sandblast surface to SSPC-SP 5.

.3 Application: Electrostatic spray.

.4 Curing: Oven baked at a metal temperature not to exceed 204^{o}C.

.5 Finished Thickness: 0.04 to 0.06 mm (1.5 to 2.5 mil) dry film thickness.

.6 Performance: Coating shall meet or exceed following criteria:

.1 Salt Spray Test: Minimum 1,000 hour duration, ASTM B117 test method.

.2 Humidity Resistance: Minimum 1,000 hour duration, ASTM D2247 test method.

.3 Impact Resistance: 1.10 cm-N (10 inch-pounds), ASTM D2794 test method.

.4 Pencil Hardness: 2H, ASTM D3363 test method.

.5 UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.

.6 Service Temperature: Maximum 110^{o}C, continuous.

2.13 Motors

.1 General:

.1 Fan motors shall comply with Section 15010 – General Mechanical Provisions.

.2 Provide integral self-resetting overload protection on single-phase motors.

.3 Motors for fans specified for use with variable frequency drives shall be inverter duty type. Supply and install variable frequency drives in accordance with the requirements of Section 16815 – Variable Frequency Drives.

.4 Motors shall not operate into service factor in any case.

.2 Motor requirements shall be as follows, unless designated otherwise on Equipment Schedule:

.1 Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.

.2 Winding Thermal Protection: None.

.3 Space Heater: No.

.4 Number of Speeds: Single.

.5 Number of Windings: One, two for two speed motor.

.6 Motor Efficiency: As per Section 15010 – General Mechanical Provisions.

.7 Shaft Type: Solid, carbon steel.

.8 Mounting: As required for fan arrangement.

.9 Service Factor: 1.15.

2.14 Accessories

.1 Equipment Identification Plates: Provide 1.6 mm (16 gauge) stainless steel identification plate securely mounted on each separate equipment in a readily visible location. Plate shall bear 10 mm high engraved block type black enamel filled equipment identification number and letters as shown on drawings.

.2 Lifting Lugs: suitably attached for equipment assemblies and components weighing over 45 kg.

2.15 Source Quality Control

.1 General:

.1 Fan shall operate at single stable point as indicated by fan curve. Fans having two potential operating points are not acceptable.

.2 Fan and motor combination shall be capable of delivering 110% of scheduled air quantity and static pressure. Motor shall not operate into motor service factor in any listed case.

.3 Consider drive efficiency in motor selection according to Manufacturer's published recommendation or according to AMCA 203, Appendix L.

.2 Testing Provisions:

.1 Provide tachometer access holes large enough to accept standard tachometer drive shaft.

.2 Center punch fan shaft to accommodate tachometer readings.

.3 Acoustical Levels:

.1 Perform noise tests in accordance with AMCA 300 and AMCA 301.

.2 Fan sound power levels (dB, Reference 10^{-12} Watts) shall be no greater than scheduled values.

.4 Balancing:

.1 Unless noted otherwise, each fan wheel shall be statically and dynamically balanced to ANSI S2.19 Grade G6.3.

.2 Fans controlled by VFDs shall be dynamically balanced at speeds 25%, 50 percent, 75% and 100% of design revolutions per minute.

.5 Vibration Test:

.1 Each fan supplied with a 3.7 kW or larger motor shall have factory run vibration test, including vibration signatures taken on each bearing in horizontal, vertical, and axial direction.

.2 Vibration reading as measured at scheduled rotational speed shall not exceed the following values when fan is rigidly mounted:

.1 Belt Drive (except Vane Axial): 0.38 cm per second peak velocity.

.2 Belt Drive Vane Axial: 0.2 cm per second peak velocity.

.3 Direct Drive: 0.2 cm per second peak velocity.

.3 Written records of run test and vibration test shall be made available upon request.

3. EXECUTION

3.1 Installation

.1 Install fans level and plumb.

.2 Secure roof-mounted fans to roof curbs with Type 316 stainless steel hardware.

.3 Ceiling Units: Suspend units from structure; use steel wire or metal straps.

.4 Scroll Drains: Pipe drain connection through running trap to floor drain.

.5 Labeling:

.1 Label fans in accordance with Article, Accessories.

.2 Mark exhaust fans serving fume hoods with arrows to indicate proper direction of rotation, in accordance with NFPA 45.

.6 Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.

.7 Connections:

.1 Refer to Section 15810 – Metal Ductwork and Accessories.

.2 Isolate duct connections to fans.

.3 Install ductwork adjacent to fans to allow proper service and maintenance.

3.2 Field Quality Control

.1 Functional Tests:

.1 Verify blocking and bracing used during shipping are removed.

.2 Verify fan is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.

.3 Verify proper thermal-overload protection is installed in motors, starters, and disconnect switches.

.4 Verify that cleaning and adjusting are complete.

.5 Disconnect fan drive from motor; verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.

.6 Reconnect fan drive system; align and adjust belts and install belt guards.

.7 Verify lubrication for bearings and other moving parts.

.8 Verify manual and automatic volume control and fire and smoke dampers in connected ductwork are in fully open position.

.2 Performance Tests:

.1 Starting Procedures:

.1 Energize motor and adjust fan to indicated revolutions per minute.

.2 Measure and record motor voltage and amperage.

.2 Operational Test:

.1 After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

.2 Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.

.3 Test and adjust control safeties.

.4 Replace damaged and malfunctioning controls and equipment.

3.3 Manufacturer's Services

.1 Provide Manufacturer's Representative at site in accordance with Section 01650 - Equipment Installation, for installation assistance, inspection and certification of installation, equipment testing, startup assistance, and Section 01664 – Training for training of City's personnel for specified component, subsystem, equipment, or system.

3.4 Adjusting

.1 Adjust damper linkages for proper damper operation.

.2 Adjust belt tension.

.3 Lubricate bearings.

.4 Balancing:

.1 Perform air system balancing as specified in Section 15950 – HVAC Systems Testing, Adjusting, and Balancing.

.2 Replace fan and motor sheaves as required to achieve design airflow.

3.5 Cleaning

.1 After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

.2 On completion of installation, internally clean fans according to Manufacturers' written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

3.6 Schedules

.1 Refer to equipment schedules in Section 15999 – List of Schedules.

END OF SECTION

GRILLES, REGISTERS, AND DIFFUSERS

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this section:

.1 UL: Product Directories

.2 ULC

1.2 Submittals

.1 Action Submittal:

.1 Shop Drawings:

.1 Manufacturer's data and descriptive literature for products specified.

.2 Provide the following information for each type of diffuser, register, and grille installed.

.1 NC sound data

.2 Static pressure loss data

.3 Throw data

.2 Informational Submittals: List of recommended spare parts for products specified.

2. PRODUCTS

2.1 Ceiling Diffusers

.1 Square and Rectangular, CD:

.1 600 x 600 or 300 x 300 Square Ceiling Diffusers as shown on drawings.

.2 Aluminum construction.

.3 Removable core section of louvers.

.4 Round neck.

.5 Continuous sponge rubber gasket at face flange.

.6 Acceptable Manufacturers:

.1 E.H. Price, Model SDMA

.2 Titus

.3 Nailor

2.2 Supply Grilles and Registers

.1 Louvred with Volume Control Damper, SA-1:

.1 Rectangular aluminum construction. Stainless steel construction where stainless steel ductwork is required.

.2 Individually adjustable horizontal face and vertical rear louver fins.

.3 Gang-operated opposed-blade horizontal volume control damper.

.4 Continuous sponge rubber gasket at face flange.

.5 25 mm flat aluminum frame. Stainless steel where stainless steel ductwork is required.

.6 White Powder coat finish.

.7 Acceptable Manufacturers:

.1 E.H. Price, Model 620 DAL (Aluminum), 720 DAL (Stainless Steel)

.2 Titus

.3 Nailor

.2 Louvred Drum, SA-2:

.1 Industrial grade.

.2 Aluminum construction.

.3 Rotatable aluminum barrel with individually adjustable lateral diffusing vanes.

.4 Gang-operated opposed-blade vertical volume control damper.

.5 Mounting collar for direct attachment to ductwork.

.6 Continuous sponge rubber gasket at face flange.

.7 Aluminum Powder Coated finish.

.8 Acceptable Manufacturers:

.1 E.H. Price, Model HCD1D

.2 Titus

.3 Nailor

2.3 Return and Exhaust Grilles and Registers

.1 Louvred with Volume Control Damper, EA-1:

.1 Rectangular aluminum construction. Stainless steel where stainless steel ductwork is required.

.2 Fixed horizontal louvers set at 35 to 45 degrees.

.3 Gang-operated opposed-blade volume control damper.

.4 25 mm flat aluminum frame. Stainless steel where stainless steel duct work is required.

.5 White Powder Coat finish.

.6 Acceptable Manufacturers:

.1 E.H. Price , Model 630 DAL (Aluminum), 730D (Stainless steel)

.2 Titus

.3 Nailor

.2 Louvred, EA-2:

.1 Rectangular aluminum construction. Stainless steel where stainless steel ductwork is required.

.2 Fixed horizontal louvers set at 35 to 45 degrees.

.3 25 mm minimum flat aluminum frame. Stainless steel for locating inside Ozone Generator Room.

.4 White Powder Coat finish.

.5 Acceptable Manufacturers:

.1 E.H. Price , Model 630 (Aluminum), 730 (Stainless Steel)

.2 Titus

.3 Nailor

.3 Egg Crate, EA-3:

.1 Square aluminum eggcrate construction.

.2 Extruded 32 mm flat frame with concealed fasteners.

.3 Fixed 12 mm x 12 mm x 12 mm louvers.

.4 Baked white enamel finished frame.

.5 Acceptable Manufacturers:

.1 E.H. Price , Model 80

.2 Titus

.3 Nailor

2.4 Door Grilles

.1 Fabricate of V-shaped louvres of 1.0 mm (20 gauge) steel, 25 mm deep on 15 mm centres.

.2 Provide 1.0 mm steel frame with auxiliary frame to give finished appearance on both sides of door.

.3 Factory finish in prime coating.

3. EXECUTION

3.1 Installation

.1 Install diffusers, grilles, and registers tight on their respective mounting surfaces, level, plumb, and true with room dimensions.

.2 Supply and Install appropriate frame to adapt to mounting surface.

END OF SECTION

AIR OUTLETS AND INLETS

1. GENERAL

1.1 Scope

.1 Louvers

.2 Goosenecks

1.2 Quality Assurance

.1 Air flow tests and sound level measurement shall be made in accordance with applicable ADC equipment test codes, ASHRAE Standards, and AMCA Standards.

.2 Unit rating shall be approved by ADC and AMCA.

.3 Manufacturer shall certify catalogued performance and ensure correct application of air outlet types.

.4 Outside louvres shall bear AMCA seal for free area and water penetration.

1.3 Project Conditions

.1 Review requirements of outlets as to size, finish and type of mounting prior to submitting Shop Drawings and schedules of outlets.

.2 Positions indicated are approximate only. Check locations of outlets and make necessary adjustments in position to conform with Architectural features, symmetry and lighting arrangement.

1.4 Submittals

.1 Submit Shop Drawings with complete catalogue information, materials of construction, dimensions and accessories for all air outlets, louvres and components in this Specification Section, and as scheduled.

.2 Submit colour selection charts of finishes for approval prior to fabrication.

2. PRODUCTS

2.1 Louvre, LV-1

.1 Stormproof louvre 125 mm deep with continuous blades on 19° slope with centre baffle and return bend heavy channel frame, 15 mm^2 mesh birdscreen.

.2 Fabricate of 2.0 mm (14 gauge) extruded aluminum blades and frame. Where openings exceed 1800 mm in height, jamb frames shall be 2.0 mm (14 gauge). Provide welded assembly.

.3 Louvres shall appear continuous from wall opening to wall opening as indicated. Supply and install RSI 2.2 (R12.5) rigid insulation behind blanked off sections.

.4 Finish shall be PPG Duranar XL baked enamel finish. Colour UC52061XL Concord Blue Metallic.

.5 Standard of Acceptance: Price CB605X.

2.2 Goosenecks

.1 Fabricate goosenecks of minimum 1.3 mm (18 gauge) galvanized steel.

.2 Mount on minimum 300 mm high curb base where size exceeds 225 x 225 mm.

3. EXECUTION

3.1 Priming

.1 Paint ductwork visible behind air outlets matte black.

3.2 Sizing

.1 Size outside air louvres as indicated on Drawings.

.2 Size air outlets as indicated on Drawings.

3.3 Installation

.1 Install in accordance with Manufacturer's installation instructions.

END OF SECTION

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this section:

.1 ANSI: X3.4, Information Systems - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII).

.2 ASHRAE:

.1 Handbook of Fundamentals.

.2 Guideline 3, Reducing Emission of Fully Halogenated Refrigerants in Refrigeration and Air-Conditioning Equipment and Systems.

.3 135, Data Communication Protocol for Building Automation and Control Networks.

.3 ASME: B19.3, Safety Standard for Compressors for Process Industries.

.4 AWWA: C704, Propeller-Type Meters for Waterworks Applications.

.5 EIA:

.1 TIA-232-F, Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.

.2 485, Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multi-point Systems.

.6 FM

.7 ISO: 8802-3, Information Technology - Telecommunication and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - CSMA/CD Access Method and Physical Layer Specifications.

.8 NEMA: 250, Enclosures for Electrical Equipment (1,000 VMaximum).

.9 NFPA:

.1 70, National Electric Code.

.2 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

.10 UL: 916, Standard for Safety Energy Management Equipment.

.11 ULC.

.12 NBC.

.13 National Fire Code.

.14 CSA.

1.2 Definitions

.1 The terms "HVAC Control System," "Automatic Temperature Control System," "Building Automation System," and "Environmental Management and Control System" shall be considered equivalent and used interchangeably for the purposes of this Contract.

.2 Algorithm: A software procedure for solving a recurrent mathematical or logical problem.

.3 Analog: A continuously varying signal or value (temperature, current, velocity, etc.).

.4 Binary/Discrete: A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level.

.5 Control Wiring:

.1 Wiring, high or low voltage other than power wiring required for proper operation of a system.

.2 Includes conduit, wire and wiring devices to install complete control system including motor control circuits, interlocks, thermostats and like devices.

.3 Includes wiring from DDC cabinet to all sensors and points specified herein and required to execute sequence of operation.

.4 Includes necessary power wiring to HVAC control devices, digital controllers including terminal units and actuators. Refer to Supplemental Conditions, Part D, for Scope of Work.

.6 Control Process: Software required to complete control loop from input signal to interlock logic and process calculation to final output signal control.

.7 Deadband: Temperature range over which no heating or cooling energy is supplied, such as 22 to 25^{o}C; as opposed to single point changeover or overlap, or a range from set point over which no control action is taken.

.8 DDC: Consists of microprocessor-based controllers with control logic performed by software. A/D converters transform analog values into digital signals that microprocessor can use.

.9 Power Wiring: Line voltage wiring to mechanical equipment. Line voltage wiring that also serves as control circuit, such as line voltage thermostat or involves interlocking with damper shall be considered control wiring. Refer to Supplemental Conditions, Part D, for Scope of Work.

.10 Abbreviations that may be used in this section:

.1 ATC: Automatic Temperature Control.

.2 BAS: Building Automation System.

.3 CWS/R: Cooling Water Supply/Return.

.4 CMOS: Complementary Metal Oxide Semiconductor.

.5 DB: Dry Bulb Temperature.

.6 DDC: Direct Digital Control.

.7 DX: Direct Expansion.

.8 EEPROM: Electronic Erasable Programmable Read Only Memory.

.9 EMCS: Environmental Management and Control System.

.10 HCP: HVAC Control Panel.

.11 CDS/R: Condenser Water Supply/Return.

.12 HMI: Human-Machine Interface.

.13 HOA: Hand-Off-Auto (Switch).

.14 HVAC: Heating, Ventilation, and Air Conditioning.

.15 IP: Current (I) - Pressure (P), as in IP transducer.

.16 LCD: Liquid Crystal Display.

.17 LED: Light Emitting Diode.

.18 PLC: Programmable Logic Controller.

.19 RAM: Random Access Memory.

.20 RTD: Resistance Temperature Detectors.

.21 WB: Wet Bulb Temperature.

1.3 System Description

.1 General Requirements:

.1 Supply and Install control wiring, power wiring, conduit, hardware, and electrical work associated with the HVAC control system as specified in Part D.

.2 Supply and Install control wiring between HVAC control panel contacts and field control devices, such as duct smoke detectors and motor starter control coil contacts.

.3 Supply and Install controls necessary for entire system to have fail-safe operation.

.4 Provide sequences and functions as required to deliver a fully functioning HVAC system.

.2 Control System Types:

.1 The following control system shall be used in the performance of the Work.

.1 NETWORKED DDC:

.1 Microprocessor-based DDC Control System utilizing standalone DDC controllers.

.2 Information within control system can be utilized by any control component over high-speed network.

.3 User interface via computer workstation and/or portable terminal.

.4 Refer to Section 15902 – Microelectronic Control Components, for additional requirements.

.2 Electric/Electronic Control System (ELECTRIC)

.1 System using simple electric or electronic control devices

.2 User interface at control device.

.2 Supply and install control systems of architecture as follows:

.1 NETWORKED DDC:

.1 All systems except those indicated as ELECTRIC control type.

.2 ELECTRIC:

.1 All hydronic unit heaters (UH)

.2 All electric unit heaters (EHU)

.3 All electric convectors (EC) controlled by remote thermostats

.3 Performance Requirements: Design control system and equipment to perform under the following conditions:

.1 Temperature, Ambient:

.1 Summer maximum 30^0C DB/22^0C WB^{0}C.

.2 Winter minimum -35^oC DB.

.3 Based on ASHRAE Handbook Fundamentals weather data for the City of Winnipeg, Manitoba.

.2 Temperature, Indoor:

.1 Heated and Ventilated Process Areas: Summer maximum 39^oC; Winter minimum 10^oC.

.2 Air-conditioned Electrical Rooms: Summer maximum 30^oC; Winter minimum 10^oC.

.3 Air-conditioned Control Room: Summer maximum 24^oC; Winter minimum 21^oC.

.4 Refer to Section 01600 – Material and Equipment, for additional environmental performance requirements.

1.4 Submittals

.1 Action Submittals:

.1 Shop Drawings:

.1 Complete specifications, descriptive drawings, catalog cuts, and descriptive literature that includes make, model, dimensions, weight of equipment, and electrical schematics, for all control system components.

.2 Complete system power, interlock, control, and data transmission wiring diagrams no smaller than 280 mm x 432 mm.

.3 Complete drawings and schematics of proposed control system, including panel power requirements.

.4 System operating sequences to be programmed, in exact English language.

.5 Complete points list.

.6 Interfaces with HVAC equipment.

.1 Schematic diagram of each equipment item.

.2 Indicate location of each control item in equipment.

.3 Show equipment manufacturer controls where installed.

.7 Panel face layout drawings.

.2 Information Submittals:

.1 Table identifying which member of Contractor's team is responsible for supplying and setting in-place power wiring and control wiring of each item or component of HVAC equipment.

.2 Recommended procedures for protection and handling of equipment and materials prior to installation.

.3 Certificates as per Section 01650 – Equipment Installation:

.1 Certificate of Satisfactory Installation.

.2 Certificate of Equipment Satisfactory Performance.

.4 Draft maintenance agreement.

.5 Confirmation that control system Subcontractor has received, and coordinated with all approved HVAC equipment submittals.

.6 Experience and qualifications of control system Subcontractor's proposed representative who shall supervise installation, adjustment, and calibration of control systems.

.7 Performance test plan and schedule.

.8 Test Results:

.1 Functional and performance test documentation.

.2 Component calibration sheets for each instrument and panel component.

.9 Operation and maintenance data, include the following detailed information:

.1 Operation and maintenance instructions for control system as supplied and installed, including control of associated mechanical and electrical equipment.

.2 Record of system adjustments and calibration methods.

.3 Performance test results.

1.5 Quality Assurance

.1 Materials, devices, appliances, and equipment used shall be indicated as acceptable by established standards of UL, ULC and CSA.

.2 Codes and Standards: Meet requirements of applicable standards and codes, except when more detailed or stringent requirements are indicated by Contract Documents, including requirements of this section.

.1 Underwriters Laboratories: Products shall be UL 916-PAZX listed and ULC listed.

.2 Canadian Electrical Code.

.3 Networked DDC Control Systems shall comply with ASHRAE 135 (BACnet).

.3 Qualifications of HVAC Subcontractor:

.1 Minimum of 15 years' experience in design, installation, and maintenance of fully electronic building automation systems.

.2 Minimum of 10 years' experience in design, installation, and maintenance of computer based, direct digital control, facility automation systems.

.3 Minimum of 5 years' experience as manufacturer's authorized representative in design, installation, and maintenance of manufacturer's system and products.

.4 Capable of furnishing factory-trained technicians, competent to provide instruction, routine maintenance, and emergency service onsite within 4 hours after receipt of request.

.5 Factory trained certified engineering and Performance Verification staff, and complete offsite training facilities.

.6 Necessary facilities to provide City with complete maintenance, periodic inspection, and service contract. Refer to Paragraph, Maintenance.

.4 Compatibility:

.1 System shall have documented history of compatibility by design for minimum of 15 years. Future compatibility shall be supported for no less than 10 years.

.2 Compatibility shall be determined as:

.1 Ability to upgrade existing field panels to current level of technology, and extend new field panels on previously installed network.

.2 Ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers, or protocol converters.

1.6 Delivery, Storage, and Handling

.1 Comply with Section 01600 – Material and Equipment.

.2 Corrosion Protection:

.1 Control panels, enclosures, and other equipment containing electrical or instrumentation and control devices, including spare parts, shall be protected from corrosion through use of corrosion-inhibiting vapour capsules.

.2 Prior to shipment, capsules shall be provided within shipping containers and equipment as recommended by capsule Manufacturer.

.3 During construction period, capsules shall be replaced in accordance with capsule Manufacturer's recommendations.

1.7 Maintenance

.1 Maintenance Service Agreement:

.1 Furnish a draft maintenance agreement, prepared and signed by the controls Subcontractor to provide the necessary preventive maintenance to keep the various control systems in proper working condition.

.2 Fully describe the maintenance work to be performed and estimate cost of the maintenance during the 1 year correction period and the subsequent year.

.3 This service contract shall include 24 hour emergency service, 7 days per week.

2. PRODUCTS

2.1 Manufacturers and/or Agents

.1 Materials, equipment, and accessories specified shall be products of the following manufacturers and/or agents, unless indicated otherwise:

.1 Johnson Controls.

.2 All other HVAC Controls Contractors shall be submitted for review as substitutions in accordance with B7.

2.2 Materials

.1 General:

.1 Products used in this installation shall be new, currently under manufacture, and shall have been applied in similar installations for minimum of two (2) years.

.2 System shall not be used as test Site for new products, unless explicitly approved by Contract Administrator, in writing.

.2 Control Components:

.1 Control range to obtain specified capacities.

.2 Sensitivity to maintain control points close enough to set point for acceptable offset, without cycling equipment more frequently than recommended by manufacturer.

.3 Field or computer adjustable to actual set point ranges. Adjustable to other settings that will provide proper operation of entire control system.

.3 Controls Interfacing:

.1 Interface controls properly with factory supplied components of mechanical systems. Coordinate special control interfacing requirements.

.2 For equipment that requires special interfacing with control system, supply and install equipment with integral controls or supply and install accessory devices required for operation of total mechanical system.

.3 Coordinate interfaces with electrical work as necessary.

.4 Supply and install electric, electronic, and mechanical devices as required to properly interface with prewired control panels supplied with HVAC equipment and with other mechanical and electrical components.

2.3 Labeling

.1 All products, namely electrical materials, devices, appliances, and equipment used, shall be indicated as acceptable by established standards of UL, ULC, FM and CSA.

.2 Valid label affixed to item shall provide indication of product acceptance by required agencies.

.3 HVAC control panels and control components that consist of multiple components shall bear UL, ULC and CSA listing mark on unit.

2.4 Service Conditions

.1 Refer to Section 01600 – Material and Equipment, Section 16010 – Electrical General Requirements, and Electrical Drawings for classification of areas as hazardous, corrosive, wet, indoor dry, and dust-tight.

.2 Use materials and methods, and enclose devices in NEMA enclosure types suitable for classification indicated, and as required by Canadian Electrical Code.

.3 Exhaust ductwork shall be considered same classification as area served.

.4 Instruments within 900 mm of ducts conveying air from spaces classified as Class I, Zone 1 or 2 (in accordance with Canadian Electrical Code) shall be suitable for same area classification as space exhausted.

2.5 Electrical Components and Accessories

.1 Electrical components shall be in accordance with requirements of Division 16, Electrical.

.2 Wiring:

.1 In accordance with Canadian Electrical Code.

.2 Insulation shall be rated 600 V, minimum.

.3 Electrical Raceways: In accordance with Canadian Electrical Code.

.4 Supply and Install surge suppressors on each power connection.

2.6 Field Components and Instruments

.1 Refer to HVAC controls detailed specification, Section 15901 – HVAC Controls, Field Components, and Instruments.

2.7 Microelectronic Control Components

.1 Refer to HVAC controls detailed specification, Section 15902 – Microelectronic Control Components.

2.8 Accessories

.1 Lifting Lugs: suitably attached for equipment assemblies and components weighing over 45 kg.

.2 Equipment Identification Plates:

.1 Provide 1.6 mm (16 gauge) type 316 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 9.5 mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

.2 Install adjacent to the following control devices, and for equipment whose function is not readily apparent.

.1 Manual override switches.

.2 Ventilation Mode switches.

.3 Special purpose devices.

.4 HVAC control panels.

.3 Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer.

2.9 Equipment Finish

.1 Provide materials and equipment with manufacturer's standard finish system. Provide Manufacturer's standard finish colour, except where specific color is indicated.

.2 If manufacturer has no standard colour, provide gray finish as approved by Contract Administrator.

3. EXECUTION

3.1 Sequences of Operation

.1 Refer to the following Sections for detailed description of system sequence of operation:

.1 Section 15930 – Sodium Hypochlorite Building HVAC Control Sequences.

.2 Section 15940 – Bulk Chemical Building HVAC Control Sequences.

3.2 Installation

.1 General:

.1 Install systems and materials in accordance with manufacturer's instructions, rough-in drawings, and equipment details.

.2 Changes in location or installation of control devices or equipment shall be approved by Contract Administrator before proceeding with the Work.

.3 Mount devices requiring manual reset and all other user serviceable control devices in readily accessible locations.

.2 Hazardous and Corrosive Areas:

.1 Control equipment and wiring shall be suitable for classification as specified in Division 16.

.2 Protect control equipment located in areas identified as being corrosive as follows:

.1 Use corrosion-inhibiting vapour capsules.

.2 Replace capsules prior to Substantial Performance.

.3 Wiring:

.1 General:

.1 Install electric wire, cable, fittings, and conduit associated with systems specified in this section, in accordance with requirements of Canadian Electrical Code.

.2 Install control and interlock wiring separate from power wiring.

.3 Number code or colour code conductors, excluding those used for individual zone controls, appropriately for future identification and servicing of control system.

.4 Supply and install wire markers on each conductor in panel and at load connections. Identify circuit with control wire number.

.5 Restrain wiring in control panels by plastic ties or ducts.

.6 Hinge wiring shall be secured at each end so that any bending or twisting will be around longitudinal axis of wire and bend area shall be protected with sleeve.

.7 Arrange wiring neatly, cut to length, and remove surplus wiring. Provide abrasion protection for any wire bundles that pass through holes or across edges of sheet metal.

.8 Use manufacturer's recommended tool with proper sized anvil for crimp terminations. No more than two wires may be terminated in single crimp lug and no more than two lugs may be installed on single screw terminal.

.9 Wiring shall not be spliced or tapped except at device terminals or terminal blocks.

.10 Properly support and run wiring in a neat manner.

.11 Run wiring parallel or at right angles to building structure.

.12 Generally conceal wiring from view, except in mechanical rooms and areas where other conduit and piping are exposed; install exposed wiring and conduit to be as unobtrusive as possible.

.13 Install line voltage control wiring, wiring exposed to view, surface-mounted wiring, and wiring concealed within walls in conduit, in accordance with Division 16, Electrical.

.14 Install exposed and concealed low voltage control wiring systems in conduit.

.15 Wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals.

.16 Conduit shall be sized to suit the number, type, and size of conductors as specified in Section 16122 – Wires and Cable 0-1000V.

.4 End-User Accessible Control Components:

.1 Do not mark room thermostats.

.2 Mount user adjustable control components (room thermostats, humidistats, temperature sensors, humidity sensors, etc.) level and in accordance with applicable accessibility requirements of local Building Code.

.5 Control Valves:

.1 Verify correctness of installation.

.2 Verify proper control action.

.3 Adjust limit switch settings.

.4 Adjust opening and closing speeds, and travel stops.

.5 Stroke control valves by means of associated controller.

.6 Control Dampers:

.1 Verify correctness of installation.

.2 Verify proper control action.

.3 Adjust limit switch settings.

.4 Adjust opening and closing speeds, and travel stops.

.5 Stroke control dampers by means of associated control output.

.7 Adjustable Frequency Drives:

.1 Verify control wiring installed to adjustable frequency drive.

.2 Calibrate and adjust remote speed control loop and feedback loop.

.3 Verify control actions and interlocks.

.4 Adjust minimum and maximum speed settings.

.5 Ramp adjustable frequency drive by simulation of associated controller output.

.8 DDC Controllers:

.1 Verify control wiring for correctness.

.2 Verify power wiring.

.3 Calibrate and adjust manual and auto control actions of controllers.

.4 Tune control loop.

.5 Stroke associated final element through controller output.

.6 Verify set points and alarm functions.

3.3 Field Quality Control

.1 Performance Verification:

.1 Tests and certification shall be as specified in Section 01650 Equipment Installation and Section 01670 – Commissioning.

.2 HVAC controls interface with process control system shall be coordinated with the Work of Section 17500 - Programmable Logic Controllers.

3.4 Training

.1 Provide training of City's personnel for duration and number of trips as specified in Section 01664 - Training. Provide training personnel for a minimum of four (4) Business Days, or more if required to meet number of training events.

.2 Provide training of City's personnel to enable them to operate HVAC equipment in available modes, to adjust set points, and to interpret alarm signals.

.3 Training sessions shall be prepared in advance, and arranged for clear, effective transfer of information in minimum time.

3.5 Adjusting and Calibrating

.1 Control system shall be adjusted and calibrated by qualified Manufacturer's Representative.

.2 Calibrate control devices at time of installation to ensure measuring and reading accuracy.

.3 Adjustment Record:

.1 Prepare complete record of system adjustments for each control system.

.2 Indicate deviations from specified temperatures.

.3 Include copy of completed record in each copy of O&M Manual.

3.6 Cleaning and Touchup Painting

.1 Touchup scratches, scrapes, or chips in exterior surfaces with finish matching type, colour, consistency, and type of surface of original finish.

END OF SECTION

HVAC CONTROLS, FIELD COMPONENTS, AND INSTRUMENTS

1. GENERAL

1.1 General

.1 The requirements of this section shall be provided in addition to those listed in Section 15900 – HVAC Instrumentation and Controls - General.

2. PRODUCTS

2.1 Motorized Dampers

.1 General:

.1 Specification applies to control dampers, except those specified to be provided with equipment.

.2 Supply and install opposed-blade type for proportional action and parallel-blade type for two-position action, except where indicated otherwise.

.2 High Performance Type, Insulated (MD-):

.1 Frame: Frame: 100 mm by 25 mm by minimum 2.03 mm 6063-T5 extruded aluminum, mounting flanges on both sides of frame, reinforced at corners.

.2 Blades:

.1 Style: Airfoil-shaped, single-piece.

.2 Orientation: Horizontal.

.3 Material: Heavy duty 6063-T5 extruded aluminum.

.4 Thermally broken and internally insulated with expanded polyurethane foam.

.3 Bearings: Molded synthetic sleeve, turning in extruded hole in frame.

.4 Seals:

.1 Blade Seals: Extruded neoprene type for ultra-low leakage from minus 45^{o}C to 100^{o}C. Mechanically attached to blade edge.

.2 Jamb Seals: Flexible metal compression type.

.5 Linkage: Concealed in frame.

.6 Axles:

.1 Minimum 13 mm diameter, hex-shaped, mechanically attached to blade.

.2 Material: Plated steel.

.7 Performance Data: As follows:

.1 Temperature Rating: Withstand minus 45°C to 100°C.

.2 Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.

.3 Closed Position: Maximum pressure of 3.2 kPa at 305 mm blade length.

.4 Open Position: Maximum air velocity of 1,829 metre per minute.

.5 Leakage: Maximum 1.26 cubic metre per minute per square metre at 1 kPa for size 1219 by 1219 mm.

.6 Pressure Drop: Maximum 0.01 kPa at 305 metres per minute across 1219 by 1219 mm damper.

.8 Accepted Manufacturers:

.1 Ruskin.

.2 TAMCO 9000 BF.

2.2 Damper Actuators

.1 General:

.1 Drawings and Control Diagrams indicate only one damper motor for each motorized damper.

.2 Select actual quantity of motors required to operate each damper in accordance with size of damper provided.

.3 Coordinate exact quantity of damper motors with electrical work to ensure that necessary wiring and conduit is provided for installation.

.4 Supply and install operators for motorized dampers and motorized louvers.

.2 Electric Damper Actuators:

.1 Performance: As scheduled in Motorized Damper Schedule.

.2 Mounting: External side plate.

.3 Ample power to overcome friction of damper linkage and air pressure acting on damper blades.

.4 Supplied with external adjustable stops to limit stroke.

.5 Operators on modulating dampers that are to be sequenced with other control devices shall have full relay type pilot positioner and interconnecting linkage to provide mechanical feedback that will accurately position and control damper.

.6 Intake, relief, and exhaust dampers shall close and return dampers shall open on control failure, unless indicated otherwise.

.7 Operating Torque:

.1 Supply and install multiple independent damper sections, each with separate actuator sized to provide a minimum of 120 percent of operating torque required by damper(s).

.2 Required damper operating torque for actuator sizing calculations shall include friction of damper linkage and 200 Pa air pressure on damper blades:

.1 Opposed-Blade Dampers: Minimum 6 Nm per square metre of damper area, unless higher values are recommended by damper manufacturer.

.2 Parallel-Blade Dampers: Minimum 8.5 Nm per square metre of damper area, unless higher values are recommended by damper manufacturer.

.8 Accepted Manufacturers and Products:

.1 Belimo.

.2 Johnson Controls.

2.3 Automatic Three-Way Control Valves

.1 General:

.1 Valve shall be of mixing type unless otherwise indicated.

.2 Fully proportioning with modulating plugs for equal percentage of linear flow characteristics.

.3 Valve Body and Trim: Sufficient to handle system pressure and temperature.

.4 Sized for a maximum pressure drop of 35 kPa.

.2 Valves 15 mm through 50 mm:

.1 Constructed with cast brass body and screwed ends.

.2 Trim: Removable cage providing valve plug guiding throughout entire travel range.

.3 Type 316 stainless steel stem.

.4 Removable bonnet, cage, stem, and plug assembly.

.3 Valve Actuators:

.1 Sufficient power for intended duty.

.2 Capable of closing against differential pressures to be encountered.

.3 Constructed and piped to fail to full heating upon loss of control signal.

.4 Manufacturers:

.1 Belimo G3 Series.

.2 Honeywell.

.3 Johnson Controls.

2.4 Electric Thermostats

.1 Unit Heaters and Electric Convectors Room Thermostat:

.1 Modulating electric type, except where two-position action is required.

.2 Temperature Scale: Furnish 10 to 32^{o}C dial.

.3 External adjustments.

.4 Adjustable sensitivity.

.5 Nonlocking cover.

.6 Insulating back where exterior wall mounting is indicated.

2.5 Electronic Sensors

.1 Temperature:

.1 General Requirements:

.1 Supply and Install sensors and transmitters as indicated in control schematics and outlined in sequence of operations.

.2 Temperature sensor shall resistance type, and shall be either two-wire 1,000-ohm nickel RTD or two-wire 1,000-ohm platinum RTD.

.3 The following point types (and accuracy of each) are required, and their associated accuracy values include errors associated with sensor, lead wire, and A to D conversion:

Point Type	Accuracy
Heating Water	± 0.3°C.
Room Temperature	± 0.3°C.
Duct Temperature	± 0.3°C.
All Others	± 0.4°C.

.2 Room Temperature Sensor with Integral Display:

.1 Constructed for either surface or wall box mounting.

.2 Nonlocking wire protective guards for room temperature sensors installed in process areas.

.3 Integral LCD room temperature display

.3 Water Temperature:

.1 Accuracy: Plus or minus 0.5^{o}C.

.2 Range: minus 1 to 92^{o}C.

.3 Element: Removable insertion into pipe thermowell.

.4 Cover: NEMA-4 Type, suitable for area classification; in accordance with CEC.

.4 Outdoor Temperature:

.1 Accuracy: Plus or minus 0.5^{o}C.

.2 Range: Minus 40 to 60^{o}C.

.3 Cover: Weathertight, with sealed conduit connection and sun shield.

.2 Differential Pressure:

.1 General:

.1 Temperature compensated.

.2 Vary output voltage with change in differential pressure. Voltage shall vary linearly from 0 to 10 VDC according to differential pressure between high and low pressure ports.

.3 Sensing range shall be suitable for application with linearity of 1.5% of full scale and offset of less than 1% of full scale.

.4 Capable of withstanding up to 150% of rated pressure without damage.

.5 Compatible with 14 to 30 VDC supply voltage range.

.2 Pressure Differential Sensor:

.1 MAMAC Low pressure Transducer

.2 100% solid state, micro-machined, glass-on-silicon, ultra-stable capacitance sensor

.3 Up to 6 field selectable ranges in one unit

.4 Two temperature compensated output versions, 4 to 20 mA 2-wire or field selectable 0-5/0-10 VDC

.5 NEMA 4 enclosure

.6 Up to 10 psid overpressure without zero shift

.7 Supply and install all necessary accessories for each specific application.

.8 Manufacturer: MAMAC System, Model PR-275/275.

.3 Airflow Switch and Pressure Differential Switch

.1 General Description:

.1 Differential Pressure switch used for sensing airflow in ducts and filter loaded condition by means of pressure differential

.2 Unit shall consist of two sensing ports; one on each side of a spring load diaphragm, which moves to actuate the SPDT switch.

.2 Materials:

.1 Diaphragm: Buna-N

.2 Body and Wiring Compartment Enclosure: Molded polycarbonate

.3 Cover and diaphragm housing: 0.8mm cold rolled steel, zinc plated.

.3 Operating Condition:

.1 Ambient Temperature: -40°C to 75°C

.2 Maximum pressure: 6.9 kPa

.4 Accessories

.1 Supply and install all connector fittings, mounting brackets and sensing tubes required for the application indicated in this specification and drawings.

.3 Water Flow Switch:

.1 Dual Turbine Type:

.1 Material: Wetted metal parts, bright tin-plated brass.

.2 Sensing Method: Electronic impedance sensing, nonmagnetic and nonphotoelectric.

.3 Accuracy:

.1 Plus or minus 0.5% of reading at calibrated velocity.

.2 Plus or minus 1% of reading from 0.9 to 9.1 m per second (10:1 range).

.3 Plus or minus 2% of reading from 0.12 to 6.1 m per sec (50:1 range).

.4 Pressure Drop: Less than 6.9 kPa at 6.1 m per sec in 65 mm pipe, decreasing for larger pipe sizes and lower velocities.

.5 Maximum Operating Pressure: 2757 kPa.

.6 Standards Compliance: Meets or exceeds, for respective pipe or tube size, accuracy, head loss, flow limits, pressure and material requirements of AWWA C704.

.7 Supply Voltage: 24 VAC/VDC plus or minus 4 VAC/VDC at 50 mA.

.8 Electrical Connections: 3 wire minimum for 4-20 mA or 0-10 VDC output.

.9 Nonisolated Analog Output:

.1 Noninteractive ZERO and SPAN adjustments.

.2 DC Linearity: 0.1 percent of span.

.3 Voltage Output: 0-10 V.

.4 Current Output: 4-20 mA.

.10 Frequency Output: 0-15 VDC, peak pulse.

.11 Manufacturer and Product: Onicon; F-1200 Dual Turbine.

2.6 Temperature Controllers

.1 WSHP Zone Controllers

.1 Communicating Programmable Room Thermostat specifically designed for controlling heat pump systems.

.2 Network Communication: LonWorks Bus and PDA Serial Port

.3 Individual heat and cool set-points

.4 PID Control to minimize temperature fluctuations

.5 Occupied Switch overriding unoccupied setback

.6 Capable of communicating with the Building Automation System (BAS) the following:

.1 Room Temperature

.2 Heating Set Point

.3 Cooling Set point

.4 Occupied Switch Status

.5 Filter Change Status

.7 Temperature Range: 15 to 30^{o}C.

.8 System Mode Switch: Heating, Cooling, Auto, Off

.9 Fan Switch: On, Auto

.10 Manufacturers:

.1 Honeywell, Model T7350H

.2 Johnson Controls, approved equal

2.7 Miscellaneous Devices

.1 General:

.1 RTD to voltage (0-5 V) converters with zero span adjustments for use with analog inputs.

.2 Limited range thermistors are acceptable provided they sense expected range for point at specified accuracy with 0-5 V output.

.3 Auxiliary contacts in each motor starter, Work of Division 16, Electrical.

.4 START/STOP relay module for either momentary or maintained switch action as indicated.

.2 Pilot Relays:

.1 Plug-in type.

.2 Interchangeable.

.3 Mounted on a circuit board.

.4 Wired to numbered terminal strips.

.3 Motorized Step Controllers: Complete with adjustable (from -17 to -12°C) deadband between heating and cooling functions.

.4 Manual Timer:

.1 12 hour, SPST, 120 V, 20 A.

.2 Spring wound.

.3 HOLD feature to override the time clock during off-hour operation.

.4 Install on front cover of HCP.

.5 Acceptable Manufacturers:

.1 Marktime.

.2 Dayton.

.3 Nutone.

.5 Duct Mounted Ionization Detection:

.1 Refer to Section 13850 – Fire Detection and Alarm, for requirements.

.2 Supply and install duct smoke detectors for air handling systems, number and location as shown on Drawings.

.3 Type: Duct mounted, suitable for airstream sensing.

.4 Voltage: 120 VAC.

.5 Detector Type: Ionization.

.6 Supply and install with remote reset button or key switch.

.7 Include mounting bracket for installation on the ductwork.

.8 Coordinate with other trades to accomplish specified Automatic Smoke Detection shutoff control sequence.

.9 Acceptable Manufacturers:

.1 BRK Electronics; Model DH1851AC.

.2 Pyrotronics Pyr-Alarm; Model CA-4.

3. EXECUTION

3.1 Installation

.1 Control Dampers:

.1 Install at locations indicated on Drawings and in accordance with Manufacturer's instructions.

.2 Install square and free from racking with blades running horizontally.

.3 Operate opposed blade dampers from a power blade or drive axle.

.4 Bracing:

.1 Install for multiple section assemblies to support assembly weight and to hold against system pressure.

.2 Install at every horizontal and vertical mullion.

3.2 Supplements

.1 Refer to damper schedule in Section 15999 – List of Schedules.

END OF SECTION

1. GENERAL

1.1 General

.1 This Section is a supplement to Section 15900 – HVAC Instrumentation and Controls - General.

.2 The requirements of this Section shall be provided in addition to those listed in Section 15900 – HVAC Instrumentation and Controls - General.

1.2 Definitions

.1 The following terms apply only to this Section of the specification. Refer to Supplemental Conditions, Part D, for additional definitions which apply to the entire document

.2 ASCII: ANSI X3.4, Information Systems - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII).

.3 BACnet: ASHRAE 135, BACnet, Data Communication Protocol for Building Automation and Control Networks.

.4 Distributed Control: System whereby control processing is decentralized and independent of central computer. Control system is built up of standalone controllers. Single controller failure shall not impact more than one system.

.5 Ethernet: ISO/IEC 8802-3. The most common high performance peer-to-peer LAN protocol.

.6 Integration:

.1 Ability of control system components from different manufacturers to connect together and provide coordinated control via real-time data exchange through common communications data exchange protocol.

.2 Integration shall extend to operator's workstation software, which shall support user interaction with control system components.

.3 Methods of integration include industry standard protocols, such as: BACnet, LonMark/LonTalk, OPC, or integrator interfaces between manufacturer's systems.

.7 Interoperability: Ability of equipment to communicate mutually.

.8 I/O: Connections between computer and sensors and actuators.

.9 IP: Network layer protocol originally created by Defense Advanced Research Project Agency to facilitate data communication between U.S. Defense Department and defense contractors, including universities and manufacturers.

.10 LAN: Network in which devices can communicate directly without going through intervening routers. LANs commonly used by DDC system Manufacturer include Ethernet (ISO 8802-3), ARCNET, Echelon LonTalk, and EIA 485.

.11 MS/TP: One of the data link layers created specifically for use with BACnet messages.

.12 Network:

.1 System of distributed control units that are linked together on communication highway.

.2 Allows sharing of point information between control units.

.3 Provides central monitoring and control of entire system from any distributed control unit location.

.4 Primary networks provide peer-to-peer communications.

.5 Secondary networks provide either peer-to-peer, master-slave, or supervised token-passing communications.

.13 Peripheral: I/O equipment used to communicate with computer and make copies of system outputs. Peripherals include CRT, printer, tape deck, diskette.

.14 PID Control Loop: Mathematical calculation used to evaluate control input and determine control output value required to maintain input value at set point. Shall have operator adjustable maximum rate of change, P and D gains, and loop response time delay. Loop shall be self-integrating so no integral constant is required and not be subject to integral windup.

.15 TCP: Connection-oriented protocol used to convey multiple related messages (e.g., file transfers, Web pages, etc.).

.16 Abbreviations that may be used in this Section:

.1 BIOS: Basic Input Output System.

.2 DDC: Direct Digital Control.

.3 IBM: International Business Machines, Inc.

.4 LCD: Liquid Crystal Display.

.5 PC: Personal Computer.

.6 PI: Pressure Indicator.

1.3 Quality Assurance

.1 Compatibility:

.1 System shall have documented history of compatibility by design for minimum of 15 years.

.2 Future compatibility shall be supported for no less than 10 years.

.3 Compatibility shall be determined as:

.1 Ability to upgrade existing microelectronic controllers to current level of technology, and extend new microelectronic controllers on previously installed network.

.2 Ability for any existing microelectronic controller microprocessor to be connected and directly communicate with new microelectronic controllers without bridges, routers, or protocol converters.

1.4 System Performance

.1 System shall conform to the following performance standards:

.1 Graphic Display:

.1 Minimum of 20 dynamic points.

.2 Current data displayed within 5 to 10 seconds of request.

.2 Graphic Refresh: System shall update dynamic points with current data within 15 seconds.

.3 Object Command:

.1 Maximum time between command of binary object by operator and reaction by device shall be 10 seconds.

.2 Analog objects shall start to adjust within 10 seconds.

.4 Object Scan: Changes of state and change of analog values shall be transmitted over high-speed network such that any data used or displayed at controller or workstation will be current, within prior 60 seconds.

.5 Alarm Response Time: Maximum time from when object goes into alarm to when it is annunciated at workstation shall not exceed 30 seconds.

.6 Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 seconds. Select execution times consistent with mechanical process under control.

.7 Performance: Programmable Controllers shall be able to execute DDC PID control loops at selectable frequency from at least once every 5 seconds. Controller shall scan and update process value and output generated by this calculation at this same frequency.

.8 Multiple Alarm Annunciation: Workstations on network shall receive alarms within 5 seconds of each other.

.9 Reporting Accuracy: Table 1 lists minimum acceptable reporting accuracies for values reported by specified system.

Table I -- Reporting Accuracy

Measured Variable	Reported Accuracy
Space temperature	±0.5°C
Ducted air temperature	±1.0°C
Outside air temperature	±1.0°C
Water temperature	±0.5°C
Delta-T	±0.15°C
Relative humidity	±5% RH
Water flow	±5% of full scale
Air pressure (ducts)	±25 Pa
Air pressure (space)	±3 Pa
Carbon Monoxide (CO)	± 50 PPM
Carbon Dioxide (CO_2)	± 50 PPM

2. PRODUCTS

2.1 Network Communication

.1 Control products for Networked DDC Control System shall comprise a BACnet network. PC Workstations and Building Controller components shall meet ASHRAE 135, BACnet.

.2 Operator Workstations and Building Controllers shall be installed on a primary high-speed peer-to-peer ISO 8802-3 Ethernet network.

.3 Custom Application Controllers and Application Specific Controllers may be installed on either primary high-speed peer-to-peer ISO 8802-3 Ethernet network, or Secondary network.

.4 Supply and install all communication media, connectors, repeaters, hubs, and routers necessary for network.

.5 Building Controllers shall have communications port for connections with operator interfaces using BACnet Data Link/Physical layer protocol.

.6 Supply and install device on network with minimum 56K baud modem that will allow remote operator interface using BACnet Data Link/Physical layer protocol. Modem shall allow for communication with controllers on this network as described below.

.7 Communications services over network shall result in operator interface and value passing that is transparent to network architecture as follows:

.1 Connection of operator interface device to any one controller on network shall allow operator to interface with other controllers as if that interface were directly connected to other controllers.

.2 Data, status information, reports, system software, custom programs for controllers shall be available for viewing and editing from any controller on network.

.3 Database values (i.e., points, software variable, custom program variables) of any one controller shall be readable by any other controller on network.

.4 This value passing shall be automatically performed by controller when reference to point name not located in that controller is entered into controller's database.

.5 Operator shall not be required to set up any communications services to perform network value passing.

.8 Time clocks in controllers shall be automatically synchronized daily.

2.2 Network Human-Machine Interface

.1 Operator Interface:

.1 Supply and install one operator workstation. The workstation shall be located in the Control Room.

.2 The workstation shall be able to access all information in system.

.3 The workstation shall reside on same high-speed network as building controllers, and shall also be able to dial into system.

.2 Hardware: Each operator workstation shall consist of the following:

.1 PC:

.1 Supply one IBM compatible PC.

.2 Features:

.1 Monitor: 432 mm (17 in), minimum, SVGA.

.2 CPU: Intel Duo Pentium 4 minimum, and operate at a minimum of 3.0 GHz.

.3 RAM: 1024 Megabytes, minimum.

.4 Diskette Drive: One with 1.44 Mb capacity.

.5 Optical Drive: 48X speed, DVD-RW.

.6 Hard Drive: 250 GigaByte capacity, minimum, with maximum access time of 9.0 milliseconds.

.7 Mouse: Two button.

.3 Supply and Install required serial, parallel, and network communication ports, and cables for proper system operation.

.2 Modem:

.1 Auto-dial telephone modem and associated cables as required for communication to remote buildings, and workstations.

.2 Transmit at minimum of 56K baud, and communicate over voice-grade telephone lines.

.3 Printer:

.1 Each workstation shall have one ink jet printer, and associated cables.

.2 Capable of minimum 20 pages per minute operation and compatible with standard USB port communications.

.3 Supply one box of minimum 2000 sheets of printer paper and 2 printer cartridges.

.4 BACnet:

.1 Workstation shall use Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE 135, to communicate with BACnet objects in network.

.2 Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.

.3 System Software:

.1 Operating System:

.1 Commercially available, concurrent multitasking.

.2 Support use of other common software applications that operate under Microsoft Windows.

.3 Acceptable operating systems are newest release of Windows or Windows XP.

.2 System Graphics:

.1 Operator workstation software shall be graphically oriented.

.2 System shall allow display of up to ten (10) graphic screens at once for comparison and monitoring of system status.

.3 Provide method for operator to easily move between graphic displays and change size and location of graphic displays on screen.

.4 Able to be modified while on line.

.5 Operator with proper password level shall be able to add, delete, or change dynamic points on graphic.

.6 Dynamic points shall include analog and binary values, dynamic text, static text, video and animation files.

.7 Ability to show animation of equipment.

.3 Custom Graphics:

.1 Created with use of commonly available graphics packages, such as PC Paint.

.2 Graphics generation package shall create and modify graphics that are saved in industry standard formats such as PCX, BMP, GIF, and JPEG.

.3 Graphics generation package shall also provide capability of capturing or converting graphics from other programs such as Designer, or AutoCAD.

.4 Graphics Library:

.1 Complete library of standard HVAC equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators.

.2 Include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork.

.3 File format compatible with graphics generation package program.

.5 Engineering Units:

.1 Allow for selection of desired engineering units (i.e., SI) in system.

.2 Unit selection shall be able to be customized by locality to select desired units for each measurement.

.3 Engineering units selected shall be SI.

.4 System Applications. Each workstation shall provide operator interface and offline storage of system information. Supply and install the following applications at each workstation:

.1 Automatic System Database Save and Restore:

.1 Store on hard disk copy of current database of each building controller.

.2 Database shall be updated whenever change is made in any panel in system.

.3 Storage of data shall be automatic and not require operator intervention.

.4 In the event of database loss in building management panel, first workstation to detect loss shall automatically restore database for that panel.

.2 Manual Database Save and Restore:

.1 System operator with proper password clearance shall be able to archive database from any system panel and store on magnetic media.

.2 Operator shall also be able to clear panel database and manually initiate download of specified database to any panel in system.

.3 System Configuration:

.1 Workstation software shall provide graphical method of configuring system.

.2 User with proper security shall be able to add new devices and assign modems to devices.

.3 This shall allow for future system changes or additions.

.4 Online Help:

.1 Context sensitive to assist operator in operation and editing of system.

.2 Available for all applications and shall provide relevant data for that particular screen.

.3 Additional help information shall be available through use of hypertext.

.5 Security:

.1 Each operator shall be required to log on to system with user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator.

.2 System supervisor shall have ability to set passwords and security levels for other operators.

.3 Each operator password shall be able to restrict operators' access for viewing and/or changing each system application, full screen editor, and object.

.4 Each operator shall automatically be logged off system if no keyboard or mouse activity is detected.

.5 Auto logoff time shall be set per operator password.

.6 System security data shall be stored in encrypted format.

.6 System Diagnostics:

.1 System shall automatically monitor operation of workstations, printers, modems, network connections, building management panels, and controllers.

.2 Failure of any device shall be annunciated to operator.

.7 Alarm Processing:

.1 Any object in system shall be configurable to alarm in and out of normal state.

.2 Operator shall be able to configure alarm limits, warning limits, states, and reactions for each object in system.

.3 Alarm Reactions:

.1 Operator shall be able to determine what actions, if any, are to be taken, by object (or point), during alarm.

.2 Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation, or displaying specific system graphics.

.3 Each of these actions shall be configurable by workstation and time of day.

.4 Object in alarm that has not been acknowledged within operator specified time period shall be rerouted to alternate operator specified alarm receipt device.

.4 Binary Alarms:

.1 Each binary object shall be set to alarm based on operator specified state.

.2 Capability to disable alarming when associated equipment is turned off or is being serviced.

.5 Analog Alarms:

.1 Each analog object shall have both high and low alarm limits and warning limits.

.2 Alarming must be able to be automatically and manually disabled.

.8 Trend Logs:

.1 Operator shall be able to define custom trend log for any data in system.

.2 This definition shall include interval, start-time, stop-time and change of value. Time intervals of 1, 5, 15, 30, and 60 minutes as well as once a shift (8 hours), once a day, once a week, and once a month shall be selectable.

.3 Trends shall start based on the hour. Each trend shall accommodate up to 64 system objects.

.4 System operator with proper password shall be able to determine how many samples are stored in each trend.

.5 Trend Data:

.1 Sampled and stored on building controller panel, and archived on hard disk.

.2 Able to be viewed and printed from operator interface software.

.3 Storable in tab delimited ASCII format for use by other industry standard word processing and spreadsheet packages.

.9 Alarm and Event Log:

.1 Operator shall be able to view logged system alarms and events from any location in system.

.2 Events shall be listed chronologically.

.3 Operator with proper security level may acknowledge and clear alarms.

.4 All that have not been cleared by operator shall be archived to hard disk on workstation.

.10 Object and Property Status and Control:

.1 Provide method for operator with proper password protection to view, and edit if applicable, status of any object and property in system.

.2 Statuses shall be available by menu, on graphics, or through custom programs.

.11 Clock Synchronization:

.1 Real time clocks in building control panels and workstations shall be synchronized on command of operator.

.2 System shall also be able to automatically synchronize system clocks daily from any operator-designated device in system.

.3 System shall automatically adjust for daylight savings and standard time, if applicable.

.12 Reports and Logs:

.1 Reporting package shall allow operator to select, modify, or create reports.

.2 Each report shall be definable as to data content, format, interval, and date.

.3 Report data shall be archived on hard disk for historical reporting.

.4 Ability for operator to obtain real time logs of designated lists of objects.

.5 Reports and logs shall be stored on PC hard disk in format that is readily accessible by other standard software applications, including spreadsheets and word processing.

.6 Reports and logs shall be readily printed to system printer.

.7 Operator shall be able to designate reports that shall be printed or stored to disk at selectable intervals.

.8 Custom Reports:

.1 Capable for operator to easily define any system data into daily, weekly, monthly, or annual report.

.2 Time and date stamped, and shall contain report title and name of facility.

.9 Standard Reports: The following standard system reports shall be provided. Reports shall be readily customized to Project by City personnel.

.1 Weather Data Report:

.1 Monthly report showing daily minimum, maximum, and average outdoor air temperature, and number of heating and cooling degree-days for each day.

.2 Annual (12 months) report showing minimum, maximum, and average outdoor air temperature for month, and number of heating and cooling degree days for each month.

.2 Tenant Override Reports:

.1 Monthly report showing daily total time in hours that each tenant has requested after-hours HVAC and lighting services.

.2 Annual (12 months) report that shows override usage on monthly basis.

.5 Workstation Applications Editor:

.1 General:

.1 Each PC workstation shall support full screen editing of system applications.

.2 Editor for each application at PC workstation.

.3 Applications shall be downloaded and executed at corresponding controller panels.

.4 Full screen editor for each type controller and application that shall allow operator with proper password to view and change configuration, name, control parameters, and system set points.

.2 Scheduling:

.1 Editor for scheduling application shall be provided at each workstation.

.2 Monthly calendar for each schedule.

.3 Exception schedules and holidays shall be shown clearly on calendar.

.4 Capable of allowing several related objects to follow a schedule.

.5 Advance and delay time for each object shall be adjustable from this master schedule.

.6 Operator with proper password level shall be able to modify schedule.

.7 Schedules shall be able to be easily copied between objects and/or dates.

.3 Equipment Coordination:

.1 Full screen editor shall allow equipment to be grouped for proper operation as specified in sequence of operations.

.4 Custom Application Programming:

.1 Supply and Install tools to create, modify, and debug custom application programming.

.2 Operator shall be able to create, edit, and download custom programs at same time that other system applications are operating.

.3 System shall be fully operable while custom routines are edited, compiled, and downloaded.

.4 Programming language shall have the following features:

.1 English language oriented and based on syntax of programming languages such as BASIC. It shall allow for free form or fill in the blank programming. Alternatively, programming language can be graphically based using function blocks as long as blocks are available that directly provide functions listed below, and that custom or compound function blocks can be created.

.2 Full screen character editor/programming environment. Editor shall be cursor/mouse driven and allow user to insert, add, modify, and delete code from custom programming. It shall also incorporate word processing features such as cut/paste and find/replace.

.3 Allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.

.4 Editor/programming environment shall have debugging/simulation capability that allows user to step through program and to observe intermediate values and results. Debugger shall also provide error messages for syntax and execution errors.

.5 Support conditional statements (if/then/else/else-if) using compound Boolean (and, or, and not) and/or relations (equal, less than, greater than, not equal) comparisons.

.6 Support floating point arithmetic using the following operators: +, -, /, x, square root, and xy.

.7 The following mathematical functions shall also be provided: natural log, log, absolute value, and minimum/maximum value from a list of values.

.8 Predefined variables that represent clock time, day of week, and date. Variables that provide interval timing shall also be available. Language shall allow for computations using these values.

.9 Ability to predefined variables representing status and results of System Software, and shall be able to enable, disable, and change values of BACnet objects in system.

.6 Portable Operator's Terminal:

.1 Ability to connect to any point on system network or directly to any controller for programming, setup, and troubleshooting.

2.3 Networked DDC Controllers

.1 Controller Software:

.1 General:

.1 Supply and install applications software for building and energy management.

.2 Software applications shall reside and run in system controllers.

.3 Editing of applications shall occur at operator workstation.

.2 System Security:

.1 User access shall be secured using individual security passwords and user names.

.2 Passwords shall restrict user to only objects, applications, and system functions as assigned by system manager.

.3 User logon/logoff attempts shall be recorded.

.4 System shall protect itself from unauthorized use by automatically logging off following last keystroke. Delay time shall be user definable.

.3 Scheduling:

.1 General:

.1 Provide capability to schedule each object or group of objects in system.

.2 Each schedule shall include capability for start, stop, optimal start, optimal stop, and night economizer actions.

.3 Each schedule may consist of up to 10 events.

.4 When group of objects are scheduled together, provide capability to define advances and delays for each member.

.2 Weekly Schedule: Separate schedules for each day of the week.

.3 Exception Schedule:

.1 Ability for operator to designate any day of the year as an exception schedule.

.2 Shall override standard schedule for that day.

.3 May be defined up to a year in advance.

.4 Once executed, it will be discarded and replaced by standard schedule for that day of the week.

.4 Holiday Schedule:

.1 Capability for operator to define up to 99 special or holiday schedules.

.2 May be placed on scheduling calendar and repeated each year.

.3 Operator shall be able to define length of each holiday period.

.4 Alarm Reporting:

.1 Operator shall be able to determine action to be taken in event of alarm.

.2 Alarms shall be routed to appropriate workstations based on time and other conditions.

.3 Alarm shall be able to start programs, be logged in event log, printed, display custom messages or graphics.

.5 Remote Communications:

.1 Ability to dial out in event of alarm.

.2 Receivers shall include PC Workstations and alpha-numeric pagers.

.3 Alarm message shall include name of calling location, device that generated alarm, and alarm message itself.

.4 Operator shall be ably to remotely access and operate system using dial-up communications in same format and method used on Site under paragraph, Operator Interface.

.6 Maintenance Management: System shall monitor equipment status and generate maintenance messages based upon user designated run time, starts, and/or calendar date limits.

.7 PID Control:

.1 Algorithm with direct or reverse action, and anti-wind-up.

.2 Algorithm shall calculate time-varying analog value used to position output or stage series of outputs.

.3 Controlled variable, set point, and PID gains shall be user-selectable.

.4 Set point shall optionally be chosen to be reset schedule.

.8 Staggered Start: Shall prevent controlled equipment from simultaneously restarting after power outage. Order that equipment (or groups of equipment) is started, along with time delay between starts shall be user-selectable.

.9 System Calculations:

.1 Software to allow instantaneous power (e.g. kW), flow rates in L/s to be accumulated and converted to energy usage data.

.2 Algorithm shall calculate the following:

.1 Sliding-window kW demand value.

.2 Energy usage and weather data (heating and cooling degree days).

.3 Items shall all be available for daily, previous day, monthly and previous month.

.10 Anti-Short Cycling: Binary output points shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.

.2 Building Controllers:

.1 General:

.1 Performance:

.1 Supply and install adequate number of Building Controllers to provide performance specified in Article System Performance and as indicated on Drawings.

.2 Manage global strategies described in Article Controller Software.

.3 Microprocessor based, capable of stand-alone operation, and shall continue to provide control functions without being connected to network.

.2 Sufficient memory to support its operating system, database, and programming requirements.

.3 Data shall be shared between networked Building Controllers.

.4 Operating system of Controller shall manage input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

.5 Controllers that perform scheduling shall have real time clock.

.6 Continually check status of its processor and memory circuits. If abnormal operation is detected, controller shall:

.1 Assume predetermined failure mode.

.2 Generate alarm notification.

.7 BACnet:

.1 Building Controller shall communicate with other BACnet objects on primary network using Read (Execute and Initiate) and Write (Execute and Initiate) Property services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE 135.

.2 Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.

.2 Environment: Controller hardware shall be suitable for anticipated ambient conditions.

.1 Controller used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosure and shall be rated for operation at minus 40 to 65°C.

.2 Controller used in conditioned ambient shall be mounted in dust-proof enclosure and shall be rated for operation at 0 to 50°C.

.3 Keypad:

.1 Local keypad and display shall be provided for each controller.

.2 Provided for interrogating and editing data.

.3 Optional system security password shall be available to prevent unauthorized use of keypad and display.

.4 If manufacturer does not provide keypad display, supply and install portable operator terminal.

.4 Serviceability: Supply and install diagnostic LEDs for power, communications, and processor. Wiring connections shall be made to field removable, modular terminal strips or to termination card connected by ribbon cable.

.5 Memory: Building Controller shall maintain BIOS and programming information in event of power loss for at least 72 hours.

.6 Immunity to Power and Noise:

.1 Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform orderly shutdown below 80% nominal voltage.

.2 Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 watts at 1 metre (3 feet).

.7 Transformer: Power supply for Controller shall be rated at minimum of 125% of maximum power consumption, and shall be fused or current limiting type.

.3 Custom Application Controllers:

.1 General:

.1 Performance:

.1 Supply and install adequate number of Custom Application Controllers to provide performance specified in Article System Performance and as indicated on Drawings.

.2 Shall manage local strategies described in Article Controller Software.

.3 Microprocessor based, capable of standalone operation, and shall continue to provide control functions without being connected to network.

.2 Sufficient memory to support its operating system, database, and programming requirements.

.3 Data shall be shared between networked Controllers.

.4 Operating system of Controller shall manage input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

.5 Controllers that perform scheduling shall have real-time clock.

.6 Continually check status of its processor and memory circuits. If abnormal operation is detected, Controller shall:

.1 Assume predetermined failure mode.

.2 Generate alarm notification.

.7 BACnet:

.1 Controller shall communicate with other BACnet objects on primary network using Read (Execute and Initiate) and Write (Execute and Initiate) Property services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE 135.

.2 Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.

.2 Communications:

.1 Each Controller shall reside on secondary BACnet network using MS/TP EIA 485, Data Link/Physical layer protocol.

.2 Controller shall provide service communications port for connection to Portable Operator’s Terminal using BACnet Data Link/Physical layer protocol.

.3 Environment: Controller hardware shall be suitable for anticipated ambient conditions.

.1 Controller used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosure and shall be rated for operation at minus 40 to 65°C.

.2 Controller used in conditioned ambient shall be mounted in dust-proof enclosure and shall be rated for operation at 0 to 50°C.

.4 Keypad:

.1 Local keypad and display shall be provided for each controller.

.2 Provided for interrogating and editing data.

.3 Optional system security password shall be available to prevent unauthorized use of keypad and display.

.4 If manufacturer does not provide keypad display, supply and install portable operator terminal.

.5 Serviceability: Supply and install diagnostic LEDs for power, communications, and processor. Wiring connections shall be made to field removable, modular terminal strips or to termination card connected by ribbon cable.

.6 Memory: Controller shall maintain BIOS and programming information in event of power loss for at least 72 hours.

.7 Immunity to Power and Noise:

.1 Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform orderly shutdown below 80% nominal voltage.

.2 Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 watts at 1 metre.

.8 Transformer: Power supply for Controller shall be rated at minimum of 125% of maximum power consumption, and shall be fused or current limiting type.

.4 Application Specific Controllers:

.1 General:

.1 Performance:

.1 Supply and install number of Application Specific Controllers to provide performance specified in Article System Performance and as indicated on Drawings.

.2 Microprocessor based, capable of standalone operation and shall continue to provide control functions without being connected to network.

.2 Contain sufficient I/O capacity to control target system.

.3 BACnet:

.1 Controller shall communicate with other BACnet objects on primary network using Read (Execute and Initiate) and Write (Execute and Initiate) Property services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE 135.

.2 Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.

.2 Communications:

.1 Each Controller shall reside on secondary BACnet network using MS/TP EIA 485, Data Link/Physical layer protocol.

.2 Controller shall provide service communications port for connection to Portable Operators Terminal using BACnet Data Link/Physical layer protocol. Connection shall be extended to space temperature sensor where shown.

.3 Environment: Controller hardware shall be suitable for anticipated ambient conditions.

.4 Controller used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosure and shall be rated for operation at minus 40 to 65^{o}C.

.5 Controller used in conditioned ambient shall be mounted in dust-proof enclosure and shall be rated for operation at 0 to 50^{o}C.

.3 Serviceability: Supply and install diagnostic LEDs for power, communications, and processor. Wiring connections shall be made to field removable, modular terminal strips or to termination card connected by ribbon cable.

.4 Memory: Controller shall use nonvolatile memory and maintain BIOS and programming information in event of power loss.

.5 Immunity to Power and Noise:

.1 Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform orderly shutdown below 80% nominal voltage.

.2 Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 watts at 1 m.

.6 Transformer: Power supply for Controller shall be rated at minimum of 125% of maximum power consumption and shall be fused or current limiting type.

.5 Controller Input/Output Interface:

.1 Hard-wired inputs and outputs may tie into system through Building, Custom, or Application Specific Controllers.

.2 Protected such that shorting of point to itself, another point, or ground will cause no damage to Controller.

.3 Protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to Controller.

.4 Binary Inputs:

.1 Shall allow monitoring of on/off signals from remote devices.

.2 Shall provide wetting current of at least 12 mA to be compatible with commonly available control devices.

.5 Pulse Accumulation Input Points: Conform to requirements of Binary Input points and accept up to 2 pulses per second for pulse accumulation, and shall be protected against effects of contact bounce and noise.

.6 Analog Inputs:

.1 Allow monitoring of low voltage (0-10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD).

.2 Compatible with and field configurable to commonly available sensing devices.

.7 Binary Outputs:

.1 Provide for on/off operation or pulsed low voltage signal for pulse width modulation control.

.2 Binary outputs on custom and building controllers shall have three-position (On/Off/Auto) override switches and status lights.

.3 Selectable for either normally-open or normally-closed operation.

.8 Analog Outputs:

.1 Shall provide a modulating signal for control of end devices.

.2 Shall provide either 0-10 VDC or 4 to 20 mA signal as required to provide proper control of output device.

.3 Building or custom programmable controllers shall have status lights and two-position (auto/manual) switch and manually adjustable potentiometer for manual override.

3. EXECUTION

3.1 General

.1 Refer to Section 15900 - HVAC Instrumentation and Controls - General.

END OF SECTION

SODIUM HYPOCHLORITE BUILDING HVAC CONTROL SEQUENCES

1. GENERAL

.1 The control sequences contain a general description of the intent of the operation of the systems to be controlled. The Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.

.2 All setpoints and times of operation given in the control sequences are indicative. Final setpoints shall be dictated by site conditions.

.3 The relationships between the points, systems and building are described in the control sequences.

.4 Review with the Contract Administrator during the Shop Drawing stage to finalize the control sequences for each system.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 General

.1 Occupied mode shall be between the hours of 0600 and 1800 hrs. Times out with shall be known as unoccupied.

.1 Several alarm points generated by the BAS are to be reported to the on Site SCADA system. These alarm points take the form of common alarms and are identified in this sequence and on the schematic drawings.

3.2 Make Up Air Unit MAU-H850 - Sequence of Operation

.1 Description of Operation:

.1 Outside air enters the unit through the outside air damper and passes through a summer filter prior to entry into an air-to-air heat exchanger. Upon leaving the heat exchanger, the air then passes through a Hydronic heating coil, a winter filter, and finally through the supply fan before being discharged from the unit via ductwork to the ventilated space.

.2 Exhaust air enters the unit and passes through a filter, the air-to-air heat exchanger, the exhaust fan and is discharged through the exhaust air damper to outside.

.2 Prior to Start Up:

.1 During heating season, 2-port motorized valve will modulate to maintain setpoint temperature of 15ºC at TT-H850E.

.3 Start Up Normal Operation:

.1 With the system in auto, the BAS shall energize MAU-H850, the outside air damper, MD-H850A, the exhaust air damper MD-H880 and the discharge air damper MD-H850B shall motor fully open, the room air damper MD-H881 shall motor fully closed. Limit switches on the dampers shall confirm, after 2 minutes, that the dampers are fully open, fully closed for MD-H881. Failure to open the outside air or the exhaust air damper or to close room air damper shall result in the shut down of the unit.

.2 With confirmation of the dampers being in the required position, the BAS shall start the supply fan SF-H850A. The BAS shall output a 4 to 20 mA proportional signal to ramp up the VFD output to maintain the system design flow rate. There will be two distinct output values which are determined during the air balancing work. One output value reflects the condition when system MAU-H851 is off (unoccupied mode). The other value reflects the condition when both MAU-H850 and MAU-H851 are operational (occupied mode). The BAS will determine the appropriate VFD output value based on the status of the system MAU-H851.

.3 One minute after the starting of the supply fan, the exhaust fan EF-H850A, will start. The BAS shall energize the exhaust fan starter.

.4 A failure to start by either fan shall result in a shut down of the unit and an alarm indicated at the BAS.

.5 When the external temperature is less than 13ºC and the air temperature at TT-H850C is less than 15ºC, then the BAS shall modulate the 2-port valve on the heating coil, CV-H875 to maintain a minimum temperature of 15ºC in the duct at TT-H850E. Additionally the BAS shall modulate the 2-port valve on the heating coil CV-H875 to maintain a minimum temperature of 15ºC at the dictate of the room temperature sensor TT-H850D.

.4 Summer / Winter Filters:

.1 Differential pressure sensors PT-H850A and PT-H850B shall monitor the pressure drop across the filters. Upon detection of an excessive pressure drop (250 Pa) across either filter an alarm only shall be signaled to the BAS to indicate filter change is required. Upon detection of pressure drop above (80 Pa) at both filters simultaneously, an alarm only shall be signaled to the BAS to indicate double-filter condition. Upon detection of pressure drop below (60 Pa) at both filters simultaneously, an alarm only shall be signaled to the BAS to indicate filter-missing condition.

.5 Exhaust Air Filter:

.1 Differential pressure switch PS-H850B shall monitor the pressure drop across the exhaust filter. Upon detection of an excessive pressure drop (250 Pa) across the filter an alarm only shall be signaled to the BAS.

.6 Temperature Monitoring:

.1 The BAS shall monitor the following temperatures: space TT-H850D, supply air downstream of heating coil TT-H850E, outside air TT-H850A, heat exchanger inlet and outlet on both the outside air and the exhaust air sides TT-H850A, TT-H850C, TT-H850D and TT-H850B.

.7 System Shut Down:

.1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the supply and exhaust fans, open the room-air damper MD-H881 and outside air damper MD-H882. After 30 seconds, the BAS shall close the outside air damper MD-H850A, the discharge air damper MD-H850B and the exhaust air damper MD-H880.

.8 Common Fault/Alarm:

.1 Any alarm generated by the BAS shall generate a common alarm reported to the site SCADA system.

3.3 Make Up Air Unit MAU-H851 - Sequence of Operation

.1 Description of Operation:

.1 Outside air enters the unit through the outside air damper and passes through a summer filter prior to entry into an air-to-air heat exchanger. Upon leaving the heat exchanger, the air then passes through a Hydronic heating coil, a winter filter, and finally through the supply fan before being discharged from the unit via ductwork to the ventilated space.

.2 Exhaust air enters the unit and passes through a filter, the air-to-air heat exchanger, the exhaust fan and is discharged through the exhaust air damper to outside.

.2 Prior to Start Up

.1 During heating season, 3-port motorized valve will modulate to maintain setpoint temperature of 15ºC at TT-H851E.

.3 Start Up Occupied mode:

.1 With the system in auto, the BAS shall energize MAU-H851, the outside air damper, MD-H851A, the exhaust air damper MD-H851B and discharge air damper MD-H851C shall motor fully open. Limit switches on the dampers shall confirm, after 2 minutes, that the dampers are fully open. Failure to open the outside air or the exhaust air damper shall result in the shut down of the unit.

.2 With the outside air, exhaust air and discharge air dampers open, the BAS shall energize both the supply fan SF-H851A and exhaust fan EF-H851A.

.3 A failure to start by either fan shall result in a shut down of the unit and an alarm indicated at the BAS.

.4 When the external temperature is less than 13ºC and the air temperature at TT-H851C is less than 15ºC, then the BAS shall modulate the 3-port valve on the heating coil, CV-H876 to maintain a minimum temperature of 15ºC in the duct at TT-H851E. Additionally the BAS shall modulate the 3-port valve on the heating coil CV-H876 to maintain a minimum temperature of 15ºC at the dictate of the room temperature sensor TT-H850D.

.4 Summer / Winter Filters:

.1 Differential pressure sensors PT-H851A and PT-H851B shall monitor the pressure drop across the filters. Upon detection of an excessive pressure drop (250 Pa) across either filter an alarm only shall be signaled to the BAS to indicate filter change is required. Upon detection of pressure drop above (80 Pa) at both filters simultaneously, an alarm only shall be signaled to the BAS to indicate double-filter condition. Upon detection of pressure drop below (60 Pa) at both filters simultaneously, an alarm only shall be signaled to the BAS to indicate filter-missing condition.

.5 Exhaust Air Filter

.1 Differential pressure switch PS-H851C shall monitor the pressure drop across the exhaust filter. Upon detection of an excessive pressure drop (250 Pa) across the filter an alarm only shall be signaled to the BAS.

.6 Temperature Monitoring:

.1 The BAS shall monitor the following temperatures: space TT-H851D, supply air downstream of heating coil TT-H851E, outside air TT-H851A, heat exchanger inlet and outlet on both the outside air and the exhaust air sides TT-H851A, TT-H851C, TT-H851D and TT-H851B.

.7 System Shut Down:

.1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the supply and exhaust fans. After 30 seconds, the BAS shall close the outside air damper MD-H851A, the exhaust air damper MD-H851B and the discharge damper MD-H851C.

.8 Common Fault/Alarm:

.1 Any alarm generated by the BAS shall generate a common alarm reported to the site SCADA system.

3.4 Make Up Air Unit MAU-H852 - Sequence of Operation

.1 Description of Operation:

.1 Outside air enters the unit through the outside air damper and passes through a summer filter prior to entry into an air-to-air heat exchanger. Upon leaving the heat exchanger, the air then passes through a Hydronic heating coil, a winter filter, and finally through the supply fan before being discharged from the unit via ductwork to the ventilated space.

.2 Exhaust air enters the unit and passes through a filter, the air-to-air heat exchanger, passes through the exhaust fan and is discharged through the exhaust air damper to outside.

.2 Prior to Start Up:

.1 During heating season, 3-port motorized valve will modulate to maintain setpoint temperature of 15ºC at TT-H852E.

.3 Start Up/Unoccupied mode/Occupied Mode/Emergency Mode:

.1 With the system in auto, the BAS shall energize MAU-H852, the outside air damper, MD-H852A, and the exhaust air damper MD-H852B shall motor fully open. Limit switches on the dampers shall confirm, after 2 minutes, that the dampers are fully open. Failure to open the outside air or the exhaust air damper shall result in the shut down of the unit.

.2 With the outside air damper and exhaust air damper open, the BAS shall start the supply fan SF-H852A and exhaust fan EF-H852A. The BAS shall output a 4-20 mA proportional signal to ramp up the VFD output of each fan to maintain the design flow rates according to the operation mode. During unoccupied periods, the BAS shall output a value equivalent 25% of system design airflow capacity. During occupied periods, the BAS shall output a value equivalent to 100% design airflow capacity. These output values will be determined during the system air balancing period.

.3 A failure to start by either fan shall result in a shut down of the unit and an alarm indicated at the BAS.

.4 When the external temperature is less than 10ºC and the air temperature at TT-H852C is less than 15ºC, then the BAS shall modulate the 3-port valve on the heating coil, CV-H877 to maintain a minimum temperature of 15ºC in the duct at TT-H852E. Additionally the BAS shall modulate the 3-port valve on the heating coil CV-H877 to maintain a minimum temperature of 15ºC and a maximum temperature of 35ºC at the dictate of the room temperature sensor TT-H852D.

.5 When the BAS detects temperature at TT-H852C above 20ºC, the BAS shall output a discrete signal to the defrost system of the air-to-air heat exchanger to have supply air bypass the heat exchanger.

.4 Summer / Winter Filters:

.1 Differential pressure sensors PT-H852A and PT-H852B shall monitor the pressure drop across the filters. Upon detection of an excessive pressure drop (250 Pa) across either filter an alarm only shall be signaled to the BAS to indicate filter change is required. Upon detection of pressure drop above (80 Pa) at both filters simultaneously, an alarm only shall be signaled to the BAS to indicate double-filter condition. Upon detection of pressure drop below (60 Pa) at both filters simultaneously, an alarm only shall be signaled to the BAS to indicate filter-missing condition.

.5 Exhaust Air Filter:

.1 Differential pressure switch PS-H852C shall monitor the pressure drop across the exhaust filter. Upon detection of an excessive pressure drop (250 Pa) across the filter an alarm only shall be signaled to the BAS.

.6 Temperature Monitoring:

.1 The BAS shall monitor the following temperatures: space TT-H852D, supply air downstream of heating coil TT-H852E, outside air TT-H852A, heat exchanger inlet and outlet on both the outside air and the exhaust air sides TT-H852A, TT-H852C, TT-H852D and TT-H852B.

.7 System Shut Down:

.1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the supply and exhaust fans. After 30 seconds, the BAS shall close the outside air damper MD-H852A and the exhaust air damper MD-H852B.

.8 Common Fault/Alarm:

.1 Any alarm generated by the BAS shall generate a common alarm reported to the site SCADA system.

3.5 Hypochlorite Generator Room Heat Relief Exhaust Fan EF-H853

.1 Description of Operation:

.1 This exhaust system provides heat relief ventilation for the purpose of cooling the Hypochlorite Generator Room.

.2 Startup/Normal Operation:

.1 The BAS shall control the operation of this system at the dictate of the Room Temperature Transducer, TT-H853A.

.2 Upon a rise of room temperature above 25ºC, the BAS shall energize the outside air intake damper MD-H884 and exhaust air damper MD-H883. Limit switches on the dampers shall confirm, after 2 minutes, that the dampers are fully open. Failure to open the outside air or the exhaust air damper shall result in the shut down of the unit

.3 With the damper fully open, the BAS shall output a 4-20mA proportional signal to ramp up the VFD-H853A output based on the following adjustable linear schedule:

.1 Room Temperature = 25ºC, VFD output = 20%

.2 Room Temperature = 35ºC, VFD output = 100%.

.3 Shut Down Sequence:

.1 On a system shut down command, through manual or room temperature, the BAS shall de-energize the VFD-H853A, outside air intake damper MD-H884 and exhaust damper MD-H883.

.4 Common Fault/Alarm:

.1 Any alarm generated by the BAS shall generate a common alarm reported to the site SCADA system.

3.6 Air Handling Unit AHU-H854 - Sequence of Operation

.1 Description of Operation:

.1 The unit is in continuous operation.

.2 Outside air is mixed with return air at the mixing box of the air handling unit. The mixed air then passes through a set of pre-filter and a final-filter and the DX cooling coil. Conditioned supply air is then discharged into the supply air ductwork by the supply fan.

.3 The outside air and the return air motorized dampers are controlled by the BAS to at the dictate of the outside air dry bulb temperature to achieve free-cooling (economizer). When the system is not operating in economizer mode, return air damper shall open to a maximum position and outside air damper shall close to a minimum position allowing 10% of outside air entering the system.

.2 Start Up Normal Operation:

.1 With the system in auto, the BAS shall initially modulate the inlet damper to the preset minimum position and the return air damper shall close to the preset maximum.

.2 After 2 minutes the BAS shall confirm that the outside air damper is in at the defined position. A failure to open the damper shall result in the BAS initiating the shut down sequence and an alarm being generated. The BAS shall energize the AHU supply fan and maintain the design flow rate. A failure to start the fan shall result in the BAS initiating the shut down sequence and an alarm being generated.

.3 The BAS shall monitor outside air temperature at TT-H854A and determines if economizer mode is applicable. When outside air temperature is below 15ºC, the BAS shall enable the economizer mode by modulating the outside air damper MD-H854A

and the return air damper MD-H854B to maintain mixed air temperature TT-H854C at minimum 15ºC

.4 When outside air temperature is above 15ºC, the BAS shall disable the economizer mode by closing the outside air damper to the preset minimum position and open the return air damper to the preset maximum position.

.5 The BAS shall also energize the air-cooled condenser CU-H854 as required to maintain room temperature below the maximum of 25ºC. When energized, this DX cooling system shall maintain an induct temperature of 12ºC, at the dictate of the duct temperature transmitter TT-H854D, until the room temperature sensor TT-H854E indicates that the room temperature is 5ºC below the upper limit of the room temperature range.

.6 Should the space temperature sensor TT-H854E indicates a room temperature of 28ºC or greater an alarm only shall be generated

.3 Filters:

.1 Differential pressure switches PS-H854B and PS-H854C shall monitor the pressure drop across the pre-filter and Final Filter. Upon detection of an excessive pressure drop (250 Pa) across either filter an alarm only shall be signaled to the BAS. This alarm shall have no effect on the run status of the unit.

.4 System Shut Down:

.1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the AHU supply fan. After 30 seconds, the BAS shall close the outside air damper and open the return air damper.

.5 Common Fault/Alarm:

.1 Any alarm generated by the BAS shall generate a common alarm reported to the site SCADA system.

3.7 Fan Coil Unit FC-H890 - Sequence of Operation

.1 Description of Operation:

.1 Outside air enters the unit through the outside air damper and passes through a set of filter prior to entry into the fan section. The supply fan then discharges the air through a Hydronic heating coil and into the supply air ductwork.

.2 Prior to Start Up:

.1 During heating season, 3-port motorized valve will modulate to maintain setpoint temperature of 15ºC at TT-H890B.

.3 Start Up Occupied Mode:

.1 With the system in auto, the BAS shall energize FC-H890, the outside air damper, MD-H892, shall motor fully open. Limit switch on the damper shall confirm, after 2 minutes, that the damper is fully open. Failure to open the outside air damper shall result in the shut down of the unit.

.2 With the outside air damper open, the BAS shall energize the supply fan SF-H890A.

.3 A failure to start by the fan shall result in a shut down of the unit and an alarm indicated at the BAS.

.4 When the external temperature is less than 13ºC and the air temperature at TT-H890A is less than 15ºC, then the BAS shall modulate the 3-port valve on the heating coil, CV-H891 to maintain a minimum temperature of 15ºC in the duct at TT-H890B. Additionally the BAS shall modulate the 3-port valve on the heating coil CV-H891 to maintain a minimum temperature of 15ºC at the dictate of the room temperature sensor TT-H890C.

.4 Air Filter:

.1 Differential pressure switch PS-H890A shall monitor the pressure drop across the exhaust filter. Upon detection of an excessive pressure drop (250 Pa) across the filter an alarm only shall be signaled to the BAS.

.5 Temperature Monitoring:

.1 The BAS shall monitor the following temperatures: space TT-H890C, supply air downstream of heating coil TT-H890B and outside air TT-H890A.

.6 System Shut Down:

.1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the supply fan. After 30 seconds, the BAS shall close the outside air damper MD-H892.

.7 Common Fault/Alarm:

.1 Any alarm generated by the BAS shall generate a common alarm reported to the site SCADA system.

3.8 Hydronic Heating System (50% ethylene glycol solution) Pressure Differential Control Valve CV-H878, Pressure Differential Sensor PT-H878B – Sequence of Operation

.1 Description of Operation:

.1 The heat source for this hydronic heating subsystem is supplied by the central hydronic heating system, completing system circulating pumps, located in the Bulk Chemical Building.

.2 The purpose of this system is to minimize the differential pressure fluctuation in the system due to the operation of 2-port control valves within the system.

.2 Normal Operation:

.1 The BAS shall monitor the differential pressure sensed by PT-H878 and modulates the control valve CV-H878 to maintain a constant pressure differential between the supply and return headers.

3.9 Unit Heaters – UH-H860, UH-H861, UH-H862, UH-H863, UH-H864 and UH-H865 - Sequence of Operation

.1 Description of Operation:

.1 Unit heaters provide warm air to maintain localized heating to various parts of the building. The unit heats the air by means of a hydronic coil fed from the hydronic heating loop.

.2 Normal Operation:

.1 Unit heaters UH-860, HU-H861, UH-H862 and UH-H864 are designated as normal operating unit heaters. Each unit is permanently energized by an independent power supply. The BAS modulates the 3-port valve on each unit, to provide low temperature hot water to the heating coil. The BAS modulates the control valve at the dictate of the associated room temperature transducer.

.3 Emergency Operation:

.1 Unit heater UH-H865 is designated as emergency Unit Heater and it is operational only when the BAS has recognized that the system MAU-H850 has been de-energized due to a system fault.

.2 If the external temperature is 5ºC or less, then during emergency conditions, the BAS shall energize the blower of UH-H865 and modulate its 2-port valve at the dictate of its associated room temperature transducer to maintain the space temperature at 5ºC.

3.10 Electric Radiant Bird Screen Defrost Systems – Sequence of Operation.

.1 Description of Operation:

.1 The objective of this system is to prevent the build-up of hoar frost on the bird screens at the air intake louvers.

.2 This system consists of an electric radiant heater shining onto the bird screen and a pressure differential sensor that monitors the pressure drop across the exterior louver.

.3 This sequence of operation is applicable for the following systems:

.1 ERH-H850 with pressure differential switch PS-H850A and outside air temperature transducer TT-H850A

.2 ERH-H851A, ERH-H851B and ERH-H851C with pressure differential switch PS-H851A and outside air temperature transducer TT-H851A

.3 ERH-H852 with pressure differential switch PS-H852A and outside air temperature transducer TT-H852A

.4 ERH-H854 with pressure differential switch PS-H854A and outside air temperature transducer TT-H854A

.2 Startup/Normal Operation:

.1 The BAS shall control the operation of each system at the dictate of its associated outside air temperature transducer and the pressure differential switch.

.2 The BAS shall energize a discrete contact to turn on the radiant heater(s) when the outside air temperature transducer detects a temperature below 0ºC and the pressure differential switch detects a pressure drop of above 62 Pa simultaneously.

3.11 Heat Tracing - Sequence of Operation

.1 Description of Operation:

.1 Heat tracing system is incorporated behind the small intake louver for the system FC-H890. This system operates automatically dependant of the external weather conditions.

.2 Normal Operation:

.1 The BAS shall energize the heat tracing system on the louver at the dictate of the external temperature sensor TT-H890A. The system shall operate when the external temperature ranges between -5ºC and 5ºC.

.2 The BAS shall monitor the status of the heat tracing controller. Any fault in the heat tracing system shall generate an alarm only at the BAS.

3.12 Water Pressure Booster Package P-H885A, P-H885B and P-H885C - Sequence of Operation

.1 Description of Operation:

.1 This is a packaged system that comes complete with its own controls. The BAS shall receive and monitor operating status and failure alarm for each of the three pumps from packaged control system.

.2 Common Fault:

.1 Any alarm received by the BAS pertaining to this system, a common alarm shall be generated by the BAS to the site SCADA system.

END OF SECTION

BULK CHEMICAL BUILDING HVAC CONTROL SEQUENCES

1. GENERAL

.1 The control sequences contain a general description of the intent of the operation of the systems to be controlled. The Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.

.2 All set points and times of operation given in the control sequences are indicative. Final set points shall be dictated by site conditions.

.3 The relationships between the points, systems and building are described in the control sequences.

.4 Review with the Contract Administrator during the Shop Drawing stage to finalize the control sequences for each system.

.5 Supply and install all controls, wiring, and ancillaries required to provide the functionality described within this section.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 General

.1 Occupied mode shall be between the hours of 0600 and 1800 hrs Mon-Fri inclusive. Times out with this range and Holidays are designated as unoccupied.

.2 Several alarm points generated by the BAS are to be reported to the on Site SCADA system. These take the form of common alarms. These alarm points are identified in this sequence and on the schematic drawings.

.3 A hardwire interlock shall initiate the shutdown of all ventilation systems, and boilers in the event of a fire alarm activation. Supply and install an override switch to allow specific areas to be ventilated at the dictate of the attending Fire Officer.

3.2 Glycol Hot Water Boilers BG-H805A and BG-H805B, Mechanical Room Combustion Air Supply Fan SF-H831A, and Heating Pumps GP-H808A and GP-H809A - Sequence of Operation

.1 Description of Operation:

.1 The Mechanical Room Combustion Air and General Ventilation is provided by mechanical means via a fan.

.2 Natural gas fired, hot water boilers provide low temperature water/glycol to service the building. Low temperature hot water/glycol leaves the boiler and circulates around a

constant temperature/variable volume primary header circuit. Duty/stand-by pump sets GP-H808A and GP-H808B serve the primary circuit maintaining the constant temperature in the primary circuit. Secondary circuits are fed from the primary header. The boiler is complete with an integral boiler control package. This integral controls package controls the flow temperature from the boilers, the modulation of the burner, and all on board safety features for the boiler.

.2 Start Up/Normal Operation:

.1 The BAS shall energize the combustion air fan louvre damper MD-H831B. A limit switch on the damper shall confirm, after 2 minutes, that the damper is fully open. Failure to open the damper shall result in the BAS generating an alarm and initiating the shut down sequence.

.2 Upon confirmation of the damper being open the BAS shall energize the combustion air supply fan SF-H831A. The BAS shall monitor the fan status. Should the fan fail to start the BAS shall generating an alarm and initiate the shut down sequence.

.3 On proving airflow from the Combustion Air supply fan SF-H831A, the BAS shall enable the primary circuit duty pump. The BAS shall monitor the status of the duty pump. In the event of a failure of the duty primary pump, the BAS shall enable the stand-by primary circuit pump, and generate an alarm. In the event of a failure in both primary pumps, the BAS shall generating an alarm and initiate a shut down of the system.

.4 Upon confirmations that the duty primary pump has started, the BAS shall enable both boilers. The proprietary control panel on each boiler shall maintain control of its respective boiler, controlling on the supply flow temperature. The boiler controls shall shut the boiler down upon the supply temperature set point being reached.

.5 The BAS shall monitor the status of each boiler. The BAS shall continue to run the Primary Circuit pump for 20 minutes after both boilers shut down upon flow temperature being achieved.

.6 In the event of a fault being reported by a boiler control panel, the BAS shall generate an alarm and initiate a shut down of the boiler.

.3 Pump Operation:

.1 The BAS shall provide a 4 to 20mA proportional signal to the VFD of the duty primary circuit pump. This VFD shall ramp up or down to maintain a constant temperature in the primary circuit, at the dictate of TT-H805B.

.2 In the event of a pump failure, the BAS shall automatically start the stand-by pump and generate an alarm.

.3 The BAS shall auto-rotate the primary circuit duty pump on a weekly basis.

.4 System Shutdown:

.1 The BAS shall disable the boilers BG-H805A and BG-H805B. The primary circuit duty pump shall continue to run for 20 minutes after which the BAS shall de-energize the pump. Upon shutting down the boilers the Combustion air fan shall continue to run for 5 minutes after which the BAS shall de-energize the fan, SF-H831A, and close the intake damper MD-H831B.

.5 Common Fault:

.1 Any alarm generated by the BAS pertaining to the boilers, combustion air fan, and/or primary heating pumps shall generate a common alarm reported to the site SCADA system.

3.3 Heating Pumps GP-H810A and GP-H810B - Sequence of Operation

.1 Description of Operation:

.1 The Chemical Building Heating Circuit is fed from the Primary Heating Circuit. The Chemical Building Heating Circuit provides low temperature water/glycol to the Make-Up Air Units and the Unit Heaters associated with the east and west wings of the Chemical Building. The Chemical Building Heating Circuit is served by duty/stand-by circulating pumps GP-H810A and GP-H810B.

.2 Start Up/Normal Operation:

.1 The BAS shall enable the duty pump. The BAS shall monitor the status of the duty pump. In the event of a failure of the duty pump, the BAS shall enable the stand-by pump, and generate an alarm. In the event of a failure in both primary pumps, the BAS shall initiate a shut down of the system.

.2 The BAS shall auto-rotate the primary circuit duty pump on a weekly basis.

.3 System Shutdown:

.1 The BAS shall disable the pumps.

.4 Common Fault:

.1 Any alarm generated by the BAS pertaining to the Chemical Building Heating Circuit pumps shall generate a common alarm reported to the site SCADA system.

3.4 Heating Pumps GP-H812A and GP-H812A - Sequence of Operation

.1 Description of Operation:

.1 The Hypo Building Heating Circuit is fed from the Primary Heating Circuit. The Hypo Building Heating Circuit provides low temperature water/glycol to the Make-Up Air Units and the Unit Heaters associated with the Hypo Building. The Hypo Building

Heating Circuit is served by duty/stand-by circulating pumps GP-H810A and GP-H811A.

.2 Start Up/Normal Operation:

.1 The BAS shall enable the duty pump. The BAS shall monitor the status of the duty pump. In the event of a failure of the duty pump, the BAS shall enable the stand-by pump, and generate an alarm. In the event of a failure in both primary pumps, the BAS shall initiate a shut down of the system.

.2 The BAS shall auto-rotate the primary circuit duty pump on a weekly basis.

.3 System Shutdown:

.1 The BAS shall disable the pumps.

.4 Common Fault:

.1 Any alarm generated by the BAS pertaining to the Hypo Building Heating Circuit pumps shall generate a common alarm reported to the site SCADA system.

3.5 Unit Heaters – UH-H820A, UH-H821A, UH-H822A, UH-H823A, UH-H824A, UH-H825A, UH-H833A, UH-H834A, UH-H835A, UH-H836A, UH-H837A, UH-H838A, and UH-H839A - Sequence of Operation

.1 Description of Operation:

.1 Non-Emergency unit heaters provide warm air to maintain localized heating to various parts of the building. The unit heats the air by means of a hydronic coil fed from one of the secondary heating circuits.

.2 Normal Operation:

.1 Each unit is permanently energized by an independent power supply. The BAS opens the 3-port valve on each unit, to provide low temperature hot water to the heating coil. The BAS opens the 3-port valve at the dictate of the associated room temperature transducer. The BAS shall control the operation of the Unit Heater Fan at the dicatate of the associated room temperature sensor.

.3 Emergency Operation:

.1 Unit heaters UH-H820A, UH-H821A, UH-H824A, and UH-825A are designated as emergency Unit Heaters.

.2 If the outside temperature is 10ºC or less, then during emergency conditions, the BAS shall modulate the 3-port valves on unit heaters UH-H820A, UH-H821A, UH-H824A, and UH-825A to fully open.

3.6 Make Up Air Unit MAU-H800A (Ferric Chloride Room) - Sequence of Operation

.1 Description of Operation:

.1 The Make Up Air Unit runs continuously, switching between occupied mode and unoccupied mode at the times set out elsewhere in item 3.1 of this section. During occupied mode the unit runs at 6AC/HR, and 1.5AC/HR during un-occupied mode.

.2 Outside air enters the unit through the outside air damper and passes through a filter prior to entry into an air-to-air heat exchanger. Upon leaving the heat exchanger, the air then passes through a Hydronic heating coil, a second stage filter, and finally through the supply fan before being discharged from the unit via ductwork to the ventilated space.

.3 Exhaust air enters the unit and passes through the air-to-air heat exchanger, passes through the exhaust fan and is discharged through the exhaust air damper to outside.

.2 Prior to Start Up:

.1 During heating season, 3-port motorized valve will modulate to maintain setpoint temperature of 15ºC at TT-H800E.

.3 Start Up/Unoccupied mode/Occupied Mode/Emergency Mode:

.1 With the system in auto, the BAS shall energize MAU-H800A, the outside air damper, MD-H800A, and the exhaust air damper MD-H800B shall motor fully open. Limit switches on the dampers shall confirm, after 2 minutes, that the dampers are fully open. Failure to open the outside air or the exhaust air damper shall result in the shut down of the unit and an alarm being generated at the BAS.

.2 With the dampers outside air and exhaust dampers open, the BAS shall start the supply fan SF-H800A. The BAS shall output a 4-20 mA proportional signal to ramp up the VFD output to maintain the design flow rate (refer to MAU schedule for flow rates for unoccupied and occupied mode).

.3 One minute after the starting of the supply fan, the exhaust fan EF-H800A, will start. The BAS shall output a 4 to 20 mA proportional signal to ramp up the VFD output to maintain the design flow rate (refer to MAU schedule for flow rates for unoccupied and occupied mode).

.4 A failure to start by either fan shall result in a shut down of the unit and an alarm indicated at the BAS.

.5 When the outside temperature is less than 15ºC and the supply air temperature at TT-H800-C is less than 15ºC, then the BAS shall modulate the 3-port valve on the heating coil, MV-H800A to maintain a minimum temperature of 15ºC in the duct at TT-H800E.

.4 Air-to-Air Heat Exchanger:

.1 PS-H800B shall monitor the differential pressure across the air-to-air heat exchanger. Upon detection of a high differential pressure (125 Pa) and the outside temperature sensor TT-H800A indicating a temperature below 5ºC, an alarm only shall be generated and the auto-traverse defrost system initiated

.5 Filters:

.1 Differential pressure transmitters PT-H800A and PT-H800B shall monitor the pressure drop across the filters. Upon detection of an excessive pressure drop (250 Pa) across either filter an alarm only shall be signaled to the BAS. An alarm initiated by either switch shall have no effect on the run status of the unit.

.6 Temperature Monitoring:

.1 The BAS shall monitor the following temperatures: space TT-H800F, supply air downstream of heating coil TT-H800E, outside air TT-H800A, heat exchanger inlet and outlet on both the outside air and the exhaust air sides TT-H800B, TT-H800C, and TT-H800D.

.7 System Shut Down:

.1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the supply and exhaust fans. After 30 seconds, the BAS shall close the outside air damper MD-H800A and the exhaust air damper MD-H800B.

.8 Emergency Operation:

.1 In emergency operation the BAS shall ramp up the speed of both the supply and exhaust fans to provide the required design flow rate (refer to MAU schedule for flow rates for emergency operation)

.2 The BAS shall close the 3-port heating valve.

.9 Common Fault/Alarm:

.1 Any alarm generated by the BAS shall generate an alarm reported to the site SCADA system as indicated on the drawing.

3.7 Make Up Air Unit MAU-H801A (Sulphuric Acid Room) - Sequence of Operation

.1 Description of Operation:

.1 The Make Up Air Unit runs continuously, switching between occupied mode and unoccupied mode at the times set out elsewhere in this section. During occupied mode the unit runs at 6 AC/HR, and 1.5 AC/HR during un-occupied mode.

.2 Outside air enters the unit through the outside air damper and passes through a filter prior to entry into an air-to-air heat exchanger. Upon leaving the heat exchanger, the air then passes through a Hydronic heating coil, a second stage filter, and finally through the supply fan before being discharged from the unit via ductwork to the ventilated space.

.3 Exhaust air enters the unit and passes through the air-to-air heat exchanger, passes through the exhaust fan and is discharged through the exhaust air damper to outside.

.2 Prior to Start Up:

.1 During heating season, 3-port motorized valve will modulate to maintain set point temperature of 15ºC at TT-H801E.

.3 Start Up/Unoccupied mode/Occupied Mode/Emergency Mode:

.1 With the system in auto, the BAS shall energize MAU-H801A, the outside air damper, MD-H801A, and the exhaust air damper MD-H801B shall motor fully open. Limit switches on the dampers shall confirm, after 2 minutes, that the dampers are fully open. Failure to open the outside air or the exhaust air damper shall result in the shut down of the unit and an alarm being generated at the BAS.

.2 With the dampers outside air and exhaust dampers open, the BAS shall start the supply fan SF-H801A. The BAS shall output a 4 to 20 mA proportional signal to ramp up the VFD output to maintain the design flow rate (refer to MAU schedule for flow rates for unoccupied and occupied mode).

.3 One minute after the starting of the supply fan, the exhaust fan EF-H801A, will start. The BAS shall output a 4 to 20 mA proportional signal to ramp up the VFD output to maintain the design flow rate (refer to MAU schedule for flow rates for unoccupied and occupied mode).

.4 A failure to start by either fan shall result in a shut down of the unit and an alarm indicated at the BAS.

.5 When the outside temperature is less than 13ºC and the air temperature at TT-H801C is less than 15ºC, then the BAS shall modulate the 3-port valve on the heating coil, MV-H801A to maintain a minimum temperature of 15ºC in the duct at TT-H801E.

.4 Air-to-Air Heat Exchanger:

.1 PS-H801B shall monitor the differential pressure across the air-to-air heat exchanger. Upon detection of a high differential pressure (125 Pa) and the outside temperature sensor TT-H801A indicating a temperature below 5ºC, an alarm only shall be generated and the auto-traverse defrost system initiated

.5 Filters:

.1 Differential pressure transmitters PT-H801A and PDT-H801B shall monitor the pressure drop across the filters. Upon detection of an excessive pressure drop (250 Pa) across either filter an alarm only shall be signaled to the BAS. An alarm initiated by either switch shall have no effect on the run status of the unit.

.6 Temperature Monitoring:

.1 The BAS shall monitor the following temperatures: space TT-H801F, supply air downstream of heating coil TT-H801E, outside air TT-H801A, heat exchanger inlet and outlet on both the outside air and the exhaust air sides TT-H801B, TT-H801C, and TT-H801D.

.7 System Shut Down:

.1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the supply and exhaust fans. After 30 seconds, the BAS shall close the outside air damper MD-H801A and the exhaust air damper MD-H801B.

.8 Emergency Operation:

.1 In emergency operation the BAS shall ramp up the speed of both the supply and exhaust fans to provide the required design flow rate (refer to MAU schedule for flow rates for emergency operation)

.2 The BAS shall close the 3-port heating valve.

.9 Common Fault/Alarm:

.1 Any alarm generated by the BAS shall generate an alarm reported to the site SCADA system as indicated on the drawing.

3.8 Make Up Air Unit MAU-H802A (Sodium Hydroxide Room) - Sequence of Operation

.1 Description of Operation:

.1 The Make Up Air Unit runs continuously, switching between occupied mode and unoccupied mode at the times set out elsewhere in this section. During occupied mode the unit runs at 6 AC/HR, and 1.5AC/HR during un-occupied mode.

.2 Outside air enters the unit through the outside air damper and passes through a filter prior to entry into an air-to-air heat exchanger. Upon leaving the heat exchanger, the air then passes through a Hydronic heating coil, a second stage filter, and finally through the supply fan before being discharged from the unit via ductwork to the ventilated space.

.3 Exhaust air enters the unit and passes through the air-to-air heat exchanger, passes through the exhaust fan and is discharged through the exhaust air damper to outside.

.2 Prior to Start Up:

.1 During heating season, 3-port motorized valve will modulate to maintain set point temperature of 15ºC at TT-H802E.

.3 Start Up/Unoccupied mode/Occupied Mode/Emergency Mode:

.1 With the system in auto, the BAS shall energize MAU-H802A, the outside air damper, MD-H802A, and the exhaust air damper MD-H802B shall motor fully open. Limit switches on the dampers shall confirm, after 2 minutes, that the dampers are fully open. Failure to open the outside air or the exhaust air damper shall result in the shut down of the unit and an alarm being generated at the BAS.

.2 With the dampers outside air and exhaust dampers open, the BAS shall start the supply fan SF-H802A. The BAS shall output a 4 to 20 mA proportional signal to ramp up the VFD output to maintain the design flow rate (refer to MAU schedule for flow rates for unoccupied and occupied mode).

.3 One minute after the starting of the supply fan, the exhaust fan EF-H802A, will start. The BAS shall output a 4 to 20 mA proportional signal to ramp up the VFD output to maintain the design flow rate (refer to MAU schedule for flow rates for unoccupied and occupied mode).

.4 A failure to start by either fan shall result in a shut down of the unit and an alarm indicated at the BAS.

.5 When the outside temperature is less than 13ºC and the air temperature at TT-H802-C is less than 15ºC, then the BAS shall modulate the 3-port valve on the heating coil, MV-H802A to maintain a minimum temperature of 15ºC in the duct at TT-H802E.

.4 Air-to-Air Heat Exchanger:

.1 PS-H802B shall monitor the differential pressure across the air-to-air heat exchanger. Upon detection of a high differential pressure (125 Pa) and the outside temperature sensor TT-H802A indicating a temperature below 5ºC, an alarm only shall be generated and the auto-traverse defrost system initiated

.5 Filters:

.1 Differential pressure transmitters PT-H802A and PT-H802B shall monitor the pressure drop across the filters. Upon detection of an excessive pressure drop (250 Pa) across either filter an alarm only shall be signaled to the BAS. An alarm initiated by either switch shall have no effect on the run status of the unit.

.6 Temperature Monitoring:

.1 The BAS shall monitor the following temperatures: space TT-H802F, supply air downstream of heating coil TT-H802E, outside air TT-H802A, heat exchanger inlet and

outlet on both the outside air and the exhaust air sides TT-H802B, TT-H802C, and TT-H802D.

.7 System Shut Down:

.1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the supply and exhaust fans. After 30 seconds, the BAS shall close the outside air damper MD-H802A and the exhaust air damper MD-H802B.

.8 Emergency Operation:

.1 In emergency operation the BAS shall ramp up the speed of both the supply and exhaust fans to provide the required design flow rate (refer to MAU schedule for flow rates for emergency operation)

.2 The BAS shall close the 3-port heating valve.

.9 Common Fault/Alarm:

.1 Any alarm generated by the BAS shall generate an alarm reported to the site SCADA system as indicated on the drawing.

3.9 Make Up Air Unit MAU-H804A (Aqua Ammonia Room) - Sequence of Operation

.1 Description of Operation:

.1 The Make Up Air Unit runs continuously, switching between occupied mode and unoccupied mode at the times set out elsewhere in this section. During occupied mode the unit runs at 6 AC/HR, and 1.5 AC/HR during un-occupied mode.

.2 Outside air enters the unit through the outside air damper and passes through a filter prior to entry into an air-to-air heat exchanger. Upon leaving the heat exchanger, the air then passes through a Hydronic heating coil, a second stage filter, and finally through the supply fan before being discharged from the unit via ductwork to the ventilated space.

.3 Exhaust air enters the unit and passes through the air-to-air heat exchanger, passes through the exhaust fan and is discharged through the exhaust air damper to outside.

.2 Prior to Start Up:

.1 During heating season, 3-port motorized valve will modulate to maintain setpoint temperature of 15ºC at TT-H804E.

.3 Start Up/Unoccupied mode/Occupied Mode/Emergency Mode:

.1 With the system in auto, the BAS shall energize MAU-H804A, the outside air damper, MD-H804A, and the exhaust air damper MD-H804B shall motor fully open. Limit switches on the dampers shall confirm, after 2 minutes, that the dampers are fully open.

Failure to open the outside air or the exhaust air damper shall result in the shut down of the unit and an alarm being generated at the BAS.

.2 With the dampers outside air and exhaust dampers open, the BAS shall start the supply fan SF-H804A. The BAS shall output a 4 to 20 mA proportional signal to ramp up the VFD output to maintain the design flow rate (refer to MAU schedule for flow rates for unoccupied and occupied mode).

.3 One minute after the starting of the supply fan, the exhaust fan EF-H804A, will start. The BAS shall output a 4 to 20 mA proportional signal to ramp up the VFD output to maintain the design flow rate (refer to MAU schedule for flow rates for unoccupied and occupied mode).

.4 A failure to start by either fan shall result in a shut down of the unit and an alarm indicated at the BAS.

.5 When the outside temperature is less than 13ºC and the air temperature at TT-H804-C is less than 15ºC, then the BAS shall modulate the 3-port valve on the heating coil, MV-H804A to maintain a minimum temperature of 15ºC in the duct at TT-H804E.

.4 Air-to-Air Heat Exchanger:

.1 PS-H804B shall monitor the differential pressure across the air-to-air heat exchanger. Upon detection of a high differential pressure (125 Pa) and the outside temperature sensor TT-H804A indicating a temperature below 5ºC, an alarm only shall be generated and the auto-traverse defrost system initiated

.5 Filters:

.1 Differential pressure transmitters PT-H804A and PT-H804B shall monitor the pressure drop across the filters. Upon detection of an excessive pressure drop (250 Pa) across either filter an alarm only shall be signaled to the BAS. An alarm initiated by either switch shall have no effect on the run status of the unit.

.6 Temperature Monitoring:

.1 The BAS shall monitor the following temperatures: space TT-H804F, supply air downstream of heating coil TT-H8024, outside air TT-H804A, heat exchanger inlet and outlet on both the outside air and the exhaust air sides TT-H804B, TT-H804C, and TT-H804D.

.7 System Shut Down:

.1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the supply and exhaust fans. After 30 seconds, the BAS shall close the outside air damper MD-H804A and the exhaust air damper MD-H804B.

.8 Emergency Operation:

.1 In emergency operation the BAS shall ramp up the speed of both the supply and exhaust fans to provide the required design flow rate (refer to MAU schedule for flow rates for emergency operation)

.2 The BAS shall close the 3-port heating valve.

.9 Common Fault/Alarm:

.1 Any alarm generated by the BAS shall generate an alarm reported to the site SCADA system as indicated on the drawing.

3.10 Process Water Plate Heat Exchangers HEX-H806A and HEX-H806B - Sequence of Operation

.1 Description of Operation:

.1 The plate heat exchangers are supplied complete, skid mounted with a proprietary controls package and panel, controlling the plate heat exchangers proprietary pump, 3-port control valve and secondary water outlet temperature. The process plate heat exchangers are configured for duty/stand-by operation.

.2 Change over of the duty process heat exchanger to the stand by heat exchanger shall be achieved manually.

.2 Start Up/Normal Operation:

.1 The BAS shall energize the duty plate heat exchanger.

.2 The BAS shall monitor the fault condition signal from the proprietary packaged controls system on the plate heat exchanger for a fault condition. If the plate heat exchanger controls generate a fault condition, an alarm shall be generated at the BAS and the BAS shall energize the stand-by plate heat exchanger.

3.11 DHW Plate Heat Exchanger HWT-H814A - Sequence of Operation

.1 Description of Operation:

.1 The plate heat exchangers are supplied complete, skid mounted with a proprietary controls package and panel, controlling the plate heat exchangers proprietary pump, 3-port control valve and secondary water outlet temperature

.2 Start Up/Normal Operation:

.1 The DHW plate heat exchanger is permanently energized.

.2 The BAS shall monitor the fault condition signal from the proprietary packaged controls system on the plate heat exchanger for a fault condition. If the plate heat exchanger controls generate a fault condition, an alarm shall be generated at the BAS.

3.12 Air Handling Unit AHU-H803A (Electrical Room) - Sequence of Operation

.1 Description of Operation:

.1 The unit is in continuous operation.

.2 Outside air is mixed with return air from the space, before entering the air handling unit. The mixed air is then passes through a single stage filter. The DX cooling coil then conditions the air. It then passes through the supply fan, and is discharged to the ventilated space.

.3 The outside air and the return air dampers are operated from the same actuator. The dampers are configured such that if one damper is fully open then the other is fully closed. When the outside air damper is opened then the return air damper shall close by an equal amount.

.2 Start Up/Unoccupied mode/Occupied Mode:

.1 With the system in auto, the BAS shall modulate the inlet damper to a minimum setting of 40%. The return air damper shall close to 60% open.

.2 After 2 minutes, the BAS shall confirm that the outside air damper is in at the defined position. A failure to open the damper shall result in the BAS initiating the shut down sequence and an alarm being generated. The BAS shall energize the AHU supply fan and ramp the speed up to maintain the minimum design flow rate (approx 20%). A failure to start the fan shall result in the BAS initiating the shut down sequence and an alarm being generated.

.3 The BAS shall modulate the outside air and the return air dampers of the mixing box and the VFD to maintain space temperature range between 15-26ºC, at the dictate of the room temperature sensor TT-H803D.

.4 In the event that room temperature range is not achieved by modulating the dampers and the outside temperature is above 24ºC, then the BAS shall energize the DX coil.

.3 Room Pressure Control:

.1 The BAS shall maintain a positive pressure in the room at the dictate of PT-H803C. The BAS shall modulate the pressure relief damper MD-H803C and modulate the VFD on the supply fan SF-H803A to maintain a pressure of 2 Pa positive relative to the outside air. The BAS shall generate an alarm if the pressure in the room falls below neutral 0Pa or rises above 10 Pa for a continuous period of 2 minutes (re-settable).

.4 Cooling Coil:

.1 If the space temperature sensor, TT-H803D detects a temperature above 26ºC, with the outside air damper fully open and the VFD at 100%, the BAS shall energize the DX cooling unit, shut the O/A damper fully closed, and the return air damper to 100% open. The DCS shall maintain an induct temperature of 12ºC, at the dictate of the duct temperature transmitter TT-H803C, until the room temperature sensor TT-H803A indicates that the room temperature is 5ºC below the upper limit of the room temperature range.

.2 Should the space temperature sensor TT-H803D indicate a room temperature of 28ºC or greater an alarm only shall be generated

.5 Filters:

.1 Differential pressure transmitters PT-H803A and PT-H803B shall monitor the pressure drop across the filter. Upon detection of an excessive pressure drop (250 Pa) across either filter an alarm only shall be signaled to the BAS. This alarm shall have no effect on the run status of the unit.

.6 System Shut Down:

.1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the AHU supply fan. After 30 seconds, the BAS shall close the outside air inlet damper and the exhaust air damper.

.7 Common Fault/Alarm:

.1 Any alarm generated by the BAS shall generate an alarm reported to the site SCADA system as indicated on the drawing.

3.13 Air Handling Unit AHU-H828A (Control Room) - Sequence of Operation

.1 Description of Operation:

.1 The unit is in continuous operation.

.2 Outside air is mixed with return air from the space, before entering the air handling unit. The mixed air is then passes through a single stage filter. The electric resistance heater battery or the DX cooling coil then conditions the air. It then passes through the supply fan, and is discharged to the ventilated space.

.3 The outside air and the mixed air dampers are operated via the same actuator. The dampers are configured such that if one damper is fully open then the other is fully closed. When the outside air damper is opened then the return air damper shall close by an equal amount.

.2 Start Up/Unoccupied mode/Occupied Mode:

.1 On energizing the AHU, the BAS shall modulate the inlet damper to a minimum required setting to achieve the design flow rate (20% for example). The return air damper shall close to 80% open.

.2 After 2 minutes, the BAS shall confirm that the outside air damper is in the defined position. A failure to open the damper shall result in the BAS initiating the shut down sequence and an alarm being generated. The BAS shall energize the AHU supply fan and ramp the speed up to maintain the design flow rate. A failure to start the fan shall result in the BAS initiating the shut down sequence and an alarm being generated.

.3 The BAS shall modulate the outside air and the return air dampers of the mixing box to maintain space temperature range between 15-24ºC, at the dictate of the room temperature sensor TT-H828A. The outside air damper shall never be less than 40% open whilst attempting to achieve set point.

.4 Damper MD-H828C shall modulate to maintain a positive pressure within the room. The damper will in open linearly with damper MD-H828A, however damper MD-H828C will not open until damper MD-H828A has opened greater than 20%. The damper will then modulate in line with the intake damper reaching 80% open when the intake damper is 100% closed.

.5 In the event that room temperature range is not achieved by modulating the dampers and the outside temperature is below 12ºC during heating season, then the BAS shall energize the electric heating coil

.6 In the event that room temperature range is not achieved by modulating the dampers and the outside temperature is above 20ºC, then the BAS shall energize the DX coil.

.3 Heating Coil:

.1 Upon a call for heating, the BAS shall modulate the O/A damper to the minimum position to achieve the design flow rate and modulate current to the electric heat coil via the SCR to achieve room temperature at the dictate of TT-H828D. Upon achieving set point the BAS shall modulate the heater battery to maintain, an off-coil induct temperature of 20ºC, at the dictate of the duct temperature transmitter TT-H828C. A drop in room temperature will result in the BAS modulating the heater battery to achieve set point.

.2 Should the duct temperature transmitter TT-H828C detect a temperature of 10ºC or less during the heating season an alarm shall be generated and the DCS shall initiate a system shut down.

.4 Cooling Coil:

.1 If the space temperature sensor, TT-H828D detects a temperature at above 24ºC the BAS shall energize the DX cooling unit, shut the O/A damper to the minimum position to achieve the design flow rate, and the return air damper to the corresponding position.

The DCS shall maintain an induct temperature of 12ºC, at the dictate of the duct temperature transmitter TT-H828C, until the room temperature sensor TT-H828A indicates that the room temperature is 5ºC below the upper limit of the room temperature range.

.2 Should the space temperature sensor TT-H828D indicate a room temperature of 28ºC or greater an alarm only shall be generated

.5 Filters:

.1 Differential pressure transducers PT-H828A and PT-H828B shall monitor the pressure drop across the filters. Upon detection of an excessive pressure drop (250 Pa) across either filter an alarm only shall be signaled to the BAS. This alarm shall have no effect on the run status of the unit.

.6 System Shut Down:

.1 Upon receiving a signal to shut the unit down (fault alarm or manual), the BAS shall shut down the AHU supply fan. After 30 seconds, the BAS shall close the outside air inlet damper and the exhaust air damper.

.7 Common Fault/Alarm:

.1 Any alarm generated by the BAS shall generate an alarm reported to the site SCADA system as indicated on the drawing.

3.14 Mechanical Room Supply Fan SF-H831A

.1 Description of Operation:

.1 The Mechanical Room Supply Fan provides fresh air to the mechanical room for cooling purposes.

.2 Startup/Normal Operation:

.1 The BAS shall control the operation of the system at the dictate of the Mechanical Room Temperature Transducer, TT-H831A. The BAS shall energize the system when the temperature at TT-H831A reaches 30ºC and will continue to operate until the temperature is 5ºC less than the set point.

.2 The BAS shall open the outside air damper MD-H831B. Limit switches on the damper shall confirm the damper is fully open. After 2 minutes, the BAS shall confirm that the damper is fully open. A failure to open the damper will initiate the shut down sequence and an alarm being generated.

.3 With the damper fully open, the BAS shall energize the supply fan SF-H831A at low speed. A failure to start the fan shall result in the BAS initiating the shut down sequence and an alarm being generated.

.4 If the temperature continues to rise and TT-H831A detects a temperature of 35ºC then the BAS shall run SF-H831A at high speed. When the temperature is 5ºC below high setpoint the fan shall return to low speed.

.3 Shut Down Sequence:

.1 The BAS shall de-energize the fan and shut the outside air damper.

3.15 Washroom Extract Fan EF-829A

.1 Description of Operation:

.1 The washroom fan runs continuously 24/7, with make up air provided via transfer grilles from the control room.

.2 Startup/Normal Operation:

.1 The BAS shall open the exhaust damper MD-H829B. Limit switches on the damper shall confirm the damper is fully open.

.2 After 2 minutes, the BAS shall confirm that the damper is fully open. A failure to open the damper will initiate the shut down sequence and an alarm being generated.

.3 With the damper fully open, the BAS shall energize the exhaust fan EF-829A. A failure to start the fan shall result in the BAS initiating the shut down sequence and an alarm being generated.

.3 Shut Down Sequence:

.1 The BAS shall de-energize the fan and shut the exhaust damper.

3.16 Rail Car Shelter Ventilation EF-H818B and EF-H819B – Sequence of Operation

.1 Description of Operation:

.1 The Rail Car Shelter is mechanically ventilated. The system provides fresh air to the shelter by way of exhaust fans located on the roof of the shelter, which draw air through the intake louvers. The system is manually operated.

.2 All alarms generated by the BAS shall be repeated to a local annunciator panel located adjacent to the selector switch.

.2 Start Up/Normal Operation – Outside Temperature 10ºC or Less

.1 Upon energizing the system, the system shall be in stand-by mode.

.2 The system is activated by means of a remote switch located in the railcar shelter.

.3 Upon activation the dampers on the intake louvers, MD-H816A and MD-H817A, and the dampers in the exhaust ductwork, MD-H818B and MD-H819B shall open. Limit switches on the dampers shall confirm the dampers are fully open. A failure to open any of the dampers shall result in an alarm only being generated by the BAS. In the event that either supply dampers MD-H816A and MD-H817A fail to open, or exhaust dampers MD-H818B and MD-H819B fail to open, the BAS shall generate an alarm.

.4 Closing of the limit switches on the dampers shall energize the exhaust fans. A failure to start either fan shall result in an alarm being generated by the BAS. If damper MD-H818B fails to open then the BAS shall not energize EF-H818A, similarly if damper MD-H819B fails to open then fan EF-H819A will not start. A failure to start by either fan shall generate an alarm on the BAS

.3 Shut Down Sequence:

.1 Upon manually activating the system shutdown the power shall drop off the dampers shall close the intake louver dampers MD-H816A and MD-H817A, and the dampers in the exhaust ductwork, MD-H818B and MD-H819B. The opening of the damper limit switches shall cause the fans to stop.

3.17 Emergency Exhaust EF-H820C, EF-H821C, EF-H824C, and EF-H825C – Sequence of Operation

.1 Description of Operation:

.1 Due to the nature of the operation of the Emergency Exhaust Fans, these items are to be hardwired controlled with no input from the BAS. The emergency exhaust systems are initiated by the SCADA system thought sump level alarms or gas detection alarms, or are started manually by a locally positioned switch. The BAS shall monitor the system and report faults only. All motorized dampers on these systems shall have motor closed/spring open actuators.

.2 Normal (Emergency Mode) Operation:

.1 The system interlocking the dampers and the exhaust fans shall be permanently energized.

.2 Upon receiving a signal to run from the SCADA system, a normally open contact on a relay shall close. This will power the intake dampers open and the exhaust dampers open. Limit switches on the dampers will initiate the starting of the fans by closing normally open contacts on a relay.

.3 The BAS shall monitor the status of the dampers and the fans. In the event of a damper failing to open or a fan, failing to start and alarm shall be generated at the BAS.

.3 Shut Down:

.1 Shut down of the system shall be initiated manually at the SCADA system. Upon initiating the shut sequence, the SCADA system shall drop the open damper signal,

returning the circuit to open. The dampers will self close causing the damper open limit switch to open circuit shutting down the fan.

3.18 Heat Tracing - Sequence of Operation

.1 Description of Operation:

.1 Heat tracing systems are incorporated behind the intake louvers on the various mechanical ventilation systems and on pipework to the external emergency showers. The heat tracing systems operate automatically dependant of the external weather conditions.

.2 Normal Operation:

.1 The BAS shall energize the heat tracing systems on the louvers at the dictate of the outside temperature sensors. The system shall operate when the outside temperature ranges between -5ºC and 5ºC.

.2 Heat tracing on the pipework to the external showers is permanently energized and is controlled by a proprietary pipe thermostat.

.3 The BAS shall monitor the status of all the heat tracing controllers. Any fault in the heat tracing system shall generate an alarm only at the BAS.

.4 Heat tracing systems installed behind louvers designated as emergency intake louvers shall operate in-line with those systems designated for normal operation, and not only during times when the emergency systems are running.

3.19 STANDBY POWER MODE:

.1 Description of Operation:

.1 Upon receiving a digital signal identified as YY-H080A “Water Treatment Plant in Standby Power Mode – HVAC Shutdown Command” from Plant PLC, the BAS shall initiate the Standby Power Mode and initiate a system shutdown for all systems within its domain.

.2 Within 30 seconds (adjustable) immediately after YY-H080A has been received, the BAS shall resume normal operation for the first group of systems. These are:

.1 Hydronic Heating Boilers including but not limited too, all associated pumps, control valves, and ancillary items.

.2 Compressed Air System

.3 Steam Generation Plant including but not limited too, all associated pumps, control valves, and ancillary items.

.4 Process Water Heaters

.3 Within 60 seconds (adjustable) immediately after YY-H080A has been received, the BAS shall resume normal operation of the second group of systems. These are:

.1 Control Room Ventilation, and all associated dampers, fans and condenser unit.

.2 Electrical Room Ventilation, and all associated dampers, fans and condenser unit.

.3 Within 90 seconds (adjustable) immediately after YY-H080A has bee received, the BAS shall resume normal operation of all remaining HVAC systems and domestic Hot Water System.

.2 The programming of this sequence shall include functionalities that provide a means of adding and/or removing any system to and/or from the groups above through the HMI. These functionalities shall apply user-friendly operations such as drag-and-drop for the purpose of adding or removing systems.

.3 The programming of this sequence shall also take into consideration the components within each system, such that if a system is to be added or removed from a group, all components within the system must be included

END OF SECTION

LIST OF SCHEDULES

1. LIST OF SCHEDULES

.1 Hydronic Boiler Schedule

.2 Steam Boiler Schedule

.3 Makeup Air Unit Schedule

.4 Air Handling Unit Schedule

.5 Supply Air Fan Schedule

.6 Exhaust Air Fan Schedule

.7 Ductwork Schedule

.8 Electric Unit Heater Schedule

.9 Electric Radiant Heater Schedule

.10 Hydronic Unit Heater Schedule

.11 Air Compressor Schedule

.12 Air Dryer Schedule

.13 Tank Schedule

.14 Plate Heat Exchanger Schedule

.15 Pump Schedule

.16 Booster Pump Schedule

.17 Fan Coil Unit Schedule

.18 Air Cooled Condensing Unit Schedule

.19 Motorised Damper Schedule

LIST OF SCHEDULES

1.2 Hydronic Boiler Schedule

Tag	BG-H805A	BG-H805B
Location	Chem. Bldg Mechanical Room	Chem. Bldg Mechanical Room
Type	Natural Gas Boiler	Natural Gas Boiler
Manufacturer	De Dietrich	De Dietrich
Model	GT 520	GT 520
Heating Input, kW (MBH)	1458 (4975)	1458 (4975)
Rated Heating Output, kW (MBH)	1239 (4229)	1239 (4229)
Efficiency	85%	85%
Operating Pressure, kPa (psi)	572 (83)	572 (83)
Fluid	50% E Glycol	50% E Glycol
EFT, °C (°F)	82 (180)	82 (180)
LFT, °C (°F)	67 (153)	67 (153)
Flow Rate, L/s (gpm)	23.7 (376.5)	23.7 (376.5)
Pressure Drop kPa (ft H_2O)	4.5 (1.5)	4.5 (1.5)
Electrical, V/ph/Hz	575/3/60	575/3/60
Motor Power, kW (hp)	2.24 (3)	2.24 (3)
Physical Data		
Overall Length, mm (in)	2350 (94)	2350 (94)
Overall Width, mm (in)	1175 (47)	1175 (47)
Overall Height, mm (in)	1650 (66)	1650 (66)
Operating Weight, kg (lbs)	4266 (9405)	4266 (9405)
Boiler Vent Connection mm (in)	400 (16)	400 (16)
Accessories & Remarks	Riello RM-130 modulating gas burner, AL29-4C HEPL2 chimney	Riello RM-130 modulating gas burner, AL29-4C HEPL2 chimney

LIST OF SCHEDULES

1.3 Steam Boiler Schedule

Tag	BLR-S704A	BLR-S705A
Location	Chem. Bldg Mechanical Room	Chem. Bldg Mechanical Room
Type	Multi water tube, once through, forced flow, steam boiler	Multi water tube, once through, forced flow, steam boiler
Manufacturer	MIURA	MIURA
Model	LXL-50SG	LXL-50SG
Horsepower Rating	50	50
Maximum Pressure, kPa (psi)	103 (15) Design	103 (15) Design
Operating Pressure, kPa (psi)	83 (12)	83 (12)
Equivalent Output, kg/hr (lb/hr)	782 (1,725)	782 (1,725)
Rated Heating Output, kW (MBH)	490 (1,674)	490 (1,674)
Heating Input, kW (MBH)	577 (1,970)	577 (1,970)
Efficiency	85%	85%
Heating Surface Area, m^2 (sq ft)	17.8 (191)	17.8 (191)
Electrical, V/ph/Hz	575/3/60	575/3/60
Motor Power, kW (hp)	2.3 (3)	2.3 (3)
NG Consumption, Nm^3/h (SCFH)	52.5 (1,960)	52.5 (1,960)
NG Supply Pressure, kPa (psi)	20.7-34.5 (3-5)	20.7-34.5 (3-5)
Flue Gas Volume, Nm^3/h (SCFH)	741 (27,600) Wet 631 (23,600) Dry	741 (27,600) Wet 631 (23,600) Dry
Flue Gas Temperature, °C (°F)	230 (450)	230 (450)
Overall Length, mm (in)	2413 (95)	2413 (95)
Overall Width, mm (in)	1092 (43)	1092 (43)
Overall Height, mm (in)	2604 (102.5)	2604 (102.5)
Operating Weight, kg (lbs)	1686 (3710)	1686 (3710)
Accessories & Remarks	C/W Economizer, High water alarm, MIURA XJ1 micro computer boiler control system, MIURA online maintenance MOM) capability, Complete gas train, Steam separator, Automatic continuous surface blowdown, Fan and blower motor, CGA and CRN approvals, Factory tested, Manual bottom blowdown system.	

LIST OF SCHEDULES

1.4 Makeup Air Unit Schedule

Tag	MAU-H850	MAU-H851	MAU-H852
Location	Hypo Bldg Mezz.	Hypo Bldg Mezz.	Hypo Bldg. Mezz.
Area Served	Hypo Storage Tanks	Hypo Storage Tanks	Hypo Generator Rm
Type	Indoor Heat Recovery	Indoor Heat Recovery	Indoor Heat Recovery
Manufacturer	Circul-Aire	Circul-Aire	Circul-Aire
Model	TMP-40P-X2F1	TMP-120P-X2F1	TMP-25P-X2F1
Supply Fan			
Tag	SF-H850A	SF-H851A	SF-H852A
Volume, L/s (cfm)	1887 (4000)	5660 (12000)	1038 (2200)
ESP, Pa (in.wg.)	250 (1.0)	250 (1.0)	188 (0.75)
Fan Type	DWDI-BI	PLENUM	DWDI-BI
Fan Speed, rpm	2711	1565	2635
Motor Power, kW (hp)	3.75(5.0)	11.2 (15.0)	1.5 (2.0)
Power Supply, V/ph/Hz	575-3-60	575-3-60	575-3-60
Exhaust Fan			
Tag	EF-H850A	EF-H851A	EF-H852A
Volume, L/s (cfm)	1887 (4000)	5660 (12000)	1038 (2200)
ESP, Pa (in.wg.)	125 (0.5)	125 (0.5)	125 (0.5)
Fan Type	DWDI-BI	PLENUM	DWDI-BI
Speed, rpm	2593	1499	2500
Motor Power, kW (hp)	3.75(2.0)	7.5 (10.0)	1.12 (1.5)
Power Supply, V/ph/Hz	575-3-60	575-3-60	575-3-60
Minimum Outdoor Air, L/s (cfm)			
Heating Section			
Tag	HC-H850A	HC-H851A	HC-H852A
Fluid	50% E. Glycol	50% E. Glycol	50% E. Glycol
EAT, °C (°F)	-9.3 (15.3)	-8.4 (16.9)	-10.5 (13.1)
LAT, °C (°F)	23.0 (73.5)	24.4 (76.0)	23.8 (74.8)
EWT, °C (°F)	82.2 (180)	82.2 (180)	82.2 (180)
LWT, °C (°F)	65.6 (150)	65.6 (150)	65.6 (150)
Capacity, kW (MBH)	73.9 (253)	225.5 (769)	43.2 (147)

LIST OF SCHEDULES

Tag	MAU-H850	MAU-H851	MAU-H852
Total Face Area, m^2 (sq. ft.)	0.65 (7.0)	2.04 (22.0)	0.42 (4.5)
Max. Face Velocity, m/s (fpm)	2.9 (571.4)	2.7 (545.5)	2.4 (488.9)
Material, Header/Pipe/Fin	Cu/Al	Cu/Al	Cu/Al
Rows, High x Deep	2. 600x1050	2. 900x2200	2. 450x900
Fin Spacing, fpi	8	8	8
Max Tube PD, kPa (ft wg)	25.2 (8.43)	21.8 (7.30)	12.0 (4.03)
Max Air PD, Pa (in wg)	64 (0.26)	59 (0.24)	64 (0.26)
Plate HX Section			
Tag	HE-H850	HE-H851	HE-H852
Material	Aluminum	Aluminum	Aluminum
Face Areas, EA/OA, m^2 (ft^2)	0.95 (10.2)/0.95 (10.2)	2.68 (28.8)/2.68 (28.8)	0.54 (5.81) /0.54 (5.81)
Surface Areas, EA/OA, m^2 (ft^2)			
Face Velocities, EA/OA, m/s (fpm)	1.96 (386)/1.96 (386)	2.08 (409)/2.08 (409)	1.86 (366)/1.86 (366)
Max Air PDs, EA/OA, Pa (in.wg.)	178 (0.71)/178 (0.71)	222 (0.89)/222 (0.89)	220 (0.88)/220 (0.88)
Maximum Efficiency			
Minimum Circuit Ampacity			
Arrangement			
Supply Outlet	Top	Top (Angle)	Top
Return Inlet	Front Bottom	Front Bottom	Bottom
Outdoor Air Inlet	Back Bottom	Back Bottom	Back Bottom
Relief Air Outlet	Top	Top	Top
Physical Data			
Overall Length, mm	4623	4775	3759
Overall Width, mm	1321	2591	1397
Overall Height, mm	1981	2697	1828
Operating Weight, kg (lbs)	925(2040)	2576(5680)	676(1490)
Accessories & Remarks	Traversing Defrost System Inverter duty motor for supply fan	Traversing Defrost System Angled supply discharge as shown on drawing	Face & Bypass Defrost system Inverter duty motor for both supply and exhaust fans.

LIST OF SCHEDULES

Tag	MAU-H800A	MAU-H801A	MAU-H802A
Location	Chem. Bldg Platform.	Chem. Bldg Platform.	Chem. Bldg Platform.
Area Served	Ferric Chloride Tanks	Sulphuric Acid Tanks	Sodium Hydroxide
Type	Indoor Heat Recovery	Indoor Heat Recovery	Indoor Heat Recovery
Manufacturer	Circul Aire	Circul Aire	Circul Aire
Model	TMP-60P-X2F1	TMP-40P-X2F1	TMP-60P-X2F1
Supply Fan	SF-H800A	SF-H801A	SF-H802A
Volume, L/s (cfm)	2500 (5300)	1840 (3900)	2500 (5300)
ESP, Pa (in.wg.)	249 (1.00)	187 (0.75)	249 (1.00)
Fan Type	DWDI-BI	DWDI-BI	DWDI-BI
Fan Speed, rpm	2041	1778	2051
Motor Power, kW (hp)	3.73 (5)	2.24 (3)	3.73 (5)
Power Supply, V/ph/Hz	575-3-60	575-3-60	575-3-60
Minimum Outdoor Air, L/s (cfm)	625 (1325)	460 (975)	625 (1325)
Exhaust Fan	EF-H800A	EF-H801A	EF-H802A
Volume, L/s (cfm)	2500 (5300)	1660 (3510)	2500 (5300)
ESP, Pa (in.wg.)	187 (0.75)	187 (0.75)	187 (0.75)
Fan Type	DWDI-BI	DWDI-BI	DWDI-BI
Speed, rpm	1447	1293	1444
Motor Power, kW (hp)	2.24 (3)	1.5 (2)	2.24 (3)
Power Supply, V/ph/Hz	575-3-60	575-3-60	575-3-60
Heating Section			
Fluid	50% E. Glycol	50% E. Glycol	50% E. Glycol
EAT, °C (°F)	-40 (-40)	-40 (-40)	-40 (-40)
LAT, °C (°F)	-10 (13.9)	-6.7 (19.9)	-7.2 (19.1)
EWT, °C (°F)	82 (180)	82 (180)	82 (180)
LWT, ºC (F)	65.5 (150)	65.5 (150)	65.5 (150)
Capacity, kW (MBH)	98.3 (335.6)	64.5 (220.2)	105.8 (361.3)
Total Face Area, m^2 (sq. ft.)	0.93 (10)	0.65 (7)	0.93 (10)
Max. Face Velocity, m/s (fpm)	2.69 (530)	2.83 (557)	2.69 (530)
Material, Header/Pipe/Fin	Cu/Al	Cu/Al	Cu/Al
Rows, Fin High x Deep (in)	2, 24x60	2, 24x42	2, 24x60
Fin Spacing, fpi	9	10	8
Max Tube PD, kPa (ft wc)	13.2 (4.44)	11 (3.7)	13.5(4.51)
Max Air PD, Pa (in wc)	393 (1.58)	398 (1.60)	393 (1.58)

LIST OF SCHEDULES

Tag	MAU-H800A	MAU-H801A	MAU-H802A
Plate HX Section			
Material	Aluminum	Aluminum	Aluminum
Face Areas, EA/OA, m² (ft²)			
Surface Areas, EA/OA, m² (ft²)			
Face Velocities, EA/OA, m/s	1.97 (387.9)/2.19 (431)	1.75 (343.5)/1.94 (382)	1.97 (387.9)/2.19 (431))
Max Air PDs, EA/OA, Pa	154 (0.62)/239 (0.96)	154 (0.62))/244 (0.98)	152 (0.61)/241 (0.97)
Maximum Efficiency			
Minimum Circuit Ampacity			
Arrangement			
Supply Outlet	Low Right Side	Low Right Side	Low Left Side
Return Inlet	Low Left Side	Low Left Side	Low Right Side
Outdoor Air Inlet	High Left Side	High Left Side	High Right Side
Exhaust Air Outlet	Top	Top	Top
Physical Data			
Overall Length, mm (in)	3607 (142)	3607 (142)	3607 (142)
Overall Width, mm (in)	1727 (68)	1448 (57)	1727 (68)
Overall Height, mm (in)	2133 (84)	2133 (84)	2133 (84)
Operating Weight, kg (lbs)	1818 (4000)	1682 (3700)	1818 (4000)
Remarks			

Accessories:

1. Motorized outside air intake damper (insulated).
2. MERV 6 prefilter.
3. Motorized exhaust air discharge damper (insulated).
4. Recirculation damper.
5. Condensation drain pipe complete with drain pan.
6. Unit mounted control panel.
7. Traversing defrost system.
8. MERV 6 winter filter.

LIST OF SCHEDULES

1.4 Makeup Air Unit Schedule (con't)

Tag	MAU-H804A		
Location	Chem. Bldg Platform.		
Area Served	Aqua Ammonia Tanks		
Type	Indoor Heat Recovery		
Manufacturer	Circul Aire		
Model	TMP-25P-X2F1		
Supply Fan	SF-H804A		
Volume, L/s (cfm)	1062 (2250)		
ESP, Pa (in.wg.)	187 (0.75)		
Fan Type	DWDI-BI		
Fan Speed, rpm	2049		
Motor Power, kW (hp)	1.1 (1.5)		
Power Supply, V/ph/Hz	575-3-60		
Minimum Outdoor Air, L/s (cfm)	625 (560)		
Exhaust Fan	EF-H804A		
Volume, L/s (cfm)	1062 (2250)		
ESP, Pa (in.wg.)	187 (0.75)		
Fan Type	DWDI-BI		
Speed, rpm	1869		
Motor Power, kW (hp)	1.1 (1.5)		
Power Supply, V/ph/Hz	575-3-60		
Heating Section			
Fluid	50% E. Glycol		
EAT, °C (°F)	-40 (-40)		
LAT, °C (°F)	-10.5 (13.1)		
EWT, °C (°F)	82 (180)		
LWT, ºC (ºF)	65.5 (150)		
Capacity, kW (MBH)	43.7 (149.1)		
Total Face Area, m^2 (sq. ft.)	0.42 (4.5)		
Max. Face Velocity, m/s (fpm)	2.54 (500)		
Material, Header/Pipe/Fin	Cu/Al		
Rows, Fin High x Deep (in)	2, 18x36		
Fin Spacing, fpi	8		
Max Tube PD, kPa (ft wg)	14.6 (4.87)		
Max Air PD, Pa (in wg)	378 (1.52)		

LIST OF SCHEDULES

Tag	MAU-H804A		
Plate HX Section			
Material	Aluminum		
Face Areas, EA/OA, m² (ft²)			
Surface Areas, EA/OA, m² (ft²)			
Face Velocities, EA/OA, m/s	1.76 (347)/1.94 (381)		
Max Air PDs, EA/OA, Pa (in.wg.)	149 (0.6)/229 (0.92)		
Maximum Efficiency			
Minimum Circuit Ampacity			
Arrangement			
Supply Outlet	Low Right Side		
Return Inlet	Low Left Side		
Outdoor Air Inlet	High Left Side		
Exhaust Air Outlet	Top		
Physical Data			
Overall Length, mm (in)	3251 (128)		
Overall Width, mm (in)	1270 (50)		
Overall Height, mm (in)	1879 (74)		
Operating Weight, kg (lbs)	1364 (3000)		
Remarks			

Accessories:

1. Motorized outside air intake damper (insulated).
2. MERV6 prefilter.
3. Motorized exhaust air discharge damper (insulated).
4. Recirculation damper.
5. Condensation drain pipe complete with drain pan.
6. Unit mounted control panel.
7. Traversing defrost system.
8. MERV6 winter filter.

LIST OF SCHEDULES

1.5 Air Handling Unit Schedule

Tag	AHU-H854	AHU-H803A	AHU-H828A
Location	Hypo Bldg Mezzanine	Chem. Bldg Electrical Room	Chem. Bldg Control. Room
Area Served	Electrical Room	Electrical Room	Control Room
Type	Indoor	Indoor Air Purified	Indoor Air Purified
Manufacturer	McQuay	McQuay	McQuay
Model	CAH006GDAC	CAH0106DAM	CAH005GDAM
Supply Fan			
Volume, L/s (cfm)	1509 (3200)	2052 (4350)	943 (2000)
TSP, Pa (in wg)			
ESP, Pa (in.wg.)	250 (1.0)	249 (1.0)	249 (1.0)
Fan Type	Centrifugal FC 10”	Centrifugal FC 15”	Centrifugal FC 9.5”
Fan Speed, rpm	1881	1032	1703
Motor Power, kW (hp)	3.7 (5.0)	2.24 (3.0)	1.5 (2.0)
Power Supply, V/ph/Hz	575-3-60	575-3-60	575-3-60
Minimum Outdoor Air, L/s (cfm)	0(0)	0 (0)	189 (400)
Return Fan	N/A	N/A	N/A
Volume, L/s (cfm)			
ESP, Pa (in.wg.)			
Fan Type			
Speed, rpm			
Motor Power, kW (hp)			
Power Supply, V/ph/Hz			
Heating Section	N/A	N/A	
Type			Electric SCR
Capacity, kW (MBH)			15 (51.2)
Electrical, V/ph/Hz			575-3-60
Temperature Rise, ºC (°F)			13.3 (24)
DX Coil			
Size, H x L, mm	525 x 1125	750 x 1125	600 x 625
Face Area, m² (ft²)	0.61 (6.56)	0.87 (9.38)	0.39 (4.17)

LIST OF SCHEDULES

Tag	AHU-H854	AHU-H803A	AHU-H828A
Rows Deep / FPI	6 / 6	4 / 6	6 / 7
Face Velocity, m/s (fpm)	2.44 (488)	2.36 (464)	2.44 (480)
Air side PD, Pa (in.wg.)	210 (0.84)	120 (0.48)	129 (0.52)
Clg. Capacity, kW (TR)	34.6 (10)	36.1 (10.3)	15.66 (4.45)
EAT DB/WB, ºC (°F)	28 (82) / 20 (68)	27.1/18.1 (80.8/64.6)	25.9/18.7 (78.6/65.7)
LAT DB/WB, ºC (°F)	14 (58) / 13 (56)	14.7/12.9 (58.5/55.2)	14.8/13.9 (58.7/57.1)
Arrangement			
Supply Outlet	Top Horizontal	Top	Top
Return Inlet	Top	Top	Top
Outdoor Air Inlet	Back	Left Side	Right Side
Relief Air Outlet	N/A	N/A	N/A
Physical Data			
Overall Length, mm	2591	2750 (110)	3200 (128)
Overall Width, mm	1321	1450 (58)	950 (38)
Overall Height, mm	900	1000(40)	850 (34)
Operating Weight, kg (lbs)	599	659 (1449)	471 (1038)
SPL (dbA) @ 3m all Freq.	80 max	80 max	80 max
Accessories & Remarks	C/W MERV 6 pre-filter, MERV 13 final filter, and premium efficiency	C/W MERV 6 pre-filter, MERV 13 final filter, and premium efficiency VFD rated motor	C/W MERV 6 pre-filter, MERV 13 final filter, and premium efficiency rated motor

LIST OF SCHEDULES

1.6 Supply Air Fan Schedule

Tag	SF-H831A		
Function	Chemical Building Mech. Room Ventilation & Combustion		
Location	Mechanical Room		
Type	Centrifugal Inline		
Volume, L/s (cfm)	1062 (2250)		
E.S.P., Pa (in.wg.)	250 (1.0)		
Fan Speed, rpm	1137		
Motor Power, kW (hp)	0.56 (0.75)		
Power Supply, V/ph/Hz	575-3-60		
Drive	Belt		
Arrangement			
Manufacturer	Greenheck		
Model	BSQ-180HP-7		
Control	1725/860 2-Speed		
Accessories & Remarks	1-11		

Accessories:

1. Galvanized steel housing
2. Backward inclined aluminum wheel
3. Static free belts
4. Two bolted access panels
5. Integral duct connections
6. Ball bearing motors
7. Adjustable motor pulley and plate
8. Galvanized motor cover
9. Bearings with grease fittings
10. Spring hanging isolators and brackets
11. Corrosion resistant Fasteners

LIST OF SCHEDULES

1.7 Exhaust Air Fan Schedule

Tag	EF-H818B	EF-H819B	EF-H820C
Function	Chemical Building Rail Car Enclosure Ventilation	Chemical Building Rail Car Enclosure Ventilation	Chemical Building Mech. Room Emergency Relief
Location	Rail Car Enclosure	Rail Car Enclosure	Aqua Ammonia Room
Type	Vaneaxial Roof Exhaust	Vaneaxial Roof Exhaust	Vaneaxial Roof Exhaust
Volume, L/s (cfm)	1982 (4200)	1982 (4200)	1062 (2250)
E.S.P., Pa (in.wg.)	63 (0.25)	63 (0.25)	125 (0.5)
Fan Speed, rpm	1480	1480	1551
Motor Power, kW (hp)	0.75 (1.0)	0.75 (1.0)	0.37 (0.5)
Power Supply, V/ph/Hz	575-3-60	575-3-60	575-3-60
Drive	Belt	Belt	Belt
Arrangement	9	9	9
Manufacturer	Northern Blower	Northern Blower	Northern Blower
Model/Size	7412/1825	7412/1825	7412/1500
Control	1725/860 2 Speed	1725/860 2 Speed	On/Off
Weight, kg (lbs)	114 (250)	114 (250)	114 (250)
Accessories & Remarks	1-12	1-12	1-12

Accessories :

1. Galvanized Steel case
2. Gasketted bolted access door
3. Square mounting Curb Base
4. Weather Hood
5. Jack Screw Motor Base
6. Extended grease fittings
7. Nylon Bushings
8. Fan base and vibration isolators
9. Weatherproof motor
10. Drive cover
11. Shaft seal
12. Motorized Damper

LIST OF SCHEDULES

Tag	EF-H821C	EF-H824C	EF-H825C
Function	Chemical Building Mech. Room Emergency Relief	Chemical Building Mech. Room Emergency Relief	Chemical Building Mech. Room Emergency Relief
Location	Sodium Hydroxide Room	Sulphuric Acid Room	Ferric Chloride Room
Type	Vaneaxial Roof Exhaust	Vaneaxial Roof Exhaust	Vaneaxial Roof Exhaust
Volume, L/s (cfm)	2501 (5300)	1840 (3900)	2501 (5300)
E.S.P., Pa (in.wg.)	125 (0.5)	125 (0.5)	125 (0.5)
Fan Speed, rpm	1455	1384	1455
Motor Power, kW (hp)	1.12 (1.5)	0.75 (1.0)	1.12 (1.5)
Power Supply, V/ph/Hz	575-3-60	575-3-60	575-3-60
Drive	Belt	Belt	Belt
Arrangement	9	9	9
Manufacturer	Northern Blower	Northern Blower	Northern Blower
Model/Size	7412/2000	7412/1825	7412/2000
Control	On/Off	On/Off	On/Off
Weight, kg (lbs)	159 (350)	114 (250)	159 (350)
Accessories & Remarks	1-12	1-12	1-12

Accessories :

1. Galvanized Steel case
2. Gasketted bolted access door
3. Square mounting Curb Base
4. Weather Hood
5. Jack Screw Motor Base
6. Extended grease fittings
7. Nylon Bushings
8. Fan base and vibration isolators
9. Weatherproof motor
10. Drive cover
11. Shaft seal
12. Motorized Damper

LIST OF SCHEDULES

Tag	EF-H829A	EF-H853	CF-H855 to CF-H859
Function	Chemical Building Electrical & Control Room Exhaust	Hypochlorite Generator Room Heat Relief	Hypochlorite Storage Area Ventilation
Location	Wash Room	Mezzanine	Hypo. Storage Room
Type	Centrifugal Exhaust	Airfloil Single Width	Industrial Ceiling Fan
Volume, L/s (cfm)	90 (190)	4717 (10000)	20519 (43500)
E.S.P., Pa (in.wg.)	93 (0.375)	250 (1.0)	NA
Fan Speed, rpm	730	1086	330
Motor Power, kW (hp)	0.127 (0.17)	3.7 (5.0)	0.086
Power Supply, V/ph/Hz	115-1-60	575-3-60	115-1-60
Drive	Direct	Belt	Direct
Arrangement		10	NA
Manufacturer	Broan	Greenheck	Environfan
Model	L200MG	27-AFSW-41	190A-7
Control	On/Off Activation with WR light switch	VFD	SS Speed control 105F with 108C reversing switch
Weight, kg (lbs)	10.8 (23.9)		
Accessories & Remarks		1-6,8,9	

Accessories:

1. Gasketted bolted access door
2. Housing drain with plug
3. Totally enclosed belt guard
4. Shaft and bearing guard
5. Extended grease fittings
6. Fan base and vibration isolators
7. Weatherproof motor
8. Drive cover
9. Shaft seal

LIST OF SCHEDULES

1.8 Ductwork Schedule

Area Served	Systems	Service	Section	SMACNA Duct Construction Criteria			Remarks
				Pressure Class	Materials of Construction	Seal Class	
Ferric Chloride Area	MAU-H800A, EF-H825C	Supply Air	All	750	Galvanized	C	
		Exhaust Air	All	-500	Galvanized	C	
Sulphuric Acid Area	MAU-H801A, EF-H824C	Supply Air	All	750	Galvanized	C	
		Exhaust Air	All	-500	Galvanized	C	
Sodium Hydroxide Area	MAU-H802A, EF-H821C	Supply Air	All	750	Galvanized	C	
		Exhaust Air	All	-500	Galvanized	C	
Aqua Ammonia Area	MAU-H804A, EF-H820C	Supply Air	All	750	Galvanized	C	
		Exhaust Air	All	-500	Galvanized	C	
Hypochlorite Area	MAU-H850, MAU-H851	Supply Air	All	750	Galvanized	C	
		Exhaust Air	All	-500	Galvanized	C	
Hypochlorite Generator Room	MAU-H852	Supply Air	All	750	Galvanized	C	
	EF-H853	Exhaust Air	All	-500	Galvanized	C	
Railcar Shelter	EF-H818B, EF-H819B	Exhaust Air	All	-500	Galvanized	C	
Electrical Rooms	AHU-H803A, AHU-H854	Supply Air	All	750	Galvanized	C	
		Return Air	All	-500	Galvanized	C	
	EF-H829A	Exhaust Air	All	-500	Galvanized	C	
Mechanical Room	SF-H831A	Supply Air	All	750	Galvanized	C	
		Exhaust Air	All	-500	Galvanized	C	
Control Room	AHU-H828A	Supply Air	All	750	Galvanized	C	
		Return Air	All	-500	Galvanized	C	
	EF-H829A	Exhaust Air	All	-500	Galvanized	C	
Washroom	EF-H829A	Exhaust Air	All	-500	Galvanized	C	

LIST OF SCHEDULES

1.9 Electric Unit Heater Schedule

Tag	EHU-H830A	EHU-H870	EHU-H871
Location	Bulk Chemical Electrical Room	Hypochlorite Building, Generator Room	Hypochlorite Building, Electrical Room
Type	Electric Forced Air	Electric Forced Air	Electric Forced Air
Capacity, kW (MBH)	7.5 (25.6)	5.0 (17.1)	5.0 (17.1)
Temperature Rise, ºC (ºF)	24 (43)	22 (40)	22 (40)
Air Flow, L/s (cfm)	278 (590)	227 (480)	227 (480)
Motor Speed, rpm	1550	1550	1550
Motor Power, kW (hp)	0.037 (1/20)	0.037 (1/20)	0.037 (1/20)
Power Supply, V/ph/Hz	575-3-60	600-3-60	600-3-60
Manufacturer	Reznor	Reznor	Reznor
Model	EGE	EGE	EGE
Accessories & Remarks	Complete with: - Wall Bracket - Thermostat Kit (5ºC to 38ºC)	Complete with: - Wall Bracket - Thermostat Kit (5ºC to 38ºC)	Complete with: - Wall Bracket - Thermostat Kit (5ºC to 38ºC)

LIST OF SCHEDULES

1.10 Electric Radiant Heater Schedule

Tag	ERH-H850A	ERH-H851A,B,C	ERH-H852A
Location	MAU-H850 Air Intake Plenum	MAU-H851 Air Intake Plenum	MAU-H852 Air Intake Plenum
Type	Single Quartz Tube Element	Single Quartz Tube Element	Single Quartz Tube Element
Capacity, kW (MBH)	2.0 (6.82)	2.0 (6.82)	2.0 (6.82)
Power Supply, V-ph-Hz	575-1-60	575-1-60	575-1-60
Overall Length, mm	1105	1105	1105
Heated length, mm	813	813	813
Manufacturer	CCI Thermal	CCI Thermal	CCI Thermal
Model	OKB412C6	OKB412C6	OKB412C6
Accessories & Remarks	Complete with: -Mounting Bracket	Complete with: -Mounting Bracket	Complete with: -Mounting Bracket

LIST OF SCHEDULES

Tag	ERH-H854A		
Location	AHU-H850 Air Intake Plenum		
Type	Single Quartz Tube Element		
Capacity, kW (MBH)	2.0 (6.82)		
Power Supply, V-ph-Hz	575-1-60		
Overall Length, mm	1105		
Heated length, mm	813		
Manufacturer	CCI Thermal		
Model	OKB412C6		
Accessories & Remarks	Complete with: -Mounting Bracket		

LIST OF SCHEDULES

1.11 Hydronic Unit Heater Schedule

Tag	UH-H820A	UH-H821A	UH-H822A	UH-H823A	UH-H824A
Location	Aqua Ammonia Room Emergency	Sodium Hydroxide Room Emergency	Stair Well	Mechanical Room Emergency	Sulphuric Acid Room Emergency
Fluid	50% Glycol	50% Glycol	50% Glycol	50% Glycol	50% Glycol
Capacity, kW (MBH)	45.7 (156)	80 (273)	8.35 (28.5)	80 (273)	65.6 (224)
Entering Fluid Temp., ºC (ºF)	82 (180)	82 (180)	82 (180)	82 (180)	82 (180)
Leaving Fluid Temp., ºC (ºF)	65.5 (150)	65.5 (150)	65.5 (150)	65.5 (150)	65.5 (150)
Design Flow, L/s (USgpm)	0.6 (9.5)	1.05 (16.7)	0.11 (1.8)	1.05 (16.7)	0.86 (13.7)
Fluid P.D., kPa (ft. wg)	4.1 (1.37)	3.98 (1.33)	4.1 (1.37)	3.98 (1.33)	5.44 (1.82)
Air Flow, L/s (cfm)	1368 (2900)	2421 (5130)	85 (180)	2421 (5130)	2030 (4300)
Fan Speed, rpm	1075	1075	1080/850/650	1075	1075
Motor Power, W (hp)	186 (0.25)	373 (0.5)	70 (0.1)	373 (0.5)	373 (0.5)
Power Supply, V/ph/Hz	115/1/60	208/3/60	115/1/60	208/3/60	208/3/60
Arrangement	Horizontal	Horizontal	RW270-02	Horizontal	Horizontal
Manufacturer	Rittling	Rittling	Rittling	Rittling	Rittling
Model	RH-193	RH-340	Cabinet 04	RH-340	RH-290
Accessories & Remarks	Line voltage thermostat Diffuser blades	Line voltage thermostat Diffuser blades	Three speed control with thermostats	Line voltage thermostat Diffuser blades	Line voltage thermostat Diffuser blades

LIST OF SCHEDULES

Tag	UH-H825A	UH-H833A	UH-H834A	UH-H835A	UH-H836A
Location	Ferric Chloride Room Emergency	Ferric Chloride Room Space Heater	Ferric Chloride Room Space Heater	Sulphuric Acid Room Space Heater	Mechanical Room
Fluid	50% Glycol	50% Glycol	50% Glycol	50% Glycol	50% Glycol
Capacity, kW (MBH)	80 (273)	80 (273)	39.7 (135.4)	65.6 (224)	80 (273)
Entering Fluid Temp., ºC (ºF)	82 (180)	82 (180)	82 (180)	82 (180)	82 (180)
Leaving Fluid Temp., ºC (ºF)	65.5 (150)	65.5 (150)	65.5 (150)	65.5 (150)	65.5 (150)
Design Flow, L/s (USgpm)	1.05 (16.7)	1.05 (16.7)	0.54 (8.6)	0.86 (13.7)	1.05 (16.7)
Fluid P.D., kPa (ft. wg)	3.98 (1.33)	3.98 (1.33)	7.8 (2.62)	5.44 (1.82)	3.98 (1.33)
Air Flow, L/s (cfm)	2421 (5130)	2421 (5130)	481 (1020)	2030 (4300)	2421 (5130)
Fan Speed, rpm	1075	1075	1180/950/700	1075	1075
Motor Power, W (hp)	373 (0.5)	373 (0.5)	240 (0.32)	373 (0.5)	373 (0.5)
Power Supply, V/ph/Hz	208/3/60	208/3/60	115/1/60	208/3/60	208/3/60
Arrangement	Horizontal	Horizontal	Cabinet 04	Horizontal	Horizontal
Manufacturer	Rittling	Rittling	Rittling	Rittling	Rittling
Model	RH-340	RH-340	RF200-12	RH-290	RH-340
Accessories & Remarks	Line voltage thermostat Diffuser blades	Line voltage thermostat Diffuser blades	Three speed control with thermostats	Line voltage thermostat Diffuser blades	Line voltage thermostat Diffuser blades

LIST OF SCHEDULES

Tag	UH-H837A	UH-H838A	UH-H839A		
Location	Mechanical Room	Chemical Building Space Heater	Aqua Ammonia Room		
Fluid	50% Glycol	50% Glycol	50% Glycol		
Capacity, kW (MBH)	45.7 (156)	80 (273)	45.7 (156)		
Entering Fluid Temp., ºC (ºF)	82 (180)	82 (180)	82 (180)		
Leaving Fluid Temp., ºC (ºF)	65.5 (150)	65.5 (150)	65.5 (150)		
Design Flow, L/s (USgpm)	0.6 (9.5)	1.05 (16.7)	0.6 (9.5)		
Fluid P.D., kPa (ft. wg)	4.1 (1.37)	3.98 (1.33)	4.1 (1.37)		
Air Flow, L/s (cfm)	1368 (2900)	2421 (5130)	1368 (2900)		
Fan Speed, rpm	1075	1075	1075		
Motor Power, W (hp)	186 (0.25)	373 (0.5)	186 (0.25)		
Power Supply, V/ph/Hz	115/1/60	208/3/60	115/1/60		
Arrangement	Horizontal	Horizontal	Horizontal		
Manufacturer	Rittling	Rittling	Rittling		
Model	RH-193	RH-340	RH-193		
Accessories & Remarks	Line voltage thermostat Diffuser blades	Line voltage thermostat Diffuser blades	Line voltage thermostat Diffuser blades		

LIST OF SCHEDULES

Tag	UH-H860	UH-H861	UH-H862	UH-H863	UH-H864
Location	Hypochl. Storage Tanks	Hypochl. Storage Tanks	Hypochl. Storage Tanks	Water Softener Area	Mezzanine Level
Fluid	50% E. Glycol	50% E. Glycol	50% E. Glycol	50% E. Glycol	50% E. Glycol
Capacity, kW (MBH)	17 (58)	9.8 (33.3)	17 (58)	17 (58)	9.8 (33.3)
Entering Fluid Temp., ºC (ºF)	82.2 (180)	82.2 (180)	82.2 (180)	82.2 (180)	82.2 (180)
Leaving Fluid Temp., ºC (ºF)	65.6 (150)	65.6 (150)	65.6 (150)	65.6 (150)	65.6 (150)
Design Flow, L/s (USgpm)	0.29 (4.58)	0.17 (2.63)	0.29 (4.58)	0.29 (4.58)	0.17 (2.63)
Fluid P.D., kPa (ft. wg)	0.81 (0.27)	0.45 (0.15)	0.81 (0.27)	0.81 (0.27)	0.45 (0.15)
Air Flow, L/s (cfm)	731 (1550)	528 (1120)	731 (1550)	731 (1550)	528 (1120)
Fan Speed, rpm	1075	1550	1075	1075	1550
Motor Power, W (hp)	93 (1/8)	75 (1/10)	93 (1/8)	93 (1/8)	75 (1/10)
Power Supply, V/ph/Hz	115-1-60	115-1-60	115-1-60	115-1-60	115-1-60
Arrangement	Horizontal	Horizontal	Horizontal	Horizontal	Horizontal
Manufacturer	Rittling	Rittling	Rittling	Rittling	Rittling
Model	RH-108	RH-63	RH-108	RH-108	RH-63
Accessories & Remarks	Line voltage thermostat Diffuser blades	Line voltage thermostat Diffuser blades	Line voltage thermostat Diffuser blades	Line voltage thermostat Diffuser blades	Line voltage thermostat Diffuser blades

LIST OF SCHEDULES

Tag	UH-H865				
Location	Hypochl. Storage Tanks				
Fluid	50% E. Glycol				
Capacity, kW (MBH)	96.4 (329)				
Entering Fluid Temp., ºC (ºF)	82.2 (180)				
Leaving Fluid Temp., ºC (ºF)	65.6 (150)				
Design Flow, L/s (USgpm)	1.64 (26)				
Fluid P.D., kPa (ft. wg)	2.3 (0.15)				
Air Flow, L/s (cfm)	5825 (12,350)				
Fan Speed, rpm	1140				
Motor Power, W (hp)	1500 (2)				
Power Supply, V/ph/Hz	575-3-60				
Arrangement	Vertical				
Manufacturer	Rittling				
Model	RV-610				
Accessories & Remarks	Line voltage thermostat Cone Jet				

LIST OF SCHEDULES

1.12 Air Compressor Schedule

Tag	AC-H815A	AC-H816B
Location	Chemical Building Mechanical Room	Chemical Building Mechanical Room
Service	Unloading	Unloading
Type	Oil Free Scroll	Oil Free Scroll
Capacity @ 800 kPa, L/s (cfm)	10 (22)	10 (22)
Motor Power, kW (hp)	6 (8)	6 (8)
Power Supply, V/ph/Hz	575/3/60	575/3/60
Manufacturer	Atlas Copco	Atlas Copco
Model	SF6	SF6
Dimensions, mm	1450x750x1040	1450x750x1040
Operating Weight, kg (lbs)	340 (748)	340 (748)
Accessories & Remarks		

LIST OF SCHEDULES

1.13 Air Dryer Schedule

Tag	AC-H814A	AC-H814B
Location	Chemical Building Mechanical Room	Chemical Building Mechanical Room
Service	Unloading	Unloading
Type	Heatless Adsorption	Oil Free Scroll
Capacity @ 1100 kPa, L/s (cfm)	11.8 (25)	10 (22)
Nominal Pressure Dew Point C° (F°)	-4 (-20)	6 (8)
Possible Dew Point C° (F°)	-40 (-40)	575/3/60
Manufacturer	Atlas Copco	Atlas Copco
Model	CD12	SF6
Dimensions, mm	290x176x855	1450x750x1040
Operating Weight, kg (lbs)	27 (60)	340 (748)
Accessories & Remarks		

LIST OF SCHEDULES

1.14 Tank Schedule

Tag	GFT-H815A	ETNK-H815B	CFT-H815C
Service	Heating	Heating	Heating
Location	Mechanical Room	Mechanical Room	Mechanical Room
Type	Vertical	Vertical	Vertical
Capacity, L (USgal)	180 (48)	100 (264)	20 (5)
Diameter, mm (in)	610 (24)	914 (36)	250 (10)
Height/Length, mm (in)	1245 (49)	1867 (73.5)	750 (30)
Manufacturer	Axiom Industries Ltd	Armstrong	Neptune
Model	SF100	1000-L	DBF-5HP
Accessories & Remarks	Set to 138 kPa (20 psig)		

LIST OF SCHEDULES

Tag	ETNK-H815D		
Service	DHW		
Location	Mechanical Room		
Type			
Capacity, L (USgal)	38.9 (10.3)		
Diameter, mm (in)	390.5 (15 ⅜)		
Height/Length, mm (in)	488.9 (19 ¼)		
Manufacturer	Amtrol		
Model	Therm-X-Trol ST-25V		
Accessories & Remarks			

LIST OF SCHEDULES

1.15 Plate Heat Exchanger Schedule

Tag	HEX-H806A	HEX-H806B	HEX-H814A
Service	Process Water	Process Water	Domestic Hot Water
Location	Mechanical Room	Mechanical Room	Mechanical Room
Primary			
Fluid	50% Et Glycol	50% Et Glycol	50% Et Glycol
Flow Rate l/sec (usgpm)	4.7 (74.89)	4.7 (74.89)	6 (94.62)
Inlet Temperature ºC (F)	82 (180)	82 (180)	82 (180)
Outlet Temperature ºC (F)	65.5 (150)	65.5 (150)	65.5 (150)
Pressure Drop kPa (PSI)	55.6 (8.07)	55.6 (8.07)	62.4 (9.05)
Secondary			
Flow Rate l/sec (usgpm)	4.4 (70)	4.4 (70)	1.6 (25)
Inlet Temperature ºC (F)	1 (32)	1 (32)	4 (40)
Outlet Temperature ºC (F)	15.5 (60)	15.5 (60)	60 (140)
Pressure Drop Pa (wg)	1.53 (7.17)	1.53 (7.17)	0.17 (0.78)
Dimensions			
Height, mm	1875 (75)	1875 (75)	1875 (75)
Length, mm	2000(80)	2000(80)	2000(80)
width, mm	500 (20)	500 (20)	500 (20)
Electrical, V/ph/Hz	575/3/60	575/3/60	575/3/60
Motor Power, kW (hp)			
Primary	1.5 (2)	1.5 (2)	2.25 (3)
Secondary	-	-	0.75 (1)
Manufacturer	ITT	ITT	ITT
Model	P14-15-TK	P14-15-TK	P14-22-TKTM79
Accessories & Remarks	Skid mounted packaged plate heat exchangers complete with strainers, isolation valves, three port mixing valve, integral controls and panel and primary side circulation pump. Domestic hot water heat exchanger to have a circulation pump suitable for domestic water usage on the secondary side of the heat exchanger in addition to the foregoing.		

LIST OF SCHEDULES

1.16 Pump Schedule

Tag	GP-H808A & GP-H808B	GP-H810A & GP-H811A	GP-H812A & GP-H812B
Function	Glycol Hot Water Circulation Pump Duty/Stand-by	Chemical Building Heating Circulation Pump Duty/Stand-by	Hypo Building Heating Circulation Pump Duty/Stand-by
Location	Chemical Building Mechanical Room	Chemical Building Mechanical Room	Chemical Building Mechanical Room
Type	End Suction	End Suction	End Suction
Impeller	6.75”	8”	7.875”
Casing	Cast Iron	Cast Iron	Cast Iron
Fluid Pumped	50% Ethylene Glycol	50% Ethylene Glycol	50% Ethylene Glycol
Design Pressure, Pa (psi)			
Max. Operating Temp., ºC (ºF)	82 (180)	82 (180)	82 (180)
Pump Speed, rpm	1750	1750	1750
Design Flow Rate, L/s (US gpm)	17.8 (377)	12.0 (254)	6.52 (138)
Discharge Head, kPa (ft. wg)	89.6 (30)	155.3 (52)	173.2 (58)
Suction/Discharge Sizes, mm	150/125	75/65	65/50
Motor Power, kW (hp)	5.6 (7.5)	5.6 (7.5)	3.7 (5)
Power Supply, V/ph/Hz	575/3/60	575/3/60	575/3/60
Manufacturer	Bell & Gossett	Bell & Gossett	Bell & Gossett
Model	1510-5AC	1510-2-½BB	1510-2BC

LIST OF SCHEDULES

1.17 Booster Pump Schedule

Tag	P-H885A, P-H885B, P-H885C
Location	Hypochlorite Generator Building – Water Softener Area
Area Served	Hypochlorite Generator
Type	Triplex, 2 duty, 1 standby
Flow Rate, each pump	2.27 L/s
Pump Head	31.7m
Pumped Fluid	Separated Potable Water
Suction Pressure	206 kPa
Pump Discharge Pressure	483 kPa
Pump Casing Design	1207 kPa
Motor Power	3.73 kW
Motor Speed	3500 rpm
Power	575v - 3ph
Pump Speed Control	Constant
Suction Connection Size	75mm
Discharge Connection Size	75mm
Pump Manufacturer / Model	S.A. Armstrong / 4380-1.5x1.5x6
Pressurized Tank Capacity	500 Liters
Pressurized Tank Dimensions	762mm dia. x 1448mm Height
System Manufacturer /	S.A. Armstrong, Series 6700 HydroPak
Remarks	

LIST OF SCHEDULES

1.18 Fan Coil Unit Schedule

Tag	FC-H890		
Location	Link Way		
Area Served	Link Way		
Type	Indoor		
Manufacturer	Engineered Air		
Model	JM700		
Supply Fan			
Tag	SF-H890A		
Volume, L/s (cfm)	189 (400)		
ESP, Pa (in.wg.)	188 (0.75)		
Fan Type	DWDI BI		
Fan Speed, rpm	2711		
Motor Power, kW (hp)	0.75 (1.0)		
Power Supply	575-3-60		
Heating Section			
Tag	HC-H890A		
Capacity, kW (MBH)	15.3 (52.1)		
EAT, °C (°F)	-40 (-40)		
LAT, °C (°F)	80.6 (27)		
EWT, °C (°F)	82.2 (180)		
Heating Medium	50% E. Glycol		
Total Face Area, m^2 (sq.	0.09 (1.0)		
Max. Face Velocity, m/s	2.1 (419)		
Material, Header/Pipe/Fin	Cu/Al		
Rows, High x Deep	3. 300x300		
Fin Spacing, fpi	10		
Max Tube PD, kPa (ft)	2.8 (0.93)		
Max Air PD, Pa (in wg)	50 (0.20)		
Arrangement			
Supply Outlet	Top Horizontal		
Return Inlet	---		
Outdoor Air Inlet	Back		
Relief Air Outlet	---		
Physical Data			
Overall Length, mm	820		
Overall Width, mm	584		
Overall Height, mm	457		
Overall Weight, kg (lbs)	73(160)		

LIST OF SCHEDULES

1.19 Air Cooled Condensing Unit Schedule

Tag	CU-H854	CU-H803A	CU-H828A
Service	AHU-H854	AHU-H803A	AHU-H828A
Location	On Grade	On Roof	On Roof
Refrigerant	R407	R407	R407
Capacity, kW (MBH)	36.3 (123.9)	36.3 (123.9)	15.7 (53.6)
Minimum EER	12	12	12
Ambient Temperature, °C (°F)	35 (95)	35 (95)	35 (95)
Suction Temperature, °C (°F)	5.1 (41.2)	5.1 (41.2)	8.9 (48)
Electrical Data			
Full load Amps (FLA)	15	15	6
Min. Circuit Amps (MCA)	18	18	8
Max . Overcurrent (MOP)	30	30	15
Compressor			
Quantity	2	2	1
R.L.A.	12.1	12.1	5.1
Condenser Motor			
Power, kW (hp)	0.56 (0.75)	0.56 (0.75)	0.25 (0.33)
F.L.A.	2.8	2.8	1.4
Electrical (V/ph/Hz)	575-3-60	575-3-60	575-3-60
Manufacturer	Aaon	Aaon	Aaon
Model	CA-10-4	CA-10-4	CA-04-4
Operating Weight, kg (lbs)	353 (779)	353 (779)	127 (279)
Remarks	c/w Hail Guards and Hot Gas By-pass Control Circuit Transformer	c/w Hail Guards and Hot Gas By-pass	c/w Hail Guards and Hot Gas By-pass

LIST OF SCHEDULES

1.20 Motorised Damper Schedule

Tag	MD-H800C	MD-H801C	MD-H802C	MD-H803C
Service	Emergency Intake	Emergency Intake	Emergency Intake	Relief Air
Location	Ferric Chloride Room Louver	Sulphuric Acid Room Louver	Sodium Hydroxide Room Louver	Electrical Room Relief Duct
Damper size mm (in)	1200x800 (48x32)	950x800 (38x32)	1200x800 (48x32)	600x600 (24x24)
Number of dampers	2	2	2	1
Model	9000 BF Series	9000 BF Series	9000 BF Series	9000 BF Series
Manufacturer	TAMCO	TAMCO	TAMCO	TAMCO
Control	On-Off	On-Off	On-Off	Modulating
Fail Safe State	Open	Open	Open	Closed
Actuator	Belimo AF120(-S) US	Belimo AF120(-S) US	Belimo AF120(-S) US	Belimo AF120(-S) US
Number of actuators	2	1	2	1
Accessories & Remarks	Outside air damper	Outside air damper With Horizontal Jackshafts	Outside air damper	Relief air damper

Tag	MD-H804C	MD-H816A	MD-H817A	MD-H818A
Service	Emergency Intake	Ventilation Intake	Ventilation Intake	Ventilation Exhaust
Location	Aqua Ammonia Room Louver	Rail Car Enclosure Louver	Rail Car Enclosure Louver	Rail Car Enclosure Exhaust Fan
Damper size mm (in)	900x750 (36x30)	900x900 (36x36)	900x900 (36x36)	600x600 (24x24)
Number of dampers	1	2	2	1
Model	9000 BF Series	9000 BF Series	9000 BF Series	9000 BF Series
Manufacturer	TAMCO	TAMCO	TAMCO	TAMCO
Control	On-Off	On-Off	On-Off	On-Off
Fail Safe State	Open	Closed	Closed	Closed
Actuator	Belimo AF120(-S) US	Belimo AF120(-S) US	Belimo AF120(-S) US	Belimo AF120(-S) US
Number of actuators	1	2	2	1
Accessories & Remarks	Outside air damper	Outside air damper	Outside air damper	Exhaust air damper

LIST OF SCHEDULES

Tag	MD-H819A	MD-H820B	MD-H821B	MD-H824B
Service	Ventilation Exhaust	Emergency Exhaust	Emergency Exhaust	Emergency Exhaust
Location	Rail Car Enclosure Exhaust Fan	Aqua Ammonia Exhaust Fan	Sodium Hydroxide Exhaust Fan	Sulphuric Acid Exhaust Fan
Damper size mm (in)	600x600 (24x24)	450x450 (18x18)	600x600 (24x24)	600x600 (24x24)
Number of dampers	1	1	1	1
Model	9000 BF Series	9000 BF Series	9000 BF Series	9000 BF Series
Manufacturer	TAMCO	TAMCO	TAMCO	TAMCO
Control	On-Off	On-Off	On-Off	On-Off
Fail Safe State	Closed	Open	Open	Open
Actuator	Belimo AF120(-S) US	Belimo AF120-S	Belimo AF120-S	Belimo AF120-S
Number of actuators	1	1	1	1
Accessories & Remarks	Exhaust air damper	Exhaust air damper	Exhaust air damper	Exhaust air damper

Tag	MD-H825B	MD-H828C	MD-H829B	MD-H831B
Service	Emergency Exhaust	Relief Air	Ventilation Intake	Ventilation Intake
Location	Ferric Chloride Exhaust Fan	Control Room Relief Duct	Upper Level Exhaust Fan	Mechanical Room Louver
Damper size mm (in)	600x600 (24x24)	450x450 (18x18)	300x300 (12x12)	1050x800 (42x32)
Number of dampers	1	1	1	1
Model	9000 BF Series	9000 BF Series	9000 BF Series	9000 BF Series
Manufacturer	TAMCO	TAMCO	TAMCO	TAMCO
Control	On-Off	Modulating	On-Off	On-Off
Fail Safe State	Open	Closed	Open	Open
Actuator	Belimo AF120(-S) US	Belimo AF120(-S) US	Belimo AF120(-S) US	Belimo AF120(-S) US
Number of actuators	1	1	1	1
Accessories & Remarks	Exhaust air damper	Relief air damper	Exhaust air damper	Outside air damper

END OF SECTION