

PART 1 - GENERAL

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| <u>1.1 Related Sections</u> | .1 | Section 01 00 10 - General Instructions. |
| | .2 | Section 01 33 00 - Submittal Procedures. |
| | .3 | Section 01 35 29.06 - Health and Safety Requirements. |
| | .4 | Section 01 74 21 - Construction/Demolition Waste Management And Disposal. |
| | .5 | Section 01 78 00 - Closeout Submittals. |
| | .6 | Section 21 05 01 - Common Work Results - Mechanical. |
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<u>1.2 Continuity of Operation</u> | .1 | The building and mechanical systems shall remain operationall all the time during this project. Keep shutdowns to minimum. Follow the Departamental Representative requirements regarding work staging. |
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<u>1.3 Quality Assurance</u> | .1 | Health and Safety:
.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements. |

PART 2 - PRODUCTS

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| <u>2.1 Not Used</u> | .1 | Not used. |
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PART 3 - EXECUTION

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| <u>3.1 Not Used</u> | .1 | Not used. |
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PART 1 - GENERAL

<u>1.1 Related Sections</u>	.1	Section 01 00 10 - General Instructions.
	.2	Section 01 33 00 - Submittal Procedures.
	.3	Section 01 35 29.06 - Health and Safety Requirements.
	.4	Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
	.5	Section 01 78 00 - Closeout Submittals.
	.6	Section 21 05 01 - Common Work Results - Mechanical.
	.7	Section 22 13 17 - Drainage Waste and Vent Piping - Cast Iron.
	.8	Section 23 23 00 - Refrigerant Piping.
<u>1.2 References</u>	.1	Canadian General Standards Board (CGSB).
	.1	CAN/CGSB-1.181-1999, Ready-Mixed Organic Zinc-Rich Coating.
<u>1.3 Quality Assurance</u>	.1	Health and Safety:
	.1	Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
<u>1.4 Waste Management and Disposal</u>	.1	Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal, and Section 21 05 01 Common Work Results Mechanical.
<u>1.5 Delivery, Storage and Handling</u>	.1	While delivering materials to site follow requirements of Section 01 00 10 - General Instructions and Section 21 05 01 - Common Work Results Mechanical.

PART 3 - EXECUTION

3.1 Connections to Equipment

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.
- .4 Unless otherwise noted, obtain information on all equipment supplied by others that require mechanical services. Terminate services within 0.6 m from equipment connection with isolating valve and cap. Size of services same as equipment connections.

3.2 Clearances

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, components.

3.3 Drains

- .1 Install piping with grade in direction of flow except as indicated or specified otherwise.
- .2 Install drain valve at low points in piping systems, at equipment and at pipe sections isolating by valves.
- .3 Pipe each drain valve discharge separately to above floor drain. Discharge to be visible. Review mechanical drawings. If such a floor drain is not shown allow provision for new drain and piping.
- .4 Drain valves: 18 mm gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

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| <u>3.4 Air Vents</u> | .1 | Install automatic air vents at high points in piping systems. |
| | .2 | Install isolating valve at each automatic air vent. |
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| <u>3.5 Dielectric Couplings</u> | .1 | General: Compatible with system, to suit pressure rating of system. |
| | .2 | Locations: Where dissimilar metals are joined. |
| | .3 | 50 mm and under: isolating unions or bronze valves. |
| | .4 | Over 50 mm: Isolating flanges. |
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| <u>3.6 Pipework Installation</u> | .1 | Screwed fittings to be jointed with Teflon tape. |
| | .2 | Protect openings against entry of foreign material. |
| | .3 | Install so that equipment can be isolated and removed without interruption to operation of any other equipment or systems. |
| | .4 | Assemble piping using fittings manufactured to standards. |
| | .5 | Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines. |
| | .6 | Except where indicated otherwise, slope piping in direction of flow for positive drainage and venting. |
| | .7 | Except where indicated, install so as to permit separate thermal insulation of each pipe. |
| | .8 | Ream pipes, remove scale and other foreign material before assembly. |
| | .9 | Use eccentric reducers at pipe size changes to ensure positive drainage and venting. |
| | .10 | Provide for thermal expansion as indicated and specified, or as per good practice and industry standards. |
| | .11 | Valves: |
| | .1 | Install in accessible locations. |
| | .2 | Remove interior parts before soldering. |
| | .3 | Install with stems above the horizontal position unless otherwise indicated. |
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- 3.6 Pipework Installation (Cont'd)
- .11 (Cont'd)
 - .4 Valves to be accessible for maintenance without removing adjacent piping.
 - .5 Ball Valves:
 - .1 Install on branch take-offs for isolating purposes except where otherwise specified.
 - .6 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.
 - .12 Install concealed pipework so as to minimize furring space, maximize headroom, conserve space.
 - .13 Group piping wherever possible and as indicated.
 - .14 Provide detailed site specific interference drawings indicating location, elevation and sizes of: existing services, equipment and structural features. Indicate proposed layout of new services indicating location, elevation and sizes. Obtain information from other trades and indicate on the drawings location of their services. Mark up any possible interference between services, submit to the Departmental Representative and await instruction.
 - .1 The drawings show in diagrammatical form existing piping layout and sizes. Contractor to verify pipe, valves and accessories sizing prior to commencing work.
 - .2 Scope of work involve installation of new evaporators inside walkin coolers and freezers and associate piping and roof mounted condensers.
- 3.7 Sleeves
- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
 - .2 Material: Schedule 40 black steel pipe.
 - .3 Sizes: 6 mm minimum clearance all round between sleeve and uninsulated pipe or between sleeve and insulation.
 - .4 Installation:
 - .1 Concrete, masonry walls and concrete floors on grade: Terminate flush with finished surface.
 - .2 Other floors: Terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
 - .5 Sealing:
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| <u>3.7 Sleeves
(Cont'd)</u> | .5 | (Cont'd)
.1 All locations: Provide space for firestopping. Maintain fire rating integrity.
.2 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.
.3 Ensure no contact between copper pipe or tube and sleeve. |
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| <u>3.8 Escutcheons</u> | .1 | Install on pipes passing through walls, partitions, floors, and ceilings in finished areas. |
| | .2 | Construction: One piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel. |
| | .3 | Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided. |
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| <u>3.9 Preparation for Firestopping</u> | .1 | Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation. |
| | .2 | Uninsulated unheated pipes not subject to movement: No special preparation. |
| | .3 | Uninsulated heated pipes subject to movement: Wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation. |
| | .4 | Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers. |
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| <u>3.10 Flushing out of Piping Systems</u> | .1 | Before start-up, clean interior of piping systems in accordance with requirements as specified in relevant sections of each Division. |
| | .2 | Unless otherwise noted follow the following procedure:
.1 Flush after pressure test for a minimum of 4h.
.2 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate (for closed systems) or hold (for open systems) for minimum of 8h.
.3 Refill system with clean water. Circulate (for closed systems) or flush (for open systems) for at least 4 hours. Clean out strainer screens/baskets regularly. Drain entire system. |
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- END OF SECTION

PART 1 - GENERAL

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| <u>1.1 Related Sections</u> | <ul style="list-style-type: none">.1 Section 01 00 10 - General Instructions..2 Section 01 33 00 - Submittal Procedures..3 Section 01 35 29.06 - Health and Safety Requirements..4 Section 01 74 11 - Cleaning..5 Section 01 74 21 - Construction/Demolition Waste Management And Disposal..6 Section 01 78 00 - Closeout Submittals..7 Section 21 05 01 - Common Work Results - Mechanical. |
| <u>1.2 References</u> | <ul style="list-style-type: none">.1 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)<ul style="list-style-type: none">.1 ANSI/ASME B31.1-2014, Power Piping..2 Health Canada, Workplace Hazardous Materials Information System (WHMIS)<ul style="list-style-type: none">.1 Material Safety Data Sheets (MSDS)..3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)<ul style="list-style-type: none">.1 MSS SP-58-2009, Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation. |
| <u>1.3 Section Includes</u> | <ul style="list-style-type: none">.1 Design Requirements.<ul style="list-style-type: none">.1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies..2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58..3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure..4 Design hangers and supports to support systems under all conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment. |
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<u>1.3 Section Includes (Cont'd)</u>	.1	(Cont'd) .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.
<u>1.4 Quality Assurance</u>	.1	Health and Safety: .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
<u>1.5 Submittals</u>	.1	Submittals in accordance with Section 01 33 00 - Submittal Procedures, and Section 21 05 01 - Common Work Results Mechanical.
	.2	Submit shop drawings and product data for following items: .1 Bases, hangers and supports. .2 Connections to equipment and structure. .3 Structural assemblies.
<u>1.6 Closeout Submittals</u>	.1	Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
<u>1.7 Waste Management and Disposal</u>	.1	Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal, and Section 21 05 01 Common Work Results Mechanical.
<u>1.8 Delivery, Storage and Handling</u>	.1	While delivering materials to site follow requirements of Section 01 00 10 - General Instructions and Section 21 05 01 - Common Work Results Mechanical.

PART 2 - PRODUCTS

<u>2.1 General</u>	.1	Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.
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2.1 General
(Cont'd)

- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.2 Pipe Hangers

- .1 Finishes:
.1 Hangers and supports: galvanized.
.1 Special requirements: All hangers support components for installation inside walk in coolers and freezers shall be stainless steel or coated with two layers of rust proof primer and two layers of epoxy white paint.
.2 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.

2.3 Upper
Attachments

- .1 Concrete:
.1 Inserts for cast-in-place concrete: galvanized steel wedge to MSS-SP-58, type 18. ULC listed for pipe 18 mm to 203 mm.
.2 Carbon steel plate with clevis, for surface mount: malleable iron socket and expansion case and bolt. Minimum two expansion cases and bolts for each hanger.
.2 Upper attachment structural: suspension from lower flange of I-Beam:
.1 Cold piping 50 mm and under: malleable iron C clamp to MSS-SP-58, type 19. UL listed.
.2 Cold piping NPS 63 mm and larger and all hot piping: malleable iron beam clamp to MSS-SP-58, type 28 or 29. UL listed.
.3 Steel beam:
.1 Cold piping 50 mm and under: malleable iron "top of beam" C clamp to MSS-SP-58, type 19. UL listed.
.2 Cold piping 63 mm and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer, to MSS-SP-58, type 25. UL listed.
.4 Steel Joist:
.1 Cold piping 50 mm and under: steel washer plate with double locking nuts.
.2 Cold piping 63 mm and larger and all hot piping: steel washer plates with double locking nut, carbon steel clevis and malleable iron socket.

2.4 Middle Attachment
(rod)

- .1 Carbon steel threaded rod black electro-galvanized finish.

2.4 Middle Attachment
(rod)
(Cont'd)

2.5 Pipe Attachment

- .1 Cold piping, steel or cast iron: hot piping steel, with less than 25 mm horizontal movement; hot piping, steel, with more than 300mm middle attachment (rod) length: adjustable clevis to MSS-SP-58, type 1. UL listed.
- .2 Cold copper piping; hot copper piping with less than 25 mm horizontal movement; hot copper piping with more than 300 mm middle attachment (rod) length: adjustable clevis to MSS-SP-58, type 1. Copper plated.
- .3 Suspended hot piping, steel and copper, with horizontal movement in excess of 25 mm; hot steel piping with middle attachment (rod) 300 mm or less; pipe roller to MSS-SP-58, type 43.
- .4 Bottom supported hot piping, steel and copper; pipe roller stand to MSS-SP-58, type 45.

2.6 Riser Clamps

- .1 Steel or cast iron pipe: black carbon steel to MSS-SP-58, type 42. UL listed.
- .2 Copper pipe: carbon steel copper finished to MSS-SP-58, type 42.

2.7 Saddles and Shields

- .1 Cold piping 32 mm and over: protection shield with high density insulation under shield with uninterrupted vapour barrier.
- .2 Hot piping 32 mm and over: protective saddle with insulation under saddle.
- .3 Oversize pipe hangers and supports.

2.8 Supplementary
Structural Steel
Members

- .1 Provide all required supplementary structural steel members required to achieve suitable hanger and support system. Fabricate supports from structural grade steel (all welded or bolted construction). Use iron angle, U-channels or unistrut system. Secure support to building structure.
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<u>2.8 Supplementary Structural Steel Members (Cont'd)</u>	.2	Submit structural calculations with shop drawings.
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<u>2.9 Equipment Anchor Bolts and Templates</u>	.1	Provide templates to ensure accurate location of anchor bolts.
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PART 3 - EXECUTION

<u>3.1 Manufacturer's Instructions</u>	.1	Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions and datasheet.
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<u>3.2 Installation</u>	.1	Install in accordance with: .1 Manufacturer's instructions and recommendations.
	.2	Vibration Control Devices: .1 Install on piping systems at pumps, and as indicated.
	.3	Clamps on riser piping: .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser. .2 Bolt-tightening torques to industry standards. .3 Steel pipes: install below coupling or shear lugs welded to pipe. .4 Cast iron pipes: install below joint.
	.4	Clevis plates: .1 Attach to structure with 4 minimum inserts, one at each corner.
	.5	Provide supplementary structural steelwork. .1 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide at no additional cost supplementary structural steel members.

<u>3.3 Hanger Spacing</u>	.1	Spacing and middle attachment (rod) diameter as specified.
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| <u>3.3 Hanger Spacing
(Cont'd)</u> | .1 | (Cont'd)
.1 Plumbing piping: most stringent requirements of National Plumbing Code, Provincial Code, or authority having jurisdiction.
.2 Copper piping: up to 13mm: every 1.5 m.
.3 Within 300 mm of each horizontal elbow.
.4 Fire protection: to applicable Fire Code. |
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| <u>3.4 Hanger Installation</u> | .1 | Install hanger so that rod is vertical under operating conditions. |
| | .2 | Adjust hangers to equalize load. |
| | .3 | Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members. |
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| <u>3.5 Horizontal Movement</u> | .1 | Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4° from vertical. |
| | .2 | Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position. |
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| <u>3.6 Final
Adjustment</u> | .1 | Adjust hangers and supports:
.1 Ensure that rod is vertical under operating conditions.
.2 Equalize loads. |
| | .2 | Adjustable clevis:
.1 Tighten hanger load nut securely to ensure proper hanger performance.
.2 Tighten upper nut after adjustment. |
| | .3 | C-clamps:
.1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam. |
| | .4 | Beam clamps:
.1 Hammer jaw firmly against underside of beam. |
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| <u>3.7 Ceiling Mounted
Support System</u> | <p>.1 Allow for 1 (one) day of field review of installation for walk in coolers and freezers structure. Review shop drawings for ceiling or wall mounted support system system for evaporators. Submit proposed method of equipment support and walls/ceiling penetration. Assure all penetrations are thermally insulated, provide thermal break and maintain thermal integrity of the ceiling/wall panels. Coordinate with other trades. Notify Departmental Representative about any interferences.</p> <p>.2 Coordinate installation of ceiling mounted support system.</p> <p>.3 Use proper attachments to suspend piping and equipment.</p> |
| <u>3.8 Field Quality
Control</u> | <p>.1 Manufacturer's Field Services:
.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports.</p> |

PART 1 - GENERAL

- 1.1 Related Sections .1 Section 01 00 10 - General Instructions.
- .2 Section 01 33 00 - Submittal Procedures.
- .3 Section 01 35 29.06 - Health and Safety Requirements.
- .4 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .5 Section 01 78 00 - Closeout Submittals.
- .6 Section 01 91 13 - General Commissioning (Cx) Requirements.
- .7 Section 21 05 01 - Common Work Results - Mechanical.
- 1.2 References .1 National Building Code of Canada 2010
- 1.3 Definitions .1 Priority Two (P2) Buildings: buildings in which life safety is paramount concern. It is not necessary that P2 buildings remain operative during or after an earthquake.
- .2 SRS: acronym for Seismic Restraint System.
- 1.4 Limitations .1 Each trade shall be responsible for all applicable seismic restraint systems for all systems and equipment forming part of their respective contracts. All trades shall coordinate SRS design and implementation.
- 1.5 System Description .1 This section covers design, supply and installation of complete SRS for all systems, equipment specified for installation on this project. This includes chillers, HVAC equipment, piping and ductwork, mechanical equipment and systems, both vibration isolated and statically supported.
- .2 SRS to be fully integrated into, compatible with:
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<u>1.5 System Description (Cont'd)</u>	.2	(Cont'd) .1 Noise and vibration controls specified elsewhere in this project specification. .2 Structural, mechanical, electrical design of project. .3 During seismic event, SRS to prevent systems and equipment from causing personal injury and from moving from normal position. .4 Design to be by Professional Engineer specializing in design of SRS and registered in Province of Ontario.
<u>1.6 Quality Assurance</u>	.1	Health and Safety: .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
<u>1.7 Submittals</u>	.1	Submittals in accordance with Section 01 33 00 - Submittal Procedures, and Section 21 05 01 - Common Work Results Mechanical. .1 Submittals to include: Full details of design criteria and system components and installation. .2 Submit additional copy of shop drawings and product data to Departmental Representative for review by all parties having interest in SRS design.
<u>1.8 Closeout Submittals</u>	.1	Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
<u>1.9 Waste Management and Disposal</u>	.1	Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal, and Section 21 05 01 Common Work Results Mechanical.
<u>1.10 Delivery, Storage and Handling</u>	.1	While delivering materials to site follow requirements of Section 01 00 10 - General Instructions and Section 21 05 01 - Common Work Results Mechanical.

PART 2 - PRODUCTS

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| <u>2.1 SRS Manufacturer</u> | .1 | SRS to be from one manufacturer regularly engaged in production of same. |
| <u>2.2 General</u> | .1 | SRS to provide gentle and steady cushioning action and avoid high impact loads. |
| | .2 | SRS to restrain seismic forces in all directions. |
| | .3 | Fasteners and attachment points to resist same load as seismic restraints. |
| | .4 | SRS of Piping systems to be compatible with:
.1 Expansion, anchoring and guiding requirements.
.2 Equipment vibration isolation and equipment SRS. |
| | .5 | SRS utilizing cast iron, threaded pipe, other brittle materials not permitted. |
| | .6 | Attachments to RC structure:
.1 Use high strength mechanical expansion anchors.
.2 Drilled or power driven anchors not permitted. |
| <u>2.3 SRS for Static Equipment, Systems</u> | .1 | Floor and roof mounted equipment, systems:
.1 Anchor equipment to equipment supports.
.2 Anchor equipment supports to structure.
.3 Use size of bolts scheduled in approved shop drawings. |
| | .2 | Suspended equipment, systems:
.1 Use one or combination of following methods:
.1 Install tight to structure.
.2 Cross-brace in all directions.
.3 Brace back to structure.
.4 Slack cable restraint system.
.2 SRS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
.3 Hanger rods to withstand compressive loading and buckling. |

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| <u>2.4 SRS for
Vibration Isolated
Equipment</u> | .1 | Suspended equipment, systems:
.1 Use one or combination of following methods:
.1 Slack cable restraint system.
.2 Brace back to structure via vibration isolators and snubbers. |
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PART 3 - EXECUTION

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| <u>3.1 Installation</u> | .1 | Attachment points and fasteners:
.1 To withstand same maximum load that seismic restraint is to resist and in all directions.

.2 Install SRS at least 25 mm from equipment, systems, services.

.3 Miscellaneous equipment not vibration-isolated:
.1 Bolt through house-keeping pad to structure.

.4 Co-ordinate connections with all disciplines.

.5 Vertical tanks:
.1 Anchor through house-keeping pad to structure.
.2 Provide steel bands above centre of gravity.

.6 Provide SRS system for all existing equipment currently not having any restraints. |
| <u>3.2 Inspection and
Certification</u> | .1 | SRS to be inspected and certified by Departmental Representative upon completion of installation. |
| | .2 | Provide written report to Departmental Representative with certificate of compliance. |
| <u>3.3 Commissioning
Documentation</u> | .1 | Upon completion and acceptance of certification, hand over to Departmental Representative complete set of construction documents, revised to show "as-built". |

PART 1 - GENERAL

1.1 Related Sections

- .1 Section 01 00 10 - General Instructions.
- .2 Section 01 33 00 - Submittal Procedures.
- .3 Section 01 35 29.06 - Health and Safety Requirements.
- .4 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .5 Section 01 78 00 - Closeout Submittals.
- .6 Section 01 91 13 - General Commissioning (Cx) Requirements.
- .7 Section 21 05 01 - Common Work Results - Mechanical.

1.2 References

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-24.3-92, Identification of Piping Systems.
- .2 National Fire Protection Association
 - .1 NFPA 13-2010, Installation of Sprinkler Systems.

1.3 Quality Assurance

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 Submittals

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures, and Section 21 05 01 - Common Work Results Mechanical.

1.5 Closeout Submittals

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

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| <u>1.6 Waste Management and Disposal</u> | .1 | Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal, and Section 21 05 01 Common Work Results Mechanical. |
| <u>1.7 Delivery, Storage and Handling</u> | .1 | While delivering materials to site follow requirements of Section 01 00 10 - General Instructions and Section 21 05 01 - Common Work Results - Mechanical. |

PART 2 - PRODUCTS

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| <u>2.1 Manufacturer's Equipment Nameplates</u> | .1 | Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer. Where nameplates are not provided by manufacturer Division 23 to supply the nameplates. See para 2.2 for required information. |
| | .2 | Information to include, as appropriate:
.1 Equipment: Manufacturer's name, model, size, serial number, capacity.
.2 Motor: voltage, Hz, phase, power factor, duty, frame size. |
| <u>2.2 System Nameplates</u> | .1 | Colours:
.1 Hazardous: red letters, white background.
.2 Elsewhere: black letters, white background (except where required otherwise by applicable Codes). |
| | .2 | Construction:
.1 3 mm thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core. |
| | .3 | Sizes:
.1 Conform to following table: |

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

.2 Use maximum of 25 letters/numbers per line.

.3 Locations:

.1 Equipment in Mechanical Rooms: Use size #9.

.4 Identification for Preventive Maintenance Support System (PMSS):

.1 Use arrangement of Main identifier, Source identifier, Destination identifier.

.2 Equipment in Mechanical Room:

.1 Main identifier: Size #9.

.2 Source and Destination identifiers: Size #6.

.3 Terminal cabinets, control panels: Size #5.

.3 Equipment elsewhere: Sizes as appropriate.

2.3 Identification
of Piping Systems

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB-24.3.
- .3 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
 - .2 Outside diameter of pipe or insulation 75mm and greater: 150 mm long x 50 mm high.
 - .3 Use double-headed arrows where flow is reversible.
- .4 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .5 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20 mm and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 All other pipes: Pressure sensitive plastic-coated cloth or vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100%RH and continuous operating temperature of 150°C and intermittent temperature of 200°C.
- .6 Colours and Legends:
 - .1 Where not listed, obtain direction from Departmental Representative.
 - .2 Colours for legends, arrows: To following table:

<u>Background colour:</u>	<u>Legend, arrows:</u>
Yellow	BLACK
Green	WHITE
Red	WHITE

- .3 Background colour marking and legends for piping systems:

<u>Contents</u>	<u>Background colour</u>	<u>Legend marking</u>
Drain	Green	DRAIN
Refrigeration	Yellow	REFRIGERANT

<u>2.4 Identification Ductwork Systems</u>	.1	50 mm high stenciled letters and directional arrows 150 mm long x 50 mm high.
	.2	Colours: Black, or coordinated with base colour to ensure strong contrast.
<u>2.5 Valves</u>	.1	Brass tags with 12mm stamped identification data filled with black paint. Secure tags with non-ferrous chains or closed "S" hooks.
	.2	Include flow diagrams for each new system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.
	.3	Number valves in each system consecutively.
<u>2.6 Controls Components Identification</u>	.1	By Division 25 according to this section requirements.
<u>2.7 Language</u>	.1	Identification to be in English and French.

PART 3 - EXECUTION

<u>3.1 Installation</u>	.1	Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
	.2	Provide ULC and CSA registration plates as required by respective agency.
	.3	Identify systems, equipment to conform to PWGSC PMSS. Provide detailed list of equipment and systems installed under this contract and obtain numbering list from the Departmental Representative.

3.2 Nameplates

- .1 Locations:
 - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Protection:
 - .1 Do not paint, insulate or cover in any way.

3.3 Location of Identification on Piping and Ductwork Systems

- .1 On long straight runs in open areas: At not more than 3.0m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 On both sides of visual obstruction or where run is difficult to follow.
- .4 On both sides of separations such as walls, floors, partitions.
- .5 At branch take-offs on both main and branch.
- .6 Identification to be easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification to be approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.4 Valves

- .1 Valves, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Departmental Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

END OF SECTION

PART 1 - GENERAL

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|-----------------------------|----|--|
| <u>1.1 Related Sections</u> | .1 | Section 01 00 10 - General Instructions. |
| | .2 | Section 01 33 00 - Submittal Procedures. |
| | .3 | Section 01 35 29.06 - Health and Safety Requirements. |
| | .4 | Section 01 74 21 - Construction/Demolition Waste Management And Disposal. |
| | .5 | Section 01 78 00 - Closeout Submittals. |
| | .6 | Section 01 91 13 - General Commissioning (Cx) Requirements. |
| | .7 | Section 21 05 01 - Common Work Results - Mechanical. |
| | | |
| <u>1.2 General</u> | .1 | TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section. |
| | .2 | TAB process shall be performed with full cooperation with CXA-Independent Commissioning Agent/Company employed by the Contractor to perform CX activity. |
| | | |
| <u>1.3 Purpose of TAB</u> | .1 | Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads |
| | .2 | Adjust and regulate equipment and systems so as to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions. |
| | .3 | Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges. |
| | | |
| <u>1.4 Exceptions</u> | .1 | TAB of systems and equipment regulated by codes, standards to be to satisfaction of authority having jurisdiction. |
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<u>1.5 Co-ordination</u>	.1	Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule so as to ensure completion before acceptance of project.
	.2	Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.
<u>1.6 Start-up</u>	.1	Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
	.2	Follow special start-up procedures specified elsewhere in each Division.
<u>1.7 Operation of Systems During TAB</u>	.1	Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.
<u>1.8 Start of TAB</u>	.1	Notify Departmental Representative and CXA 7 days prior to start of TAB.
	.2	Start TAB when new installation is essentially completed.
	.3	Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to: <ul style="list-style-type: none">.1 Proper thermal overload protection in place for electrical equipment..2 Air systems:<ul style="list-style-type: none">.1 Correct fan rotation..2 Coil fins, clean.
<u>1.9 Application Tolerances</u>	.1	Do TAB to following tolerances of design values: <ul style="list-style-type: none">.1 HVAC systems: plus 10%, minus 10%.
<u>1.10 Accuracy Tolerances</u>	.1	Measured values to be accurate to within plus or minus 5% of actual values.

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| <u>1.11 Instruments</u> | .1 | Prior to TAB, submit to Departmental Representative list of instruments to be used together with serial numbers. |
| | .2 | Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system. |
| | .3 | Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative. |
| | | |
| <u>1.12 Submittals</u> | .1 | Submit, prior to commencement of TAB:
.1 Proposed methodology and procedures for performing TAB if different from referenced standard.
.2 Submittals in accordance with Section 01 33 00 - Submittal Procedures, and Section 21 05 01 - Common Work Results Mechanical. |
| | | |
| <u>1.13 TAB Report</u> | .1 | TAB report to show results in SI units and to include:
.1 Project record drawings.
.2 System schematics.
.3 Final air flow results. |
| | .2 | Submit 6 copies of TAB Report to Departmental Representative and CXA for verification and approval, in English in D-ring binders, complete with index tabs. |
| | | |
| <u>1.14 Verification</u> | .1 | Reported results subject to verification by Departmental Representative. |
| | .2 | Provide manpower and instrumentation to verify up to 100% of reported results. |
| | .3 | Number and location of verified results to be at discretion of Departmental Representative. |
| | .4 | Bear costs to repeat TAB as required to satisfaction of Departmental Representative. |
| | | |
| <u>1.15 Settings</u> | .1 | After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings. |
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<u>1.16 Completion of TAB</u>	.1	TAB to be considered complete when final TAB Report received and approved by Departmental Representative.
<u>1.17 Air Systems</u>	.1	Standard: TAB to be to most stringent of this section or TAB standards of AABC, NEBB, SMACNA and ASHRAE.
	.2	Qualifications: personnel performing TAB to be qualified to standards of AABC or NEBB.
	.3	Quality assurance: Perform TAB under direction of supervisor qualified to standards of AABC or NEBB.
	.4	Locations of equipment measurements: To include, but not be limited to, following as appropriate: .1 Outlet of Cooling Units.
<u>1.18 Quality Assurance</u>	.1	Health and Safety: .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
<u>1.19 Closeout Submittals</u>	.1	Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
<u>1.20 Waste Management and Disposal</u>	.1	Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal, and Section 21 05 01 Common Work Results Mechanical.
<u>1.21 Delivery, Storage and Handling</u>	.1	While delivering materials to site follow requirements of Section 01 00 10 - General Instructions and Section 21 05 01 - Common Work Results Mechanical.

PART 2 - PRODUCTS

2.1 Not Used .1 Not used.

PART 3 - EXECUTION

3.1 Not Used .1 Not used.

PART 1 – GENERAL

1.1 Related
Sections

- .1 Section 01 00 10 - General Instructions.
- .2 Section 01 33 00 - Submittal Procedures.
- .3 Section 01 35 29.06 - Health and Safety Requirements.
- .4 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .5 Section 01 78 00 - Closeout Submittals.
- .6 Section 01 91 13 - General Commissioning (Cx) Requirements.
- .7 Section 21 05 01 - Common Work Results - Mechanical.
- .8 Section 23 23 00 - Refrigerant Piping.

1.2 Reference

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1-01, Energy Standard for Buildings except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C335/C335M-10E1, Standard Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .2 ASTM C 411-2011, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .3 ASTM C449-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .4 ASTM C 547-2012, Mineral Fiber Pipe Insulation.
 - .5 ASTM C 921-2010, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.40-1995, Elastomeric, Unicellular Thermal Insulation, Sheet and Pipe Covering.
 - .2 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .3 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .6 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-2010, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-2011, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702-2014, Thermal Insulation,

Mineral Fibre, for Buildings

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| <u>1.3 Definitions</u> | .1 | For purposes of this section:
.1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
.2 "EXPOSED" - will mean "not concealed" as specified. |
| | .2 | TIAC SS:
.1 CRF: Code Rectangular Finish.
.2 CPF: Code Piping Finish. |
| <u>1.4 Shop Drawings</u> | .1 | Submit shop drawings in accordance with Section 01 00 10 - General Instructions. |
| | .2 | Submit for approval manufacturer's catalogue literature related to installation, fabrication for pipe, fittings, valves and jointing recommendations. |
| <u>1.5 Manufacturer's Instructions</u> | .1 | Submit manufacturer's installation instructions in accordance with Section 01 00 10 - General Instructions. |
| | .2 | Installation instructions to include procedures to be used, installation standards to be achieved. |
| <u>1.6 Qualification</u> | .1 | Installer to be specialist in performing work of this section, have successful experience in size and type of similar projects and be qualified to standards of TIAC. |
| <u>1.7 Waste Management and Disposal</u> | .1 | Separate and recycle waste material in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal, and Section 21 05 01 - Common Work Results - Mechanical. |

1.8 Delivery,
Storage and Handling

- .1 While delivering materials to site follow requirements of Section 01 00 10 - General Instructions and Section 21 05 01 - Common Work Results Mechanical.

PART 2 - PRODUCTS

2.1 Fire and Smoke
Rating

- .1 In accordance with CAN/ULC-S102.
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 Insulation

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C 335.
- .3 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702,
 - .2 Jacket: to CGSB 51-GP-52Ma,
 - .3 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code A-6: flexible unicellular tubular elastomer.
 - .1 Insulation: with vapour retarder jacket,
 - .2 Jacket: to CGSB 51-GP-52Ma,
 - .3 Maximum "k" factor: CAN/CGSB 51.40,
 - .4 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

2.3 Insulation
Securement

- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Bands: stainless steel, 19 mm wide, 0.5 mm thick.

<u>2.4 Cement</u>	.1	Thermal insulating and finishing cement: .1 Hydraulic setting or Air drying on mineral wool, to ASTM C 449/C 449M.
<u>2.5 Vapour Retarded Lap Adhesive</u>	.1	Water based, fire retardant type, compatible with insulation.
<u>2.6 Jackets</u>	.1	Polyvinyl Chloride (PVC): .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required. .2 Colours: to match adjacent finish paint and existing jacketing, .3 Minimum service temperatures: -30 C., .4 Maximum service temperature: 65 C., .5 Moisture vapour transmission: 0.02 perm., .6 Thickness: 0.5 mm, .7 Fastenings: .1 Use solvent weld adhesive compatible with insulation to seal laps and joints, .2 Tacks, .3 Pressure sensitive vinyl tape of matching colour.
	.2	Aluminum: .1 To ASTM B 209. .2 Thickness: 0.50 mm sheet. .3 Finish: smooth or stucco embossed .4 Joining: longitudinal and circumferential slip joints with 50 mm laps. .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner. .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5mm thick at 300 mm spacing.
<u>2.7 Weatherproof Caulking for Jackets Installed Outdoors</u>	.1	Caulking to Manufacturer requirements.

PART 3 - EXECUTION

3.1 Manufacturer's Instructions

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 Pre-Installation Requirements

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.
- .3 A complete inspection by the Departmental Representative must be completed and signed off before the piping system or portion of piping system is insulated.

3.3 Installation

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Install hangers, supports outside vapour retarder jacket.
- .5 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.
- .6 Coordinate insulation installation for condensate drains with pipe heat trace installation.

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| <u>3.4 Installation of Elastomeric Insulation</u> | .1 | Insulation to remain dry. Overlaps to manufacturer's instructions. Ensure tight joints. |
| | .2 | Provide vapour retarder as recommended by manufacturer. |
| <u>3.5 Piping Insulation Schedules</u> | .1 | Includes valves, valve bonnets, strainers, flanges and fittings, unless otherwise specified. |
| | .2 | TIAC Code: A-3.
.1 Securements: Stainless steel wire bands or Tape at 300 mm on centre.
.2 Seals: VR lap seal adhesive, VR lagging adhesive.
.3 Installation: TIAC Code: 1501-C. |
| | .3 | TIAC Code: A-6.
.1 Insulation securements: Stainless steel wire tape at 300 mm on centre.
.2 Seals: lap seal adhesive, lagging adhesive.
.3 Installation: TIAC Code: 1501-C. |
| | .4 | Thickness of insulation as listed in following table.
.1 Run-outs to individual units and equipment not exceeding 4000 mm long.
.2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings. |

Application	Temp. degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)				
			Run Out	to 1	1 ¼ to 2	2 ½ to 4	5 to to 6
Refrigerant hot gas liquid suction	below 4	A-6	25	25	38	38	38
Cooling coil condensate drain		A-3	25	25	25	25	25

- .5 Finishes:
 - .1 Exposed indoors: PVC jacket.
 - .2 Exposed in mechanical rooms: aluminum or PVC jacket.
 - .3 Concealed, indoors: PVC jacket
 - .4 Outdoors: water-proof aluminum jacket.
 - .5 Finish attachments: Stainless Steel (SS) bands, at 150 mm on centre. Seals: closed.
 - .6 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.6 Cleaning

- .1 Proceed in accordance with Section 01 74 11-
Cleaning.

END OF SECTION

PART 1 - GENERAL

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|-----------------------------|--|
| <u>1.1 Related Sections</u> | <ul style="list-style-type: none">.1 Section 01 00 10 - General Instructions..2 Section 01 33 00 - Submittal Procedures..3 Section 01 35 29.06 - Health and Safety Requirements..4 Section 01 74 21 - Construction/Demolition Waste Management And Disposal..5 Section 01 78 00 - Closeout Submittals..6 Section 21 05 01 - Common Work Results - Mechanical. |
| <u>1.2 References</u> | <ul style="list-style-type: none">.1 ASME<ul style="list-style-type: none">.1 ASME B16.22-2013, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings..2 ASME B16.24-2011, Cast Copper Alloy Pipe Flanges and Flanged Fittings: Class 150, 300, 600, 900, 1500 and 2500..3 ASME B16.26-2013, Cast Copper Alloy Fittings for Flared Copper Tubes..4 ASME B31.5-2013, Refrigeration Piping and Heat Transfer Components..2 ASTM International<ul style="list-style-type: none">.1 ASTM B280-13, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service..3 CSA Group<ul style="list-style-type: none">.1 CSA B52-13, B52 Mechanical Refrigeration Code..4 Environment Canada (EC)<ul style="list-style-type: none">.1 EPS 1/RA/1-96, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems..2 Federal Halocarbon Regulations, 2003 (SOR 2003-289) with 2009 Amendment. |
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| <u>1.3 Quality Assurance</u> | .1 | Health and Safety:
.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements. |
| <u>1.4 Submittals</u> | .1 | Submittals in accordance with Section 01 33 00 - Submittal Procedures, and Section 21 05 01 - Common Work Results Mechanical. |
| | .2 | Submit data for following:
.1 Pipes.
.2 Fittings. |
| <u>1.5 Closeout Submittals</u> | .1 | Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals. |
| <u>1.6 Waste Management and Disposal</u> | .1 | Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal, and Section 21 05 01 Common Work Results Mechanical. |
| <u>1.7 Delivery, Storage and Handling</u> | .1 | While delivering materials to site follow requirements of Section 01 00 10 - General Instructions and Section 21 05 01 - Common Work Results Mechanical. |

PART 2 - PRODUCTS

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|---------------------|----|---|
| <u>2.1 Tubing</u> | .1 | Processed for refrigeration installations, deoxidized, dehydrated and sealed.
.1 Hard copper: to ASTM B 280, type ACR .
.2 Annealed copper: to ASTM B 280, with minimum wall thickness as per CSA B52 and ASME B31.5. |
| <u>2.2 Fittings</u> | .1 | Service: design pressure 2070 kPa and temperature 121 degrees C. |

2.2 Fittings

(Cont'd)

- .2 Brazed:
 - .1 Fittings: wrought copper to ASME B16.22.
 - .2 Joints: silver solder, 15% Ag-80% Cu-5%P or copper-phosphorous, 95% Cu-5%P and non-corrosive flux.
- .3 Flanged:
 - .1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.
 - .2 Gaskets: suitable for service.
 - .3 Bolts, nuts and washers: to ASTM A 307, heavy series.
- .4 Flared:
 - .1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 Pipe Sleeves

- .1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.
 - .1 Assure all penetrations are thermally insulated, provide thermal break and maintain thermal integrity of the ceiling/wall panels.

2.4 Valves

- .1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.
- .2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

PART 3 - EXECUTION

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for refrigerant piping installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.

<u>3.1 Examination (Cont'd)</u>	.1	(Cont'd)
	.2	Inform Departmental Representative of unacceptable conditions immediately upon discovery.
	.3	Allow for 1 (one) day of field review of installation for walk in coolers and freezers structure. Submit proposed method of walls/ceiling penetration.
<u>3.2 Manufacturer's Instructions</u>	.1	Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.
	.2	Submit to manufacturer layout and field measurements for design and verification of refrigeration lines sizes and installation method. All refrigeration piping design including valves, auxiliary components and sizing shall be done by unit manufacturer or authorized representative. Submit installation drawings for review.
<u>3.3 General</u>	.1	Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5 and Section 23 05 05 - Installation of Pipework.
<u>3.4 Brazing Procedures</u>	.1	Bleed inert gas into pipe during brazing.
	.2	Remove valve internal parts, solenoid valve coils, sight glass.
	.3	Do not apply heat near expansion valve and bulb.
	.4	The space is use as Food Production Facility. Use enclosures and smoke eliminating devices during pipe installation. The installation procedure can not affect building environment.
<u>3.5 Piping Installation</u>	.1	General: .1 Soft annealed copper tubing: bend without crimping or construction Hard drawn copper tubing: do not bend. Minimize use of fittings.
	.2	Hot gas lines:

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| 3.5 Piping Installation
(Cont'd) | .2 | (Cont'd)
.1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
.2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.
.3 Provide inverted deep trap at top of risers.
.4 Provide double risers for compressors having capacity modulation.
.1 Large riser: install traps as specified.
.2 Small riser: size for 5.1 m ³ /s at minimum load.
Connect upstream of traps on large riser. |
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| 3.6 Pressure and Leak Testing | .1 | Close valves on factory charged equipment and other equipment not designed for test pressures. |
| | .2 | Leak test to CSA B52 before evacuation to 2 MPa and 1 MPa on high and low sides respectively. |
| | .3 | Test procedure: build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests. |
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| 3.7 Field Quality Control | .1 | Site Tests/Inspection:
.1 Close service valves on factory charged equipment. |
| | .2 | Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration. |
| | .3 | Use copper lines of largest practical size to reduce evacuation time. |
| | .4 | Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5 Pa absolute and filled with dehydrated oil. |
| | .5 | Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed. |
| | .6 | Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:
.1 Twice to 14 Pa absolute and hold for 4 hours. |
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- 3.7 Field Quality Control
(Cont'd)
- .6 (Cont'd)
- .2 Break vacuum with refrigerant to 14 kPa.
 - .3 Final to 5 Pa absolute and hold for at least 12 hours.
 - .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
 - .5 Submit test results to Departmental Representative.
- .7 Charging:
- .1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
 - .2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
 - .3 Re-purge charging line if refrigerant container is changed during charging process.
- .8 Checks:
- .1 Make checks and measurements as per manufacturer's operation and maintenance instructions.
 - .2 Record and report measurements to Departmental Representative.
- .9 Manufacturer's Field Services:
- .1 Arrange and pay all cost for representative of manufacturer of products, supplied under this Section to review Work involved in the handling, installation and start up of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract. Submit report to Departmental Representative.
- 3.8 Cleaning
- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

PART 1 - GENERAL

- 1.1 Related Sections
- .1 Section 10 00 10 - General Instruction.
 - .2 Section 01 33 00 - Submittal Procedures.
 - .3 Section 01 35 29.06 - Health and Safety.
 - .4 Section 01 74 21 - Construction/Demolition Waste.
 - .5 Section 01 78 00 - Closeout Submittals.
 - .6 Section 21 05 01 - Common Work Results - Mechanical.
 - .7 Section 22 13 17 - Drainage Waste and Vent Piping - Cast Iron.
 - .8 Section 23 23 00 - Refrigerant Piping.
- 1.2 References
- .1 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)
 - .1 ANSI/ARI 210/240-2008, Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
 - .2 American National Standards Institute/American Society of Heating, Refrigeration and Air-Conditioning Engineers (ANSI/ASHRAE)
 - .1 ANSI/ASHRAE Standard 15-2010, Safety Standard for Refrigeration Systems.
 - .3 CSA International
 - .1 CAN/CSA-C656-14, Performance Standard for Split-System and Single Package Central Air Conditioners and Heat Pumps.
 - .2 CSA B52-13, Mechanical Refrigeration Code.
 - .4 Environment Canada (EC)
 - .1 EPS 1/RA/1-96, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.
 - .2 Federal Halocarbon Regulations, 2003 (SOR 2003-289) with 2009 Amendment.
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1.2 References (Cont'd)	.4	(Cont'd)
	.3	Environment Canada-1994, Ozone-Depleting Substances Alternatives and Suppliers List.
	.5	National Fire Protection Association (NFPA)
	.1	NFPA (Fire) 90A (2015), Standard for Installation of Air Conditioning and Ventilating Systems.
1.3 Quality Assurance	.1	Health and Safety:
	.1	Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
1.4 Waste Management and Disposal	.1	Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal, and Section 21 05 01 Common Work Results - Mechanical.
1.5 Delivery, Storage and Handling	.1	While delivering materials to site, follow requirements of Section 01 00 10 - General Instructions and Section 21 05 01 - Common Work Results Mechanical.

PART 2 - PRODUCTS

2.1 Refrigerant	.1	Type of Refrigerant: R404A.
2.2 Air-Cooled DX Split Units	.1	General:
	.1	Three component unit consisting of refrigerant compressor section, for outdoor installation.
	.2	See schedule for capacity and performance data.
	.2	Outdoor unit:

2.2 Air-Cooled DX
Split Units
(Cont'd)

- .2 (Cont'd)
- .1 High efficiency type piped and automatically controlled to operate at lower head pressures during low ambient temperature conditions, designed and weather proofed for outdoor installation, to operate satisfactorily at winter ambient temperatures down to -30 degrees C, and be provided with crankcase and receiver heaters.
 - .1 Receiver capacity shall be not less than 125 percent of system refrigerant charge. Liquid line receiver shall be equipped with fusible plug, liquid shutoff valve and charging port.
 - .2 Provide Crankcase Pressure Regulator.
 - .2 Compressor Motor: Squirrel cage induction type of ample size for continuous operating at maximum compressor performance indicated. Provide inherent protection, in compressor terminal box, for each phase of motor.
 - .3 Unit shall have positive oil lubrication and oil level indicating device for each compressor.
 - .4 Unit shall be equipped with following Pressure Switches:
 - .1 Automatic reset low pressure switch
 - .2 Automatic reset high pressure cutout
 - .5 Base and Housing:
 - .1 Base made of sturdy heavy gauge galvanized steel formed profiles. The base shall allow the contractor to install pipes clamps to secure its pipe run to the roof opening.
 - .2 Weather proof enclosure shall be made of white pre-painted thick gauge aluminum with rust proof hardware or galvanized steel metal with baked on paint.
 - .3 For the hood style design, when open it shall give full access to all the components.
 - .6 Condenser coil:

2.2 Air-Cooled DX
Split Units
(Cont'd)

- .2 (Cont'd)
 - .6 (Cont'd)
 - .1 The condenser coil shall be enclosed in a galvanized casing. The 9.3mm copper rifled tubes shall be mechanically expanded in self-spaced, full-collared aluminum corrugated plate fins for permanent bond and maximum heat transfer. All coils shall have 4 fins per 10mm for easy cleaning and high efficiency. A separate sub-cooling circuit shall be integrated at the base of the coil to provide a vapour free liquid to the metering device. Coils shall be pressure tested under water with 7557 kPa. They shall be dried with nitrogen and shipped pressurized. A factory installed fixed head pressure flooding valve shall be installed to maintain an adequate head pressure during the low ambient temperature operation. The condenser coil incorporates a friction free expansion coil design.
 - .2 Refrigerant circuits shall have liquid line site glasses, filter driers, expansion valves, room thermostats interlocked with liquid line solenoid valves.
 - .7 Fans:
 - .1 Direct driven EC motors quiet design fans.
 - .1 Statically and dynamically balanced.
 - .2 Each fan section shall be divided to prevent by-pass.
- .3 Indoor unit:
 - .1 Comply with ARI Standard 420. Units shall be UL listed, forced ventilation type integral defrosting, internal refrigerant distributor, single or multiple fans and motors, drip pan, deflectors, aluminum or baked enamel steel housing, hangers, and all accessories. Unit shall be NSF approved.
 - .2 Base and Housing:
 - .1 Casing shall be compact low profile design with a side pitched drain pan for positive condensate removal and painted white.
 - .2 For freezer units provide electrically heated drain pan.
 - .3 Mounting brackets for flush mounting to the ceiling.
 - .3 Evaporator coil shall be made of smooth copper tube mechanically expanded into self-spaced aluminum plate fins for permanent bond and maximum heat transfer.

2.2 Air-Cooled DX
Split Units
(Cont'd)

- .3 (Cont'd)
 - .4 Permanently lubricated and thermally protected motor combined with heavy duty 350mm dia aluminum fans individually balanced provide vibration free operation and a long and dependable service. Fan guards shall be injection molded polymer to provide consistency of dimension and corrosion protection.
 - .5 Defrost Provision:
 - .1 Refrigerators: Defrost shall occur during compressor off cycle with evaporator fan running continuously.
 - .2 Freezer defrost: Defrost by heating elements incorporated into coil and drain pan. Operation of evaporator fan shall be delayed after defrost cycle until evaporator is cold enough to freeze any water droplets that are on evaporator coil. Defrosting unit shall be automatically controlled by an electric clock, refrigerant suction gas pressure sensing device, or by means of sensing increased air resistance due to ice accumulation.
- .4 Room temperature Control and Alarms
 - .1 Control system design and architecture shall be provided by unit manufacturer.
 - .2 Controller shall offer control and monitoring for medium and low temperature refrigerated applications. The controller integration also enables remote accessibility and alarm management to protect food quality
 - .1 Control boards shall provide a flexible I/O system for use with the controller. Analog and digital inputs are supported, as well as relay and analog outputs
 - .3 Controller shall use data from the relative humidity sensor to maximize anti-condensate control.
 - .4 The controller shall communicate with DX valve driver to improve system efficiency by maintaining superheat at an optimized setting. The DX valve shall regulate refrigerant flow in response to temperature and pressure sensor readings to maximize performance. A fast recovery algorithm shall correct superheat problems more rapidly than traditional systems after verifying a superheat abnormality.
 - .5 Control system shall consist but not be limited to:
 - .1 Controller.
 - .2 50 VA 24V transformer
 - .3 Single condenser defrost time and control board.
 - .4 Combination board enclosure
 - .5 General purpose and defrost sensors

- 2.2 Air-Cooled DX Split Units (Cont'd) .4 (Cont'd)
.5 (Cont'd)
.6 Current relay.
.6 Controller programing and commissioning by manufacturer shall be part of the control package.

PART 3 - EXECUTION

- 3.1 Examination .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for heat pumps installation in accordance with manufacturer's written instructions.
.1 Visually inspect substrate in presence of Departmental Representative .
.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

- 3.2 Installation .1 Install where indicated and in accordance with manufacturer's instructions.
.2 Install outdoor units on roof with vibration isolation providing 95% isolation efficiency.
.1 Co-ordinate installation with "green roof" (vegetation) conditions present on site.
.3 Secure with hold-down bolts in accordance with manufacturer's recommendations. Follow requirements of Section 23 05 48 - Vibration and Seismic Controls HVAC.
.4 Level unit with fans running. Align duct work. flexible connections. Misalignment with fan stopped not to strain or damage flexible connection.
.5 Make piping connections.
.6 Nothing to obstruct ready access to components or to prevent removal of components for servicing.

- 3.3 Drain Pans .1 Install so that no water can accumulate. Arrange easy access for cleaning.

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| <u>3.3 Drain Pans
(Cont'd)</u> | .2 | Include internal or external trap for proper draining. |
| | .3 | Run drain piping as shown and connect to existing condensate drain. In case maintaining the slop does not allow connection to existing horizontal line, extend drain and connect to closest vertical riser. Allow 30m of extra piping and insulation for site adjustments. |
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| <u>3.4 Sequence of
Operation</u> | .1 | The new refrigeration system shall be considered as "standby" and operate only:
.1 The "primary" system fails,
.2 Once a week (adjustable) for standby/readiness/maintenance run,
.3 When manually operated by building maintenance staff. |
| | .2 | "Standby" system space temperature sensor shall be programmed 5 degree Celcius higher (adjustable) than current space setting. When space temperature reach the setpoint, the delay timer shall count down 15 min. (adjustable) and energize "standby" system. Controller shall run system operation to maintain set point temperature including required defrost mode.
.1 Controller shall be able to interface with Ethernet and via web base programming announce alarm conditions.
.2 Provide relay to assure evaporator fans operate only as required for "standby" mode. |
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| <u>3.5 Start up and
Commissioning</u> | .1 | Have manufacturer certify installation. |
| | .2 | Have manufacturer present during tests and start up units and certify performance. |
| | .3 | Submit written start-up and commissioning reports to Departmental Representative. |
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| <u>3.6 Closeout Activities</u> | .1 | Manufacturer to deliver written instructions to operating personnel.
.1 Training: according to Section 01 79 00 - Demonstration and Training. |
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- 3.7 Cleaning
- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.