Part 1 General

1.1 USE OF SYSTEMS

.1 Use of existing permanent ventilating and heating systems for supplying temporary heat and ventilation is permitted (or permitted only under following conditions):

- .1 Entire system is complete, pressure tested, cleaned, flushed out.
- .2 Specified water treatment system has been commissioned, water treatment is being continuously monitored.
- .3 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
- .4 There is no possibility of damage.
- .5 Supply ventilation systems are protected by 60% filters, inspected daily, changed every week or more frequently as required.
- .6 Return systems have approved filters over openings, inlets, outlets.
- .7 Systems will be:
  - .1 Operated as per manufacturer's recommendations and instructions.
  - .2 Operated by Contractor.
  - .3 Monitored continuously by Contractor.
- .8 Warranties and guarantees are not relaxed.
- .9 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Departmental Representative.
- .10 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.

.2 Filters specified in this Section are over and above those specified in other Sections of this project.

.3 Exhaust systems are not included in approvals for temporary heating ventilation.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 – Common Work Results for Mechanical.

1.2 DEFINITIONS

.1 Demolish: Detach items from existing construction and legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.

.2 Remove: Planned deconstruction and disassembly of electrical items associated with mechanical equipment from existing construction including removal of conduit, junction boxes, cabling and wiring from electrical component to panel taking care not to damage adjacent assemblies designated to remain; legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled. All electrical work 120V and higher shall be performed by Division 26.

.3 Remove and Salvage: Detach items from existing construction and deliver them to Departmental Representative ready for reuse.

.4 Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

.5 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.

.6 Hazardous (Designated) Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB's, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by the Federal Hazardous Products Act (RSC 1985) including latest amendments.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Action Submittals: Provide the following in accordance with Section 01 33 00 – Submittal Procedures before starting work of this Section:

.1 Construction Waste Management Plan (CWM Plan): Submit plan addressing opportunities for reduction, reuse, or recycling of materials prepared in accordance with Section 01 74 19 – Waste Management and Disposal.

.2 Landfill Records: Indicate receipt and acceptance of selective demolition waste and hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.4 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Coordinate work of this Section to avoid interference with work by other Sections.

.2 Scheduling: Account for Departmental Representatives continued occupancy requirements during selective demolition, and schedule staged occupancy and worksite activities.

1.5 QUALITY ASSURANCE

.1 Regulatory Requirements: Perform work of this Section in accordance with the following

.1 Federal Workers' Compensation Service and/or Provincial Workers' Compensation Boards and Commissions, as applicable.

.2 Government of Canada, Labour Program: Workplace Safety and Provincial Occupational Health and Safety Standards and Programs.

1.6 SITE CONDITIONS

.1 Existing Conditions: Condition of materials identified as being salvaged or demolished are based on their observed condition on date that tender is accepted.

.2 Existing Hazardous Substances: Departmental Representative has performed a hazardous substances assessment and identified materials requiring abatement as follows:

.1 Existing Hazardous Substances: Departmental Representative has performed a hazardous substances assessment and has identified that materials are required for abatement. Hazardous substances shall be removed by the Contractor as a part of the Contract before starting Work in accordance with work results described in Related Requirements listed above. Refer to Refer to the Designated Substances Report included as part of this tender package.

.3 Discovery of Hazardous Substances beyond the expected limits: immediately notify the Departmental Representative if materials suspected of containing hazardous substances are encountered and perform the following activities:

.1 Refer to Section 01 41 00 – Regulatory Requirements for directives associated with specific material types.

.2 Hazardous substances will be as defined in the Hazardous Products Act.

.3 Stop work in the area of the suspected hazardous substances.

.4 Take preventative measures to limit users' and workers' exposure, provide barriers and other safety devices and do not disturb.

.5 Proceed only after written instructions have been received from the Departmental Representative.

1.7 SALVAGE AND DEBRIS MATERIALS

.1 Demolished items become Contractor's property and will be removed from Project site; except for items indicated as being reused, salvaged, or otherwise indicated to remain Departmental Representative's property.

.2 Carefully remove materials and items designated for salvage and store in a manner to prevent damage or devaluation of materials.

Part 2 Products

2.1 MATERIAL

.1 General Patching and Repair Materials: to match existing building materials and in accordance with Section 21 05 01 – Common Work Results for Mechanical.

.2 HVAC Repair Materials: Use only new materials required for completion or repair matching materials damaged during performance of work of this Section; new materials are required to meet assembly or system characteristics as existing systems indicated to remain and carry CSA approval labels required by the Authority Having Jurisdiction.

.3 Fire stopping Repair Materials: Use fire stopping materials compatible with existing fire stopping systems where removal or demolition work affects rated assemblies, restore to existing fire rated performance.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Existing Conditions: Visit site, thoroughly examine and become familiar with conditions that may affect the work of this Section before tendering the Bid; Departmental Representative will not consider claims for extras for work or materials necessary for proper execution and completion of the contract that could have been determined by a site visit.

3.2 PREPARATION

.1 Protection of Existing Systems to Remain: Protect systems and components indicated to remain in place during selective demolition operations and as follows:

.1 Prevent movement and install bracing to prevent settlement or damage of adjacent services and parts of existing buildings scheduled to remain.

.2 Notify Departmental Representative and cease operations where safety of buildings being demolished, adjacent structures or services appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

.3 Prevent debris from blocking drainage inlets.

.4 Protect mechanical systems that must remain in operation.

.2 Protection of Building Occupants: Sequence demolition work so that interference with the use of the building by the Departmental Representative and users is minimized and as follows:

.1 Prevent debris from endangering the safe access to and egress from occupied buildings.

.2 Notify Departmental Representative and cease operations where safety of occupants appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

3.3 EXECUTION

.1 Demolition & Removal: Coordinate requirements of this Section with information as follows:

.1 Disconnect and cap gas supply and electrical services in accordance with requirements of local Authority Having Jurisdiction.

.2 Do not disrupt active or energized utilities without approval of the Departmental Representative.

.3 Erect and maintain dust proof and weather tight partitions to prevent the spread of dust and fumes to occupied building areas; remove partitions when complete.

.4 Demolish parts of existing building to accommodate new construction and remedial work as indicated.

.5 At end of each day's work, leave worksite in safe condition.

.6 Perform demolition work in a neat and workmanlike manner:

.1 Remove any tools or equipment after completion of work and leave site clean and ready for subsequent renovation work.

.2 Repair and restore damages caused as a result of work of this Section to match existing materials and finishes.

3.4 CLOSEOUT ACTIVITIES

.1 Demolition Waste Disposal: Arrange for legal disposal and remove demolished materials to accredited provincial landfill site or alternative disposal site (recycle centre), except where explicitly noted otherwise for materials being salvaged for re use in new construction.

.2 Hazardous Substances Disposal: Arrange for disposal of hazardous substances. Ensure disposal activities are conducted in accordance with all applicable codes, regulations and authorities having jurisdiction.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 – Common Work Results for Mechanical.

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 ASHRAE 90.1-19, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).

.2 Electrical Equipment Manufacturers' Association Council (EEMAC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Prior to commencement of new work, submit the following information in accordance with Section 21 05 01 – Common Work Results for Mechanical:

.1 Product Data, for:

.1 Motors.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 21 05 01 – Common Work Results for Mechanical.

.2 Submit O&M data as part of O&M manual for:

.1 Motors.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 21 05 01 – Common Work Results for Mechanical.

Part 2 Products

2.1 GENERAL

.1 Motors: high efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.

2.2 MOTORS

.1 Provide motors for mechanical equipment as specified.

.2 Motors under 1/2 HP (373 W): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120V, unless otherwise specified or indicated.

.3 Motors 1/2 HP (373 W) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C, 3 phase.

2.3 TEMPORARY MOTORS

.1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Departmental Representative for temporary use. Work will only be accepted when specified motor is installed.

2.4 BELT DRIVES

.1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.

.2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.

.3 For motors under 10 HP (7.5 kW): standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.

.4 For motors 10 HP (7.5 kW) and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.

.5 Correct size of sheave determined during commissioning.

.6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.

.7 Motor slide rail adjustment plates to allow for centre line adjustment.

2.5 DRIVE GUARDS

.1 Provide guards for unprotected drives.

.2 Guards for belt drives;

.1 Expanded metal screen welded to steel frame.

.2 Minimum 1.2 mm thick sheet metal tops and bottoms.

.3 38 mm dia holes on both shaft centres for insertion of tachometer.

.4 Removable for servicing.

.3 Provide means to permit lubrication and use of test instruments with guards in place.

.4 Install belt guards to allow movement of motors for adjusting belt tension.

.5 Guard for flexible coupling:

.1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.

.2 Securely fasten in place.

.3 Removable for servicing.

.6 Unprotected fan inlets or outlets:

.1 Wire or expanded metal screen, galvanized, 19 mm mesh.

.2 Net free area of guard: not less than 80% of fan openings.

.3 Securely fasten in place.

.4 Removable for servicing.

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01 – Common Work Results for Mechanical, supplemented as noted herein.

3.2 INSTALLATION

.1 Fasten securely in place.

.2 Make removable for servicing, easily returned into, and positively in position.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 – Common Work Results for Mechanical.

.2 Section 23 05 23.03 – Valves – Cast Steel.

.3 Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

.4 Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.

.5 Section 23 05 53 – Identification for HVAC Piping and Equipment.

1.2 REFERENCE STANDARDS

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

.2 National Research Council Canada (NRC)

.1 National Building Code of Canada 2015 (NBC)

.2 National Fire Code of Canada (NFCC 2015)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Prior to commencement of new work, submit the following information in accordance with Section 21 05 01 – Common Work Results for Mechanical:

.1 Product Data, for:

.1 Paint.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 21 05 01 – Common Work Results for Mechanical.

Part 2 Products

2.1 MATERIAL

.1 Paint: zinc-rich to CAN/CGSB-1.181.

.1 Primers, Paints, Coating: in accordance with manufacturer's recommendations for surface conditions.

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01 – Common Work Results for Mechanical, supplemented as noted herein.

3.2 PREPARATION

.1 Lay out work in accordance with lines and grades as indicated.

.2 Verify lines, levels, dimensions as indicated against established benchmarks. Report discrepancies to Departmental Representative and obtain written instruction.

.3 When required by Departmental Representative, provide drawings showing relative locations of various services.

3.3 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.

3.4 CLEARANCES

.1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance, and as recommended by manufacturer and National Fire Code of Canada.

.2 Maintain clearance between pipes and structures for O&M as indicated, as directed.

.3 Provide space for disassembly, removal of equipment and components as recommended by manufacturer and as indicated without interrupting operation of other system, equipment, components.

3.5 DRAINS

.1 Locations:

.1 At bottom of risers.

.2 At low points in mains and branches.

.3 Elsewhere as indicated on drawings.

.2 Discharge:

.1 Pipe drain valves discharge separately to above floor drain. Discharge to be visible.

.2 Provide hose adapter on drain valves where discharge piping cannot conveniently be carried to floor drains.

3.6 AIR VENTS

.1 Install at high points and elsewhere as indicated on drawings.

.2 Installation to consist of full size tee, pipe extension and accumulator, isolation valve, and discharge pipe to floor drains with visible termination a maximum of 400mm above floor.

3.7 DIELECTRIC COUPLINGS

.1 General: compatible with system, to suit pressure rating of system.

.2 Locations: where dissimilar metals are joined.

.3 NPS 2 and under: isolating unions or bronze valves.

.4 Over NPS 2: isolating flanges.

3.8 PIPEWORK INSTALLATION

.1 Install pipework to applicable code based on service and specification section.

.2 Screwed fittings jointed with Teflon tape.

.3 Use flanges or unions at connections between existing and new piping.

.4 Protect openings against entry of foreign material.

.5 Assemble piping using fittings manufactured to ANSI standards:

Branch Connection Table

Branch Size \ Header Size	NPS	½	¾	1	1-½	2	3	4	6	8	10	12	14	16	18	20	24
	½	T	TR	TR	TR	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO
	¾		T	TR	TR	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO
	1			T	TR	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO
	1-½				T	TR	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO
	2					T	TR	TR	TR/SO/W	SO/W	SO/W	SO/W	SO/W	SO/W	SO/W	SO/W	SO/W
	3						T	TR	TR	TR/W	TR/W	W	W	W	W	W	W
	4							T	TR	TR	TR/W	W	W	W	W	W	W
	6								T	TR	TR	TR	W	W	W	W	W
	8									T	TR	TR	TR	TR	W	W	W
	10										T	TR	TR	TR	TR	TR	W
	12											T	TR	TR	TR	TR	TR
	14												T	TR	TR	TR	TR
	16													T	TR	TR	TR
	18														T	TR	TR
	20															T	TR
	24																T

T - Tee TO - Threadolet W - Weldolet TR - Reducing Tee SO - Sockolet

.6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.

.1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.

.7 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

.8 Run exposed piping parallel to walls.

.9 Provide drip legs, dirt pockets as indicated.

.10 Remove all burrs from piping. Clean scale and dirt, inside and out before and after assembly.

.11 Cap open ends of piping during installation.

.12 Flanges: Tighten bolts evenly with torque wrench. Re tighten bolts with torque wrench after system is in operation.

.13 Removal of a portion of pipe to facilitate welding of the joint and then replacing the cut out section, sometimes called "fish mouth" or Window" welding will not be permitted.

.14 Revisions to routing/location of piping require approval of Departmental Representative.

.15 Reducers at pump suction connections to be eccentric with flat on top.

.16 Install piping to minimize pipe dismantling for equipment removal. This would include removable flanged spool sections as required.

.17 Grade nominally horizontal piping at 0.5% slope generally in direction of flow, except where indicated.

.18 Install, except where indicated, to permit separate thermal insulation of each pipe.

.19 Group piping wherever possible and as indicated on drawings.

.20 Ream pipes, remove scale and other foreign material before assembly.

.21 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

.22 Provide for thermal expansion as indicated.

.23 Valves:

.1 Install in accessible locations.

.2 Remove interior parts before soldering.

.3 Welding to valves must be done in accordance with the manufacturers recommendations in order to prevent body distortion and to maintain tight shutoff characteristics of the valve.

.4 Install with stems above horizontal position unless indicated.

.5 Install isolating valves at branch take-offs, at pieces of equipment and elsewhere as indicated.

.6 Valves accessible for maintenance without removing adjacent piping.

.7 Use butterfly valves at branch take-offs for isolating purposes except where specified.

.8 Install butterfly valves between weld neck flanges to ensure full compression of liner.

.9 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.

.24 Check Valves:

.1 Install silent check valves on discharge of pumps and elsewhere as indicated.

.25 Strainers:

.1 Install in horizontal or down flow lines.

.2 Install in locations to allow easy access for removal of screen.

.3 Install ahead of each heat exchanger as indicated.

.4 Provide Drain Ball Valve as per Section 23 05 23.03 – Valves – Cast Steel, and piping to terminate at 400 mm from a floor drain. The pipe end shall be provided with a threaded forged steel cap.

.26 Leave joints in piping systems uncovered until tests are completed and system inspected as directed by Departmental Representative.

3.9 COLD SPRINGING

.1 Except where cold springing is indicated or specified, do not force pipes into position.

.2 Cold springing and pre-compression requirements to be based upon ambient temperature during installation of 22 degrees C and maximum operating temperature.

.3 Cold springing of expansion loops, offsets: as indicated and in presence of Departmental Representative.

.4 Cold springing of expansion joints: to recommendation of manufacturer and in presence of Departmental Representative.

.5 Pre-compress expansion joints in accordance with manufacturer's recommendations.

3.10 PIPE SUPPORTS

.1 In accordance with Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment, supplemented as specified herein.

.2 Spring hangers to remain blocked until completion of hydro test, after which initial free adjustments are to be made.

.3 Adjust supports, hangers, and springs, with system at operating temperature.

.4 Install expansion loops and supports as indicated and required to maintain venting and/or drainage.

.5 Pipe supports shall be seismically-restraint in accordance with the requirements of the National Building Code. The Contractor shall retain and pay for the services of a Seismic Restraint Systems (SRS) engineer. Contractor’s SRS engineer shall provide engineer’s sealed shop drawings, conduct necessary site inspections, and certify the final installation complies with the NBC requirements with final engineer’s sealed certification letter. Refer to Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.

3.11 ANCHORS AND GUIDES

.1 Locate anchors as required and shown.

.2 Align piping at guides to avoid damage by movement of piping against fixed structures.

.3 Guide expansion joints as per manufacturers’ recommendations. Size to accommodate specified thickness of insulation.

3.12 ESCUTCHEONS

.1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.

.2 Construction: one-piece type with set screws.

.1 Chrome- or nickel-plated brass or type 302 stainless steel.

.3 Sizes: outside diameter to cover opening or sleeve.

.1 Inside diameter to fit around pipe or outside of insulation if so provided.

3.13 PAINTING

.1 Paint exposed steelwork, including hangers and supports, with two (2) coats of rust inhibitive primer after construction and prior to beginning of insulation.

.2 Painting of supports, steelwork to be completed before heat is applied to system.

3.14 IDENTIFICATION

.1 In accordance with Section 23 05 53 – Identification for HVAC Piping and Equipment, supplemented as specified herein.

.1 Identify all piping at each energy transfer station and tie-in location with prefabricated pipe markers.

.2 In addition, identify piping at building entry.

3.15 CERTIFICATES

.1 Obtain data form for new pressure vessels, including heat exchangers, chillers, boilers, tanks from manufacturer and submit data form and fee at own expense to authority having jurisdiction for certificate for pressure vessels.

3.16 EXISTING SYSTEMS

.1 Connect into existing piping systems at times approved by Departmental Representative.

.2 Request written approval by Departmental Representative 10 days minimum, prior to commencement of work.

.3 Be responsible for damage to existing plant by this work.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 23 21 13.02 – Hydronic Systems: Steel

1.2 REFERENCE STANDARDS

.1 ASTM International (ASTM)

.1 ASTM A53/A53M-18, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

.2 ASTM A105/A105M-18 , Standard Specification for Carbon Steel Forgings, for Piping Applications.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit the following for work of this section in accordance with Section 21 05 01 – Common Work Results for Mechanical:

.1 Shop drawings.

1.4 CLOSEOUT SUBMITTALS

.1 Submit the following for work of this section in accordance with Section 21 05 01 – Common Work Results for Mechanical:

.1 Operation data.

.2 Maintenance data.

Part 2 Products

2.1 FLEXIBLE CONNECTIONS

.1 Application: to suit motion.

.2 Inner hose: stainless steel corrugated.

.3 Braided wire mesh stainless steel outer jacket.

.4 Diameter and type of end connection: as indicated.

.5 Operating conditions:

.1 Working pressure: 1034 kPa.

.2 Working temperature: 50°C.

.3 To meet system requirements.

.6 Three flexible grooved couplings placed in close proximity to vibration source for vibration attenuation and stress relief.

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01 – Common Work Results for Mechanical, supplemented as noted herein.

3.2 INSTALLATION

.1 Install flexible connections in accordance with manufacturer's instructions.

END OF SECTION

Approved: 2008-12-31

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 – Common Work Results for Mechanical

.2 Section 23 21 13.02 – Hydronic Systems: Steel

1.2 REFERENCE STANDARDS

.1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)

- .1 ANSI/ASME B31.9-2017, Building Services Piping.
- .2 ANSI/ASME Boiler and Pressure Vessel Code-2019:
  - .1 BVPC 2019 Section I: Rules for Construction of Power Boilers
  - .2 BPVC 2019 Section V: Non-destructive Examination.
  - .3 BPVC 2019 Section IX: Welding and Brazing Qualifications.

.2 American National Standards Institute/American Water Works Association (ANSI/AWWA)

- .1 ANSI/AWWA C206-17, Field Welding of Steel Water Pipe.

.3 American Welding Society (AWS)

- .1 AWS B2.1/B2.1M-2014, Specification for Welding Procedure and Performance Qualification
- .2 AWS C1.1M/C1.1:2019, Recommended Practices for Resistance Welding.

.4 Canadian General Standards Board (CGSB)

- .1 CGSB 48.2-1992, Spot Radiography of Welded Butt Joints in Ferrous Materials
- .2 CGSB 48.9712-2014, Non-Destructive Testing - Qualification and Certification of NDT Personnel.

.5 Canadian Standards Association (CSA International)

- .1 CSA B51-14, Boiler, Pressure Vessel and Pressure Piping Code.
- .2 CSA W48-18, Filler Metals and Allied Materials for Metal Arc Welding.
- .3 CSA W59-18, Welded Steel Construction (Metal Arc Welding).
- .4 CSA-W117.2-12 (R2017), Safety in Welding, Cutting and Allied Processes.
- .5 CSA W178.1-18, Certification of Welding Inspection Organizations.
- .6 CSA W178.2-18, Certification of Welding Inspectors.

.6 National Research Council of Canada (NRCC)

- .1 National Fire Code of Canada (NFC) 2015.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00- Submittal Procedures.

1.4 QUALITY ASSURANCE

.1 Qualifications:

- .1 Welders:
  - .1 Welding qualifications in accordance with CSA B51.
  - .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
  - .3 Submit welder's qualifications to Departmental Representative.
  - .4 Each welder to possess identification symbol issued by authority having jurisdiction.
  - .5 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.
- .2 Inspectors:
  - .1 Inspectors qualified to CSA W178.2.
- .3 Certifications:
  - .1 Registration of welding procedures in accordance with CSA B51.
  - .2 Copy of welding procedures available for inspection.
  - .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

Part 2 Products

2.1 ELECTRODES

.1 Electrodes: in accordance with CSA W48 Series.

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01 – Common Work Results for Mechanical, supplemented as noted herein.

3.2 QUALITY OF WORK

.1 Welding: in accordance with ANSI/ASME B31.9, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, applicable requirements of provincial authority having jurisdiction.

3.3 INSTALLATION REQUIREMENTS

.1 Identify each weld with welder's identification symbol.

.2 Backing rings:

.1 Where used, fit to minimize gaps between ring and pipe bore.

.2 Do not install at orifice flanges.

.3 Fittings:

.1 NPS 2 and smaller: install welding type sockets.

.2 Branch connections: install welding tees or forged branch outlet fittings.

3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS

.1 Review weld quality requirements and defect limits of applicable codes and standards with Departmental Representative before work is started.

.2 Formulate "Inspection and Test Plan" in co-operation with Departmental Representative.

.3 Do not conceal welds until they have been inspected, tested and approved by inspector.

.4 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

3.5 SPECIALIST EXAMINATIONS AND TESTS

.1 General:

.1 Perform examinations and tests by specialist qualified to CSA W178.1 and CSA W178.2 and approved by Departmental Representative.

.2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.

.2 Hydrostatically test welds to ANSI/ASME B31.9.

.3 Visual examinations: include entire circumference of weld externally and internally.

.4 Failure of visual examinations:

.1 Upon failure of welds by visual examination, perform additional testing as directed by Departmental Representative.

3.6 DEFECTS CAUSING REJECTION

.1 As described in ANSI/ASME B31.9 and ANSI/ASME Boiler and Pressure Vessels Code.

.2 In addition, chilled water systems:

.1 Undercutting greater than 0.8 mm adjacent to cover bead on outside of pipe.

.2 Undercutting greater than 0.8 mm adjacent to root bead on inside of pipe.

.3 Undercutting greater than 0.8 mm at combination of internal surface and external surface.

.4 Incomplete penetration and incomplete fusion greater than total length of 38 mm in 1500 mm length of weld depth of such defects being greater than 0.8 mm.

.5 Repair cracks and defects in excess of 0.8 mm in depth.

.6 Repair defects whose depth cannot be determined accurately on basis of visual examination or particle tests.

3.7 REPAIR OF WELDS WHICH FAILED TESTS

.1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 – Common Work Results for Mechanical.

.2 Section 23 05 53 – Identification for HVAC Piping and Equipment.

.3 Section 23 21 13.02 – Hydronic Systems: Steel.

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B40.100-2013, Pressure Gauges and Gauge Attachments.

.2 ASME B40.200-2008, Thermometers, Direct Reading and Remote Reading.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Prior to commencement of new work, submit the following information in accordance with Section 21 05 01 – Common Work Results for Mechanical:

.1 Product Data, for:

.1 Thermometers and pressure gauges.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 21 05 01 – Common Work Results for Mechanical.

.2 Submit O&M data as part of O&M manual for:

.1 Thermometers and pressure gauges.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 21 05 01 – Common Work Results for Mechanical.

Part 2 Products

2.1 GENERAL

.1 Refer to Section 23 21 13.02 – Hydronic Systems: Steel for operating pressures, temperatures, ASME/ANSI Codes of Construction, and BPV Registration requirements.

2.2 DIRECT READING THERMOMETERS

.1 Industrial, variable angle type, mercury-free liquid filled, 125 mm scale length: to ASME B40.200

.1 Resistance to shock and vibration.

.2 Range:

.1 Chilled Water: 0 – 50°C.

2.3 THERMOMETER WELLS

.1 Copper pipe: copper or bronze.

.2 Steel pipe: type 304 stainless steel, lagging type.

.3 Insertion length: 50% of pipe diameter.

.4 Allowance for insulation: Thermowell extends a minimum of 50mm (2 inches) to allow for pipe insulation.

2.4 PRESSURE GAUGES

.1 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel bourdon tube having 0.5% accuracy full scale unless otherwise specified.

.2 Gauges shall be provided with both metric and imperial units (kPa and psi).

.3 Provide ball valve upstream of all pressure gauges for isolation.

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01 – Common Work Results for Mechanical, supplemented as noted herein.

3.2 GENERAL

.1 Install thermometers and gauges so they can be easily read from floor or platform.

.1 If this cannot be accomplished, install remote reading units.

.2 Install between equipment and first fitting or valve.

3.3 THERMOMETERS

.1 Install in wells on piping. Include heat conductive material inside well.

.2 Install in locations as indicated in mechanical drawings, and on inlet and outlet of:

.1 Chillers: chilled water and condenser water connections.

.3 Install wells for balancing purposes.

.4 Use extensions where thermometers are installed through insulation.

.5 In general, where thermowells are installed in elbows:

.1 Minimize turbulence and resistance to flow.

.2 Install in direction of flow.

.3 Full length of thermowell to be in the fluid being measured.

.4 Increase size of piping to ensure velocity of fluid at thermowell is equal to flow rate in adjacent piping.

3.4 PRESSURE GAUGES

.1 Install in locations as follows:

.1 Chillers: chilled water and condenser water connections.

.2 In locations as indicated in the mechanical drawings.

.2 Install gauge cocks for balancing purposes, elsewhere as indicated.

.3 Use extensions where pressure gauges are installed through insulation.

3.5 NAMEPLATES

.1 Install engraved nameplates in accordance with Section 23 05 53 – Identification for HVAC Piping and Equipment, identifying medium.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 – Common Work Results for Mechanical.

.2 Section 23 07 16 – HVAC Equipment Insulation

.3 Section 23 07 19 – HVAC Piping Insulation.

.4 Section 23 21 13.02 – Hydronic Systems: Steel

.5 Section 23 21 16 – Hydronic Piping Specialties

1.2 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME):

.1 ASME B16.5-2017, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.

.2 ANSI/ASME B16.10-2017, Face-to-Face and End-to-End Dimensions Valves.

.3 ANSI/ASME B16.34-2017, Valves Flanged, Threaded and Welding End.

.2 ASTM International:

.1 ASTM A49-12(2019), Standard Specification for Heat-Treated Carbon Steel Joint Bars, Micro Alloyed Joint Bars, and Forged Carbon Steel Comprise Joint Bars.

.2 ASTM A105/A105M-18, Standard Specification for Carbon Steel Forgings for Piping Applications.

.3 ASTM A182/A182M-19a, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.

.4 ASTM A216/A218M-18, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.

.5 ASTM A276/A276M-17, Standard Specification for Stainless Steel Bars and Shapes.

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

.7 ASTM B85/B85M-18e1, Standard Specification for Aluminum-Alloy Die Castings.

.3 Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):

.1 MSS SP-25-2018, Standard Marking System for Valves, Fittings, Flanges and Unions.

.2 MSS SP-61-2019, Pressure Testing of Valves.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Prior to commencement of new work, submit the following information in accordance with Section 21 05 01 – Common Work Results for Mechanical:

.1 Product Data, for:

.1 Valves.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 21 05 01 – Common Work Results for Mechanical.

.2 Submit O&M data as part of O&M manual for:

.1 Valves.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 21 05 01 – Common Work Results for Mechanical.

Part 2 Products

2.1 MATERIAL

.1 Refer to Section 23 21 13.02 – Hydronic Systems: Steel for operating pressures, temperatures, ASME/ANSI Codes of Construction, and BPV Registration requirements.

.2 Valves:

.1 To be of single manufacturer.

.2 Test valves individually.

.3 Requirements common to valves, unless specified otherwise:

.1 Valves to be repackable under full line pressure while fully open.

.2 Pressure-temperature ratings: to ANSI B16.34.

.3 Inspections and tests: to API 598.

.4 Pressure testing: to MSS SP-61.

.5 Flanged valves:

.1 Face-to-face dimensions: to ANSI B16.10.

.2 Flange dimensions: to ANSI B16.5 with 1.6 mm raised face.

.6 Handwheel: non-heating type with raised rim of die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49.

.1 Handwheel with chain operators: on valves installed more than 2400 mm above floor in mechanical equipment rooms.

.7 Markings: to MSS SP-25.

.8 Identification:

.1 Plate showing catalogue number, size, material of body disc, stem seat, fluid, pressure-temperature rating.

.2 Body markings: manufacturer, size, primary service rating, material symbol.

.9 CRN registration number required for all products on primary DES side.

2.2 DRAIN AND VENT VALVES

.1 Application: DN 50 and smaller.

.1 Class PN 25, end connections to suit piping.

.2 Valve stems to be sufficiently long to clear insulation.

.3 Manual lever actuator with memory stop.

2.3 CIRCUIT BALANCING VAVES

.1 In accordance with Section 23 21 16 – Hydronic Piping Specialties.

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01 – Common Work Results for Mechanical, supplemented as noted herein.

3.2 INSTALLATION

.1 Install in accordance with manufacturer's recommendations in upright position with stem above horizontal.

3.3 INSTALLATION OF INSULATION

.1 Insulated valves shall be provided such that the insulation material is easily removable to provide access and maintenance to the valve. Permanent setting-type insulation shall not be provided unless otherwise specifically directed by the Departmental Representative.

.2 In accordance with Section 23 07 16 – HVAC Equipment Insulation and Section 23 07 19 – HVAC Piping Insulation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 – Common Work Results for Mechanical.

.2 Section 23 07 16 – HVAC Equipment Insulation.

.3 Section 23 07 19 – HVAC Piping Insulation.

.4 Section 23 21 13.02 – High Pressure Piping Systems Inside Buildings and CHC Plants.

1.2 REFERENCE STANDARDS

.1 American Petroleum Institute (API)

.1 API STD 598-2016, Valve Inspection and Testing, 10th Edition.

.2 API STD 609-2017, Butterfly Valves: Double Flanged, Lug- and Wafer-Type, 8th Edition

.2 American Society of Mechanical Engineers (ASME)

.1 ASME B16.5-2017, Pipe Flanges and Flanged Fittings: NPS ½ through 24.

.2 ASME B16.34-2017, Valves – Flanged, Threaded and Welding End

.3 ASME B16.47-2017, Large Diameter Steel Flanges: NPS 26 through NPS 60

.4 ASME B31.1-2018, Power Piping

.5 ASME B31.3-2018, Process Piping

.3 ASTM International (ASTM)

.1 ASTM A216/A216M-18, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, For High-Temperature Service.

.2 ASTM A564/A564M-19a, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes

.4 International Organization for Standardization (ISO)

.1 ISO 5752:1982, Metal Valves for use in Flanged Pipe Systems – Face-to-Face and Centre-to-Face Dimensions

.5 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)

.1 MSS SP-67-2017, Butterfly Valves.

.6 Spanish Association for Standardization (UNE)

.1 UNE-EN 558:2008, Industrial Valves – Face-to-face and Centre-to-Face Dimensions of Metal Valves for Use in Flanged Piping Systems – PN and Class Designated Valves

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Prior to commencement of new work, submit the following information in accordance with Section 21 05 01 – Common Work Results for Mechanical:

.1 Product Data, for:

.1 Valves.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 21 05 01 – Common Work Results for Mechanical.

.2 Submit O&M data as part of O&M manual for:

.1 Valves.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 21 05 01 – Common Work Results for Mechanical.

Part 2 Products

2.1 GENERAL

.1 Refer to Section 23 21 13.02 – Hydronic Systems: Steel for operating pressures, temperatures, ASME/ANSI Codes of Construction, and BPV Registration requirements.

.2 Except to specialty valves, to be of single manufacturer.

.3 To be installed between weld neck flanges.

.4 To be suitable for dead-end service.

.5 CRN registration number required for products.

.6 Valves to be repackable under full line pressure while fully open.

2.2 BUTTERFLY VALVES –RESILIENT SEAT –1378 kPag

.1 Except for specialty valves, to be of single manufacturer.

.2 To be suitable for dead-end service.

.3 CRN registration number required for products.

.4 Application: on-off operation.

.5 Sizes:

.1 Lug type: NPS 2-1/2 to 30.

.2 Wafer type shall not be permitted.

.6 Pressure rating for tight shut-off at temperatures up to maximum for seat material.

.1 NPS 2 - 12: 1378 kPag.

.2 NPS 14 - 48: 1378 kPag.

.7 One-piece full lug body.

.8 Operators:

.1 Handles capable of locking in any of ten (10) positions – 0 degrees to 90 degrees. Handle and release trigger – ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel.

.2 Provide chain operator on valves if installed higher than 2400mm above finished floor.

.3 Install parallel or perpendicular to pipeline.

.9 Designed to comply with MSS SP-67 and API 609.

.10 Compatible with ANSI Class 150 flanges.

.11 Construction:

.1 Body: ductile iron

.2 Disc: 316 SS.

.3 Shaft: 316 SS.

.4 Seat: EPDM.

.5 Taper pin: 316 SS

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01 – Common Work Results for Mechanical, supplemented as noted herein.

3.2 PREPARATION

.1 Valve and mating flange preparation.

.1 Inspect adjacent pipeline, remove rust, scale, welding slag, other foreign material.

.2 Ensure that valve seats and pipe flange faces are free of dirt or surface irregularities which may disrupt flange seating and cause external leakage.

.3 Install butterfly valves with disc in almost closed position.

.4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.

3.3 INSTALLATION OF VALVES

.1 Install in accordance with manufacturer's instructions.

.2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.

.3 Verify suitability of valve for application by inspection of identification tag.

.4 Handle valve with care to prevent damage to disc and seat faces.

.5 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.

.6 Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

3.4 INSTALLATION OF INSULATION

.1 Insulated valves shall be provided such that the insulation material is easily removable to provide access and maintenance to the valve. Permanent setting-type insulation shall not be provided unless otherwise specifically directed by the Departmental Representative.

.2 In accordance with Section 23 07 16 – HVAC Equipment Insulation and Section 23 07 19 – HVAC Piping Insulation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 – Common Work Results for Mechanical.

.2 Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B31.9-20, Building Services Piping.

.2 ASTM International

.1 ASTM A125-96(2018), Standard Specification for Steel Springs, Helical, Heat-Treated.

.2 ASTM A307-14e1, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.3 ASTM A563-15, Standard Specification for Carbon and Alloy Steel Nuts.

.3 Factory Mutual (FM)

.1 Government of Ontario

.1 Ontario Building Code 2012 O.Reg. 332/12, including up to and including all amendments effective January 1, 2015.

.2 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)

.1 MSS SP58-2018, Pipe Hangers and Supports – Materials, Design and Manufacture.

.3 National Research Council Canada (NRC)

.1 National Building Code of Canada (2015) (NBC).

.4 Underwriter's Laboratories of Canada (ULC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Prior to commencement of new work, submit the following information in accordance with Section 21 05 01 – Common Work Results for Mechanical:

.1 Submit shop drawings stamped by a professional engineer registered in the province of installation for:

.1 Bases, hangers and supports.

.2 Connections to equipment and structure.

.3 Structural assemblies.

.4 Seismic restraint systems of HVAC piping, ductwork and equipment in accordance with Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.

.2 Product Data, for:

.1 Hangers and supports not addressed by shop drawings.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 21 05 01 – Common Work Results for Mechanical.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Design Requirements:

.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 B31.9 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 conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.

.5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

.6 Provide seismic restraint systems of HVAC piping and equipment in accordance with NBC requirements and Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.

.7 Retain a structural engineer to review installations and provide a stamped letter stating hangers and supports do not apply undue stress to the supporting structure.

2.2 GENERAL

.1 Fabricate hangers, supports and sway braces in accordance with MSS SP58 and ASME B31.9.

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

.3 Equipment supports supplied by equipment manufacturer: specified elsewhere in Mechanical specifications.

.4 Equipment supports not supplied by equipment manufacturer: Fabricate from structural grade steel. Submit structural calculations with engineer-stamped shop drawings.

.5 All support attachments to the building structure are to be detailed and submitted to the Departmental Representative for review. The attachment details submittal will bear the stamp of a Professional Engineer licensed to practice in the Province having jurisdiction.

.6 Steel platforms to be provided will also require submission of assembly drawings to the Departmental Representative for review. Steel joint connection details must also be provided in addition to general assembly drawings and material lists.

.7 Platform design shall incorporate safety barrier/fall protection per OHSA.

.8 All equipment and piping supports, pads, and platforms to be included in the 3D CAD model of the system.

.9 Percussion type inserts not permitted.

.10 Power driven fasteners not permitted.

.11 In addition to above, provide hangers as indicated in all details provided in project documents.

2.3 PIPE HANGERS

.1 Finishes:

.1 Pipe hangers and supports: galvanized painted with zinc-rich paint after manufacture.

.2 Use hot dipped or zinc-plated galvanizing process.

.3 Ensure steel hangers in contact with copper piping are epoxy coated or copper plated.

.2 Upper attachment structural: suspension from lower flange of I-Beam:

.1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut carbon steel retaining clip.

.1 Rod: 9 mm ULC listed or 13 mm FM approved.

.2 Cold piping NPS 2 1/2 or greater: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, ULC listed, FM approved, to MSS-SP58.

.3 Upper attachment structural: suspension from upper flange of I-Beam:

.1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, ULC listed, FM approved, to MSS SP58.

.2 Cold piping NPS 2 1/2 or greater: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut ULC listed, FM approved.

.4 Upper attachment to concrete:

.1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6mm minimum greater than rod diameter.

.2 Concrete inserts: wedge shaped body with knockout protector plate ULC listed, FM approved, to MSS SP58.

.5 Shop and field-fabricated assemblies:

.1 Provide shop drawings for supports of this type.

.6 Hanger rods: threaded rod material to MSS SP58:

.1 Ensure that hanger rods are subject to tensile loading only.

.2 Provide linkages where lateral or axial movement of pipework is anticipated.

.3 Do not use 22 mm or 28mm rod.

.7 Pipe attachments: material to MSS SP58:

.1 Attachments for steel piping: carbon steel galvanized.

.2 Attachments for copper piping: copper plated black steel.

.3 Use insulation shields for hot pipework.

.4 Oversize pipe hangers and supports.

.8 Adjustable clevis: material to MSS SP58, FM approved, ULC listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.

.1 Ensure "U" has hole in bottom for rivetting to insulation shields.

.9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP58.

.10 U-bolts: carbon steel to MSS SP58 with 2 nuts at each end to ASTM A563.

.1 Finishes for steel pipework: galvanized.

.2 Finishes for copper, glass, brass or aluminum pipework: epoxy coated, with formed portion plastic coated.

.11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP58.

.12 Piping supports shall be seismically-restraint in accordance with Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.

2.4 RISER CLAMPS

.1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, ULC listed, FM approved.

.2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.

.3 Bolts: to ASTM A307.

.4 Nuts: to ASTM A563.

2.5 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:

.1 64 kg/m^3 density insulation plus insulation protection shield to: MSS SP58, galvanized sheet carbon steel. Length designed for maximum 3 m span.

2.6 CONSTANT SUPPORT SPRING HANGERS

.1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).

.2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.

.3 Provide upper and lower factory set travel stops.

.4 Provide load adjustment scale for field adjustments.

.5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.

.6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.7 VARIABLE SUPPORT SPRING HANGERS

.1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.

.2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.

.3 Variable spring hanger complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.

.4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.8 EQUIPMENT SUPPORTS

.1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel. Submit calculations with engineer-stamped shop drawings.

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

.1 Provide templates to ensure accurate location of anchor bolts.

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01 – Common Work Results for Mechanical, supplemented as noted herein.

3.2 INSTALLATION

.1 Vibration Control Devices:

.1 Install on piping systems at pumps, heat exchangers, and as required.

.2 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.

.3 Clevis plates:

.1 Attach to concrete with 4 minimum concrete inserts, one at each corner.

.4 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

.5 Use approved constant support type hangers where:

.1 Vertical movement of pipework is 13 mm or more,

.2 Transfer of load to adjacent hangers or connected equipment is not permitted.

.6 Use variable support spring hangers where:

.1 Transfer of load to adjacent piping or to connected equipment is not critical.

.2 Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

.1 Plumbing piping: to National Building Code and Ontario Building Code.

.2 Fire protection: to applicable fire code.

.3 Within 300mm of each elbow.

Maximum Pipe Size: NPS	Maximum Spacing Steel Pipe	Maximum Spacing Copper Pipe
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

.4 Pipework greater than NPS 12: to MSS SP58.

3.4 HANGER INSTALLATION

.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.

3.5 HORIZONTAL MOVEMENT

.1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees 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.

3.6 FINAL ADJUSTMENT

.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.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 – Common Work Results for Mechanical.

.2 Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.

1.2 REFERENCE STANDARDS

.1 National Research Council Canada (NRC)

.1 National Building Code of Canada (2015) (NBC).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Prior to commencement of new work, submit the following information in accordance with Section 21 05 01 – Common Work Results for Mechanical:

.1 Shop Drawings, for:

.1 Seismic control measures.

.1 Provide separate shop drawings for each isolated system.

.2 Provide detailed drawings of seismic control measures for equipment and piping. Submit drawings stamped and signed by a seismic restraint systems professional engineer who is registered or licensed in Ontario, Canada. The Contractor shall retain and pay for the services of a Seismic Restraint Systems (SRS) engineer. Contractor's SRS engineer shall provide engineer's sealed shop drawings, conduct necessary site inspections, and certify the final installation complies with the National Building Code requirements with final engineer's sealed certification letter.

.2 Product Data, for:

.1 Vibration isolation measures.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 21 05 01 – Common Work Results for Mechanical.

.2 Submit O&M data as part of O&M manual for:

.1 Vibration and Seismic Control Measures.

.3 Submit final seismic restraint certification letter as detailed in Part 3.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 21 05 01 – Common Work Results for Mechanical.

Part 2 Products

2.1 GENERAL

.1 General:

- .1 Seismic control systems to work in every direction.
- .2 Fasteners and attachment points to resist same maximum load as seismic restraint.
- .3 Drilled or power-driven anchors and fasteners not permitted.
- .4 No equipment, equipment supports or mounts to fail before failure of structure.
- .5 Supports of cast iron or threaded pipe not permitted.
- .6 Seismic control measures not to interfere with integrity of fire stopping.

.2 Static equipment:

- .1 Anchor equipment to equipment supports. Anchor equipment supports to structure.
- .2 Suspended equipment:
  - .1 Use one or more of following methods depending upon site conditions:
    - .1 Install tight to structure.
    - .2 Cross brace in every direction.
    - .3 Brace back to structure.
    - .4 Cable restraint system.
- .3 Seismic restraints:
  - .1 Cushioning action gentle and steady.
  - .2 Never reach metal-like stiffness.

.3 Vibration isolated equipment:

- .1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.
- .2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.
- .3 As indicated.

.4 Piping systems:

- .1 Piping systems: hangers longer than 300 mm; brace at each hanger.
- .2 Compatible with requirements for anchoring and guiding of piping systems.

.5 Bracing methods:

- .1 Approved by Departmental Representative.
- .2 Structural angles or channels.
- .3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

.1 Seismic restraint systems to meet the requirements of NBC and authority having jurisdiction. Seismic restraint systems design are the sole responsibility of the Contractor and their retained seismic restraint systems engineer.

.2 Provide vibration isolation devices on equipment as indicated in PART 3 and elsewhere in Divisions 21, 22, 23, and 25.

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01 – Common Work Results for Mechanical, supplemented as noted herein.

3.2 INSTALLATION

.1 Seismic control measures to meet requirements of NBC.

.2 Install vibration isolation equipment in accordance with manufacturer’s instructions and adjust mountings to level equipment.

.3 No rigid connections between equipment and building structure shall be made that degrades the noise and vibration isolation system herein specified. Electrical conduit connections to isolated equipment shall be looped to allow free motion of isolated equipment.

.4 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.

.5 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:

.1 Up to NPS 4: first 3 points of support.

.2 NPS 5 to NPS 8: first 4 points of support.

.3 NPS 10 and Over: first 6 points of support.

.4 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.

.6 Where isolation is bolted to floor use vibration isolation rubber washers.

.7 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.

.2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:

.1 After delivery and storage of Products.

.2 After preparatory work is complete but before installation commences.

.3 Twice during the installation, at 25% and 60% completion stages.

.4 Upon completion of installation.

.3 Submit manufacturer's reports to Departmental Representative within 3 days of manufacturer representative's review.

.4 Make adjustments and corrections in accordance with written report.

.2 Inspection and Certification:

.1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systems after start-up and TAB of systems to Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.

.2 Take vibration measurements for equipment as indicated listed below.

.1 Pumps

.3 Provide Departmental Representative with notice 24h in advance of commencement of tests.

.4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).

.5 Submit complete report of test results including sound curves.

.6 Provide final letter by seismic restraint systems engineer (under Contractor’s mandate), licensed in the province of work, to certify the systems have been adequately seismically restrained in accordance with the NBC and engineer’s requirements, witnessed by the engineer. The final letter shall be signed, sealed with the engineer’s stamp, and dated by the Contractor’s seismic restraint systems engineer.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 09 91 00.08 – Painting for Minor Works.

.2 Section 21 05 01 – Common Work Results for Mechanical.

1.2 REFERENCE STANDARDS

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-24.3-92, Identification of Piping Systems.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Prior to commencement of new work, submit the following information in accordance with Section 21 05 01 – Common Work Results for Mechanical:

.1 Samples, for:

.1 Nameplates.

.2 Identification labels.

.3 Valve tags.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 21 05 01 – Common Work Results for Mechanical.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

.1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers raised or recessed.

.3 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.

2.2 SYSTEM NAMEPLATES

.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.

.4 Locations:

.1 Terminal cabinets, control panels: use size #5.

.2 Equipment in Mechanical Rooms: use size #9.

.5 Identification for Departmental Representative's Maintenance Management System (NMMS):

.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 EXISTING IDENTIFICATION SYSTEMS

.1 Apply existing identification system to new work.

.2 Where existing identification system does not cover for new work, use identification system specified this section.

.3 For existing piping being converted to another source (ex: medium temperature hot water to glycol or hot water), re-label piping mains throughout all mechanical rooms, corridors, and service chases.

.4 Before starting work, obtain written approval of identification system from Departmental Representative.

2.4 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 Pictograms:

.1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.

.3 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.

.4 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 75 mm and greater: 150 mm long x 50 mm high.

.3 Use double-headed arrows where flow is reversible.

.5 Extent of background colour marking:

.1 To full circumference of pipe or insulation.

.2 Length to accommodate pictogram, full length of legend and arrows.

.6 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 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.

.7 Colours and Legends:

.1 Where not listed, obtain direction from Departmental Representative.

.2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

.3 Background colour marking and legends for piping systems:

Contents	Background Colour	Legend/Arrow Colour	English Legend	Légend Français
Condenser water supply	Green	White	COND. WTR. SUPPLY	ALIM. EAU COND.
Condenser water return	Green	White	COND. WTR. RETURN	RET. EAU COND.
Chilled water supply	Green	White	CH. WTR. SUPPLY	ALIM. EAU FROIDE
Chilled water return	Green	White	CH. WTR. RETURN	RET. EAU FROIDE

2.5 VALVES, CONTROLLERS

.1 Brass tags with 12 mm stamped identification data filled with black paint.

.2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.6 CONTROLS COMPONENTS IDENTIFICATION

.1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.

.2 Inscriptions to include function and (where appropriate) fail-safe position.

2.7 LANGUAGE

.1 Identification in both official Canadian languages English and French.

.2 Use one nameplate and label for each language.

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01 – Common Work Results for Mechanical, supplemented as noted herein.

3.2 TIMING

.1 Provide identification only after insulation specified Sections 23 07 16 – HVAC Equipment Insulation and 23 07 19 – HVAC Piping Insulation have been completed.

3.3 INSTALLATION

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide ULC & CSA registration plates as required by respective agency and authorities having jurisdiction.

.3 Identify systems, equipment to conform to PSPC NMMS.

3.4 NMMS UPDATE

.1 Contractor shall update the Departmental Representative's NMMS database by providing all the necessary information including, but not limited to, the following:

.1 Remove the existing pieces of equipment from the database demolished.

.2 Update existing equipment that have been relocated or altered.

.3 Provide all required information for new equipment, including but not limited to:

.1 Equipment type.

.2 Equipment ID / tag.

.3 Equipment location.

.4 Manufacturer.

.5 Model Number.

.6 Serial Number.

.7 Performance & equipment characteristics as required by Departmental Representative (temperature, flow, head, capacity, size, etc).

.4 Record and submit a list of equipment removed on the project, including NMMS#, make, model, and serial number.

3.5 NAMEPLATES

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate or cover.

3.6 LOCATION OF IDENTIFICATION ON PIPING SYSTEMS

.1 On long straight runs in open areas in mechanical rooms, equipment rooms, galleries, tunnels: at not more than 17 m 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 At least once in each small room through which piping or ductwork passes.

.4 On both sides of visual obstruction or where run is difficult to follow.

.5 On both sides of separations such as walls, floors, partitions.

.6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.

.7 At beginning and end points of each run and at each piece of equipment in run.

.8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.

.9 Identification easily and accurately readable from usual operating areas and from access points.

.1 Position of identification 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.

3.7 VALVES AND CONTROLLERS

.1 Valves and operating controllers, 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 Contractor shall follow the existing valve numbering system (if any). Valve numbers may be reused where valves are being removed as part of the demolition work.

END OF SECTION

Part 1 General

1.1 DEFINITIONS

.1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.

.2 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.

1.2 QUALIFICATIONS OF TAB PERSONNEL

.1 Submit names of personnel to perform TAB to Departmental Representative within 90 days of award of contract.

.2 Provide documentation confirming qualifications, successful experience.

.3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:

- .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
- .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-2005.
- .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems – Testing, Adjusting and Balancing-2002.

.4 Recommendations and suggested practices contained in the TAB Standard: mandatory.

.5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.

.6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.

.7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

.8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.

- .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
- .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

.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 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.

.4 TAB activities and report shall include all new work installed under Divisions 22, 23, and 25.

1.4 EXCEPTIONS

.1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

1.5 CO-ORDINATION

.1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule 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.

1.6 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

.1 HVAC systems: plus 5%, minus 5%.

.2 Hydronic systems: plus or minus 5%.

.3 Plumbing Systems:

.1 Pressure at fixtures: +/- 70 kPa.

.2 Flow rate at fixtures: +/- 20%.

1.7 ACCURACY TOLERANCES

.1 Measured values accurate to within plus or minus 2% of actual values.

1.8 INSTRUMENTS

.1 Prior to TAB, submit to Departmental Representative list of instruments 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.

1.9 ACTION AND INFORMATIONAL SUBMITTALS

.1 Prior to commencement of TAB, submit proposed methodology and procedures for performing TAB if different from referenced standard.

1.10 TAB REPORT

.1 Format in accordance with one of referenced standards.

.2 TAB report to show results in SI units and to include:

.1 Project record drawings.

.2 System schematics.

.3 Submit 1 electronic copy, complete with Table of Contents of TAB Report to Departmental Representative for verification and approval, in English. Once approved, issue two copies in D-ring binders, complete with index tabs.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 PRE-TAB REVIEW

.1 Review contract documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to Departmental Representative in writing proposed procedures which vary from standard.

.3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

3.2 PRELIMINARY TAB REPORT

.1 Submit for checking and approval of Departmental Representative, prior to submission of formal TAB report, sample of rough TAB sheets. Include:

.1 Details of instruments used.

.2 Details of TAB procedures employed.

.3 Calculations procedures.

.4 Summaries.

3.3 START OF TAB

.1 Notify Departmental Representative 7 days prior to start of TAB.

.2 Start TAB when building is essentially completed, including:

.1 Installation of ceilings, doors, windows, other construction affecting TAB.

.2 Application of weather-stripping, sealing, and caulking.

.3 Pressure, leakage, other tests specified elsewhere Division 23.

.4 Provisions for TAB installed and operational.

.5 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB is complete, including but not limited to:

.1 Proper thermal overload protection in place for electrical equipment.

.2 Liquid systems:

.1 Flushed, filled, vented.

.2 Correct pump rotation.

.3 Strainers in place, baskets clean.

.4 Isolating and balancing valves installed, open.

.5 Calibrated balancing valves installed, at factory settings.

.6 Chemical treatment systems complete, operational.

.6 Start-up deficiencies have been rectified.

3.4 START-UP

.1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

.2 Follow special start-up procedures specified elsewhere in Division 23.

3.5 TAB

.1 TAB test locations shall be sufficient to establish full system compliance with design documents.

.2 Locations of equipment measurement: To include, but not be limited to, following as appropriate:

.1 Inlet and outlet of each heat exchanger (primary and secondary sides), pump, control valve, other equipment causing changes in conditions.

.3 Locations of systems measurements to include, but not be limited to, following as appropriate: Supply and return of each primary and secondary loop (main, main branch, branch, sub-branch of all hydronic systems, inlet connection of make-up water).

.4 Hydronic Systems:

.1 Verify that flow rate and pressure at each device meet design criteria.

.2 Make adjustments while fixture/device flowrate or withdrawal is at:

.1 Maximum; and

.2 25% of maximum; and

.3 While pressure is at:

.1 Maximum; and

.2 Minimum.

3.6 OPERATION OF SYSTEMS DURING TAB

.1 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.

3.7 VERIFICATION

.1 Reported results subject to verification by Departmental Representative.

.2 Provide personnel and instrumentation to verify up to 30% of reported results.

.3 Number and location of verified results as directed by Departmental Representative.

.4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

3.8 SETTINGS

.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.

.2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

3.9 COMPLETION OF TAB

.1 TAB considered complete when final TAB Report received and approved by Departmental Representative.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 – Common Work Results for Mechanical.

1.2 REFERENCE STANDARDS

.1 ASTM International Inc.

.1 ASTM C335-17, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.2 ASTM C449/C449M-07(2019), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.3 ASTM C547-19, Standard Specification for Mineral Fiber Pipe Insulation.

.2 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52MA-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.2 CAN/CGSB 51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.

.3 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).

.4 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102-18, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S702.1-14AMD1, Standard for Mineral Fibre Thermal Insulation for Buildings, Part 1: Material Specification.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Prior to commencement of new work, submit the following information in accordance with Section 21 05 01 – Common Work Results for Mechanical:

.1 Product Data, for:

.1 Insulation.

.2 Insulation jackets.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 21 05 01 – Common Work Results for Mechanical.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 Fire and smoke ratings to CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 TIAC Code C-1: rigid mineral fibre board, unfaced.

.1 Mineral fibre: ASTM C612.

.2 TIAC Code C-4: rigid mineral fibre board faced with factory applied vapour retarder jacket.

.1 Mineral fibre: ASTM C612.

.2 Jacket: to CGSB 51-GP-52MA.

.3 TIAC Code C-2: mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).

.1 Mineral fibre: ASTM C553.

.2 Jacket: to CGSB 51-GP-52MA.

.4 TIAC Code A.6: flexible unicellular tubular elastomer.

2.3 CEMENT

.1 Thermal insulating and finish

.1 To: ASTM C449/C449M.

.2 Hydraulic setting on mineral wool, to ASTM C449/C449M.

2.4 JACKETS

.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 or as selected by Departmental Representative.

.3 Minimum service temperatures: -20 degrees C.

.4 Maximum service temperature: 65 degrees C.

.5 Moisture vapour transmission: 0.02 perm.

.6 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.7 Special requirements:

.1 Outdoor: UV rated material at least 0.5 mm thick.

.8 Covering adhesive: compatible with insulation

2.5 INSULATION SECUREMENTS

.1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.

.6 Facing: 25 mm galvanized steel hexagonal wire mesh on one face of insulation with expanded metal lath on other face of insulation.

.7 Fasteners: 4 mm diameter pins with 35 mm diameter clips. Length of pin to suit thickness of insulation.

2.6 VAPOUR RETARDER LAP ADHESIVE

.1 Water based, fire retardant type, compatible with insulation.

2.7 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01 – Common Work Results for Mechanical, supplemented as noted herein.

3.2 PRE- INSTALLATION REQUIREMENTS

.1 Pressure testing of equipment and adjacent piping systems complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards

.1 Cold equipment: To TIAC code 1503-C.

.2 Elastomeric Insulation: to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.

.3 Provide vapour retarder as recommended by manufacturer.

.4 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.

.5 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

.6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Hangers, supports outside vapour retarder jacket.

.7 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: At flexible connections, valves, flanges, and unions at equipment.

.2 Installation to permit periodic removal and replacement without damage to adjacent insulation.

3.5 EQUIPMENT INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 Cold Equipment insulation thickness: 50 mm.

.3 Fastenings: mechanical fastenings, wire, or bands and 13mm cement reinforced with one layer of reinforcing mesh.

.4 Provide vapour-retardant jacket for cold equipment.

.5 Finishes:

.1 Equipment in mechanical rooms: TIAC code CEF/1 with jacket.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 – Common Work Results for Mechanical.

.2 Section 23 05 53 – Identification for HVAC Piping and Equipment.

.3 Section 23 07 16 – HVAC Equipment Insulation

1.2 REFERENCE STANDARDS

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM C335-17, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.

.2 ASTM C449/C449M-07(2019), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.2 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketting Sheet, for Insulated Pipes, Vessels and Round Ducts

.3 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).

.4 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC-S102-18, Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S702.1-14AMD1, Standard for Mineral Fibre Thermal Insulation for Buildings, Part 1: Material Specification.

1.3 DEFINITIONS

.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:

.1 CRF: Code Rectangular Finish.

.2 CPF: Code Piping Finish.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Prior to commencement of new work, submit the following information in accordance with Section 21 05 01 – Common Work Results for Mechanical:

.1 Product Data, for:

.1 Insulation.

.2 Insulation jackets.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 21 05 01 – Common Work Results for 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 C335.

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702.

.2 Maximum "k" factor: to CAN/ULC-S702.

.3 With factory applied all service jacket.

.4 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.

.5 TIAC Code A-6: Flexible Unicellular Elastomer, with factory applied vapour retarder jacket.

.1 Jacket: to CGSB 51-GP-52Ma.

.2 Maximum "k" factor: 0.034 W/m-°C

.3 Certified by the manufacturer to be free of potential stress corrosion cracking corrodants.

2.3 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 In accordance with Section 23 07 16 – HVAC Equipment Insulation.

2.4 INSULATION SECUREMENT

.1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: stainless steel, 19 mm wide, 0.5 mm thick.

2.5 CEMENT

.1 Thermal insulating and finishing cement:

.1 Hydraulic setting on mineral wool, to ASTM C449/C449M.

2.6 VAPOUR RETARDER LAP ADHESIVE

.1 Water based, fire retardant type, compatible with insulation.

2.7 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.8 OUTDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: fibrous glass, untreated 305 g/m^2.

2.9 JACKETS

.1 New Jacketing required for both existing piping mains in mechanical rooms and all new piping.

.2 Aluminium:

.1 To ASTM B209.

.2 Thickness: 0.50 mm sheet.

.3 Finish: 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, 0.5 mm thick at 300 mm spacing

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01 – Common Work Results for Mechanical, supplemented as noted herein.

3.2 PRE-INSTALLATION REQUIREMENT

.1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

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.

3.4 INSTALLATION OF ELASTOMERIC INSULATION

.1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.

.2 Provide vapour retarder as recommended by manufacturer.

3.5 PIPING INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 All piping is to be insulated. For any piping not listed in the schedule below, request direction from Departmental Representative.

.3 TIAC Code: A-1.

.1 Insulation securements: Tape at 300 mm on centre.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code 1501-H.

.4 TIAC Code: A-3.

.1 Insulation securements: Tape at 300 mm on centre.

.2 Seals: VR lap seal adhesive, VR lagging adhesive.

.3 Installation: TIAC Code: 1501-C.

.5 TIAC Code: A-6.

.1 Insulation securements: Tape at 300 mm on centre.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code: 1501-C.

.6 Thickness of insulation as listed in the 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 °C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8 & over
Domestic Cold Water (within mechanical rooms)	all	A-6	25	25	25	25	25	25
Chilled Water	>4	A-3	25	25	25	25	38	38

.7 Finishes:

.1 Exposed indoors: aluminium jacket for Type A-1, A-3 insulation.

.2 Exposed in mechanical rooms: aluminium jacket for Type A-1, A-3 insulation.

.3 Concealed, indoors: canvas on valves, fittings. No further finish.

.4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.

.5 Finish attachments: SS screws or bands, at 150 mm on centre. Seals: wing or closed.

.6 Installation: to appropriate TIAC code CRF/1 through CPF/5.

.8 Insulation is not required for:

.1 Chrome plated piping, valves and fittings.

.2 Vent, relief, and drain piping under 25 mm

.3 Condenser water piping.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 – Common Work Results for Mechanical.

.2 Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.

Part 2 Products

2.1 CLEANING SOLUTIONS

.1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.

.2 Sodium carbonate: 0.40 kg per 100 L water in system.

.3 Low-foaming detergent: 0.01 kg per 100 L water in system.

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01 – Common Work Results for Mechanical, supplemented as noted herein.

.2 Timing of activities is outlined in Section 21 05 01 – Common Work Results for Mechanical.

.3 Activities including, but not limited to, testing, reports, and training, shall be in accordance with Section 01 91 13 – General Commissioning Requirements, supplemented as specified herein.

3.2 GENERAL

.1 The Contractor shall coordinate all commissioning work with the Departmental Representative. The Contractor shall allow for returning to site to perform the commissioning process.

.2 Start up systems only after written approval of installation from Departmental Representative.

.3 Before starting testing, submit testing procedures and proposed testing forms for approval by Departmental Representative.

.4 Complete start-up and test reports for each system detailing all tests, results seen, and adequacy of results. Submit reports within 3 business days of testing to Departmental Representative for review and approval. Repeat tests until Departmental Representative is satisfied with results.

.5 Upon completion of performance verification, furnish certificates confirming satisfactory installation and performance.

.6 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.

.7 Existing pumps are to be used for performance verification in coordination with building operators.

3.3 CLEANING AND FLUSHING

.1 Timing: after systems including water treatment operational, hydrostatically tested and with safety devices functional.

.2 Cleaning Agency:

.1 Retain qualified water treatment specialist to perform system cleaning.

.3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.

.4 Pre-Cleaning Report:

.1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:

.1 Cleaning procedures, flow rates, elapsed time.

.2 Chemicals and concentrations used.

.1 Chemicals shall be designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Use chemicals to inhibit corrosion of various system materials that are safe to handle and use.

.3 Inhibitors and concentrations.

.4 Specific requirements for completion of work.

.5 Special precautions for protecting piping system materials and components.

.6 Complete analysis of water used to ensure water will not damage systems or equipment.

.2 The Contractor shall furnish and install all temporary devices such as pressure pumps, gauges, valves, caps and pipes, necessary for the conducting of the leak testing and cleaning/flushing operations.

.5 Conditions at time of cleaning of systems:

.1 Systems: free from construction debris, dirt and other foreign material.

.2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.

.3 Strainers: clean prior to initial fill.

.4 Install temporary filters on pumps not equipped with permanent filters.

.5 Install pressure gauges on strainers to detect plugging.

.6 The contractor shall notify the Departmental Representative 24 hours in advance of the flushing procedure.

.7 The contractor shall provide equipment, labour, and materials as needed to perform the flushing and cleaning of the piping.

.8 Hydronic Systems:

.1 Chemically clean all new piping based on recommendations of the water treatment specialist engaged by the installing contractor, prior to connection to existing systems. Use blind flanges between new and existing piping where required to isolate for chemical cleaning. Existing isolation valves can be used for isolation, resulting in chemical cleaning including some existing piping. Once chemical cleaning is complete, flush new piping with clean water and test sample of flushing water. Repeat flushing process until sample test establishes that flushing water alkalinity matches makeup water alkalinity, then submit report to Departmental Representative to get authorization to connect new piping to existing.

.2 Fill all piping systems with water or glycol, as appropriate, and ensure air is vented from the system.

.3 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).

.4 Use water metre to record volume of water in system to +/- 0.5%.

.5 Perform a flushing of all new piping and existing non-district piping connected to new work, cycling fluid through systems for a minimum of 24 hours.

.1 New equipment, specifically heat exchangers, energy meters, and control valves on the primary and secondary, shall be bypassed during flushing/cleaning process and strainer screens temporarily replaced with temporary screens.

.2 All instrumentation installed in the piping shall be removed and not be exposed to the flushing and cleaning process.

.3 Examine and clean filters and screens, periodically during circulation of fluid, and monitor changes in pressure drop across equipment. Replace filters a minimum of every 6 hours until reviewed and signed off by Departmental Representative.

.1 Initial flush cycle shall be completed using 20 micron filters and repeated until Departmental Representative satisfied with filter cleanliness. Repeat process using 15 micron filters, then 10 micron filters, and finally 5 micron filters.

.4 Flushing velocity to be a minimum of 1.5 meters per second (4.92 ft/s).

.5 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.

.6 Provide flushing screen 20 mesh on flush discharge to monitor material carried by flushwater.

.7 The contractor shall install and remove all temporary piping and supports to introduce and dispose of flushing water at a safe discharge.

.8 Take samples of circulating water periodically and test. Repeat the flush cycle until alkalinity of rinse water is the same as to make-up water.

.6 The Contractor shall take all necessary precautions to prevent damage to the pipe, insulation, or structures from the cleaning operation.

.7 The Contractor shall take all necessary precautions to ensure that no oil or other lubricant comes into contact with either the inside or outside walls of the pipe following cleaning.

.8 On completion of Flushing/cleaning and acceptance by Departmental Representative, re-connect equipment, clean and re-install temporary and permanent strainer screens.

.1 Disposal of cleaning solutions approved by authority having jurisdiction.

.9 Temporary strainer screens shall remain in place up to 6 months after startup.

.10 The contractor shall make arrangements for and bear all costs associated with water required for flushing.

.6 The contractor is responsible for obtaining and properly disposing of all test and cleaning media.

.7 Report on Completion of Cleaning:

.1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

.8 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.4 START-UP

.1 General:

.1 Provide continuous supervision during start-up.

.2 Follow manufacturer's recommendations.

.3 Provide start-up reports for Departmental Representative approval after each system start-up is completed.

.2 Hydronic Systems:

.1 Establish circulation and expansion tank level, set pressure controls.

.2 Ensure air is removed.

.3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.

.4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.

.5 Clean out strainers repeatedly until system is clean.

.6 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.

.7 Repeat with water at design temperature.

.8 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.

.9 Perform TAB as specified in Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.

.10 Adjust pipe supports, hangers, springs as necessary.

.11 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.

.12 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.

.13 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

.14 Check operation of drain valves.

.15 Adjust valve stem packings as systems settle down.

.16 Fully open balancing valves (except those that are factory-set).

.17 Check operation of over-temperature protection devices on circulating pumps.

.18 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

.19 Bleed air from system air vents as required.

3.5 HYDRONIC PUMPS

.1 Manufacturer to provide one pre-commissioning site visit prior to start-up to certify that the installation is acceptable to the manufacturer, one day of onsite commissioning support, one post start-up site visit during guarantee period for the system. Coordinate the post start-up visit with the Departmental Representative. The manufacturer shall carry out the following procedures as a minimum during the post start visit:

.1 Inspect the pumps.

.2 Review operator’s comments and or concerns and provide any recommendations that would improve maintenance procedures.

.2 Verify that manufacturer's performance curves are accurate.

.3 Ensure valves on pump suction and discharge provide tight shut-off.

.4 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.

.1 Record of points of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.

3.6 HYDRONIC SYSTEMS – PERFORMANCE VERIFICATION (PV)

.1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.

.2 When systems are operational, perform following tests:

.1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.

.2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.

.1 Chiller operation.

.2 Control valve operation.

.3 Bypass open/closed.

.4 Control pressure failure.

.5 Maximum cooling demand.

.3 Monitor operation of provisions for controlled pipe movement including expansion joints, loops, guides, anchors.

.1 If bellows type expansion joints flex incorrectly or if sliding type expansion joints bind, shut down system, re-align, repeat start-up procedures.

3.7 HYDRONIC SYSTEM CAPACITY TEST

.1 Perform hydronic system capacity tests after:

.1 TAB has been completed

.2 Verification of operating, limit, safety controls.

.3 Verification of pump flow rates.

.4 Verification of accuracy of temperature and pressure sensors and gauges.

.2 Calculate system capacity at test conditions.

.3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.

.4 When capacity test is completed, return controls and equipment status to normal operating conditions.

.5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.

.6 Cooling system capacity test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.1 Increasing OA flow rates through cooling coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or

.2 Reducing space temperature by turning off heating system for sufficient period of time before starting testing.

.2 Test procedures:

.1 Open fully cooling coil control valves.

.2 Set thermostats on associated cooling equipment for maximum cooling.

.3 Set cooling equipment for design maximum air flow rates.

.4 Set load or demand limiters on chiller to 100%.

.5 After system has stabilized, record chilled water, and condenser water flow rates and supply and return temperatures simultaneously.

3.8 DEMONSTRATION AND TRAINING

.1 Perform demonstration and training in accordance with Section 01 79 00 – Demonstration and Training, supplemented as noted herein:

.1 Training to include all new work of Divisions 21 and 23.

.2 Provide additional specific training focused on the following:

.1 Controls and Metering Equipment Training.

.2 Chillers:

.1 The manufacturer shall hold a training seminar for the operating personnel, immediately after commissioning and start-up. Training shall cover operational, maintenance, and problem diagnostic aspects of the equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 – Common Work Results for Mechanical.

.2 Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 21 05 01 – Common Work Results for Mechanical.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 21 05 01 – Common Work Results for Mechanical.

Part 2 Products

2.1 CLEANING SOLUTIONS

.1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.

.2 Sodium carbonate: 0.40 kg per 100 L water in system.

.3 Low-foaming detergent: 0.01 kg per 100 L water in system.

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01 – Common Work Results for Mechanical, supplemented as noted herein.

.2 Timing of activities is outlined in Section 21 05 01 – Common Work Results for Mechanical.

.3 Backfilling buried systems and concealing systems shall not occur until pressure tests are complete.

3.2 PRESSURE TESTING

.1 TSSA Inspection

.1 Inspect new piping prior to hydrostatic test by authority having jurisdiction. Where Province has approved drawings, TSSA certified boiler inspector to inspect installation.

.2 Contractor to contact TSSA for requirements for inspection and testing of system modifications, design changes or repairs done in house.

.3 Costs for inspection to be covered by Contractor.

.2 Hydrostatic pressure testing of all piping:

.1 Pressure test all piping after installation and before painting, insulating, or concealing in any way.

.2 Testing shall include expansion joints, flex connections, and new piping in system.

.3 Submit test procedure for review and approval to the Departmental Representative a minimum of 48 hours prior to commencement of the operation.

.4 Notify the Departmental Representative a minimum of 48 hours prior to all pressure tests to allow Departmental Representative. Conduct tests in presence of Departmental Representative. Proceed with testing only once given approval by Departmental Representative to do so.

.5 For pressure tests, isolate new piping from all existing piping, new equipment, instrumentation, expansion joints, flexible connectors, and piping specialty components such as control valves and flow meters. Use blank flanges at connections to allow for new piping pressure tests.

.6 Provide temporary supports to steam piping as required and remove after testing is successfully completed.

.7 Remove or isolate and bypass any valves, strainers or other components whose design pressure rating is not rated to withstand the test pressure, prior to test.

.8 Use clean, filtered fresh or city hydro-test water at 10°C.

.9 Hydraulically test the system at the greater of 1.5 times the design pressure or 860 kPa for a minimum of 4 hours without any drop in pressure. Where test pressures are defined on drawings, these values supercede the specification. All equipment, including but not limited to heat exchangers, pumps, control valves, energy meters, pressure relief valves, must be isolated from test and vented.

.1 For sprinkler systems, instead test each system at 200 psig for 2 hours without any drop in pressure. The test shall include all new piping and heads, prior to connection to the existing piping network.

.10 All pipe joints must remain uncovered and be visually inspected during the pressure test. Any leaking joint must be repaired at the contractor’s cost and the pressure test repeated.

.11 The contractor will prepare test certificate and be signatory to the test result. Documentation to be submitted as required to TSSA to register the piping following a successful test. A copy to be provided to Departmental Representative as part of the OM manual.

.12 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.

.13 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

.3 Hydraulically test all sanitary piping to verify grades and freedom from obstructions.

3.3 CLEANING AND FLUSHING

.1 Timing: after systems including water treatment operational, hydrostatically tested and with safety devices functional.

.2 Cleaning Agency:

.1 Retain qualified water treatment specialist to perform system cleaning.

.3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.

.4 Pre-Cleaning Report:

.1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:

.1 Cleaning procedures, flow rates, elapsed time.

.2 Chemicals and concentrations used.

.1 Chemicals shall be designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Use chemicals to inhibit corrosion of various system materials that are safe to handle and use.

.3 Inhibitors and concentrations.

.4 Specific requirements for completion of work.

.5 Special precautions for protecting piping system materials and components.

.6 Complete analysis of water used to ensure water will not damage systems or equipment.

.2 The Contractor shall furnish and install all temporary devices such as pressure pumps, gauges, valves, caps and pipes, necessary for the conducting of the leak testing and cleaning/flushing operations.

.5 Conditions at time of cleaning of systems:

.1 Systems: free from construction debris, dirt and other foreign material.

.2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.

.3 Strainers: clean prior to initial fill.

.4 Install temporary filters on pumps not equipped with permanent filters.

.5 Install pressure gauges on strainers to detect plugging.

.6 The contractor shall notify the Departmental Representative 24 hours in advance of the flushing procedure.

.7 The contractor shall provide equipment, labour, and materials as needed to perform the flushing and cleaning of the piping.

.8 Hydronic Systems:

.1 Chemically clean all new piping based on recommendations of the water treatment specialist engaged by the installing contractor, prior to connection to existing systems. Use blind flanges between new and existing piping where required to isolate for chemical cleaning. Existing isolation valves can be used for isolation, resulting in chemical cleaning including some existing piping. Once chemical cleaning is complete, flush new piping with clean water and test sample of flushing water.

Repeat flushing process until sample test establishes that flushing water alkalinity matches makeup water alkalinity, then submit report to Departmental Representative to get authorization to connect new piping to existing.

.2 Fill all piping systems with water or glycol, as appropriate, and ensure air is vented from the system.

.3 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).

.4 Use water metre to record volume of water in system to +/- 0.5%.

.5 Perform a flushing of all new piping and existing non-district piping connected to new work, cycling fluid through systems for a minimum of 24 hours.

.1 New equipment, specifically heat exchangers, energy meters, and control valves on the primary and secondary, shall be bypassed during flushing/cleaning process and strainer screens temporarily replaced with temporary screens.

.2 All instrumentation installed in the piping shall be removed and not be exposed to the flushing and cleaning process.

.3 Examine and clean filters and screens, periodically during circulation of fluid, and monitor changes in pressure drop across equipment. Replace filters a minimum of every 6 hours until reviewed and signed off by Departmental Representative.

.1 Initial flush cycle shall be completed using 20 micron filters and repeated until Departmental Representative satisfied with filter cleanliness. Repeat process using 15 micron filters, then 10 micron filters, and finally 5 micron filters.

.4 Flushing velocity to be a minimum of 1.5 meters per second (4.92 ft/s).

.5 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.

.6 Provide flushing screen 20 mesh on flush discharge to monitor material carried by flushwater.

.7 The contractor shall install and remove all temporary piping and supports to introduce and dispose of flushing water at a safe discharge.

.8 Take samples of circulating water periodically and test. Repeat the flush cycle until alkalinity of rinse water is the same as to make-up water.

.6 The Contractor shall take all necessary precautions to prevent damage to the pipe, insulation, or structures from the cleaning operation.

.7 The Contractor shall take all necessary precautions to ensure that no oil or other lubricant comes into contact with either the inside or outside walls of the pipe following cleaning.

.8 On completion of Flushing/cleaning and acceptance by Departmental Representative, re-connect equipment, clean and re-install temporary and permanent strainer screens.

.1 Disposal of cleaning solutions approved by authority having jurisdiction.

.9 Temporary strainer screens shall remain in place up to 6 months after startup.

.10 The contractor shall make arrangements for and bear all costs associated with water required for flushing.

.6 The contractor is responsible for obtaining and properly disposing of all test and cleaning media.

.7 Report on Completion of Cleaning:

.1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

.8 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.4 START-UP

.1 General:

.1 Provide continuous supervision during start-up.

.2 Follow manufacturer's recommendations.

.3 Provide start-up reports for Departmental Representative approval after each system start-up is completed.

.2 Hydronic Pumps:

.1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.

.2 After starting pump, check for proper, safe operation.

.3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.

.4 Check base for free-floating, no obstructions under base.

.5 Run pumps for 12 continuous hours minimum.

.6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.

.7 Eliminate air from scroll casing.

.8 Adjust water flow rate through water-cooled bearings.

.9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.

.10 Adjust alignment of piping and conduit to ensure true flexibility.

.11 Eliminate cavitation, flashing and air entrainment.

.12 Adjust pump shaft seals, stuffing boxes, glands.

.13 Measure pressure drop across strainer when clean and with flow rates as finally set.

.14 Replace seals if pump used to degrease system or if pump used for temporary heat.

.15 Verify lubricating oil levels.

.3 Hydronic Pump VFDs:

.1 The Manufacturer shall test the VFD before trial operation. Coordinate expected results with other parties involved equipment, prior to the beginning any test. Specifically, ensure that no instruments can be damaged due, for example, to abnormal input conditions, and that no motors can cause damage due to reverse rotation, etc. The Contractor shall be in charge of the facilities during all tests. He shall assume responsibility for damage in the event of injury to the personnel, building, and equipment, and shall bear all costs for liability, repairs, and restoration in this connection.

.2 Conduct acceptance tests and demonstrate that the equipment and devices, power and control systems actually meet the design intentions and specified requirements. Verify and test operation of remote control system.

.3 The vendor will provide factory start-up services for each VFD.

.4 Provide support to the control system integrator to establish control and monitoring of the VFD by the building control system.

.4 Hydronic Systems:

.1 Establish circulation and expansion tank level, set pressure controls.

.2 Ensure air is removed.

.3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.

.4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.

.5 Clean out strainers repeatedly until system is clean.

.6 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.

.7 Repeat with water at design temperature.

.8 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.

.9 Bring system up to design temperature and pressure slowly over a 48 hour period.

.10 Perform TAB as specified in Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.

.11 Adjust pipe supports, hangers, springs as necessary.

.12 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.

.13 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.

.14 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

.15 Check operation of drain valves.

.16 Adjust valve stem packings as systems settle down.

.17 Fully open balancing valves (except those that are factory-set).

.18 Check operation of over-temperature protection devices on circulating pumps.

.19 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

.1 Bleed air from system air vents as required.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 – Common Work Results for Mechanical.

.2 Section 23 05 15 – Common Installation Requirements for HVAC Pipework.

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B16.11-2016, Forged Fittings, Socket-Welding and Threaded.

.2 ASTM International (ASTM)

.1 ASTM A53/A53M-18, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

.2 ASTM A105/A105M-18, Standard Specification for Carbon Steel Forgings for Piping Applications.

.3 ASTM A193/A193M-20, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Hight Temperature or High Pressure Service and Other Special Purpose Applications.

.4 ASTM A194/A194M-20a, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for Hight Pressure or High Temperature Service, or Both.

.5 ASTM A234/A234M-19, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

.3 CSA Group (CSA)

.1 CSA W48-18, Filler Metals and Allied Materials for Metal Arc Welding.

Part 2 Products

2.1 GENERAL

.1 Refer to Section 23 05 15 – Common Installation Requirements for HVAC Pipework for system pressures, temperatures, ASME/ANSI Codes of Construction, and BPV Registration requirements. All components installed in systems shall be rated for scheduled temperatures and pressures.

.2 Products to have CRN registration numbers.

2.2 MEDIUM PRESSURE PIPING

.1 Applications:

.1 Building Chilled Water.

.2 Building Condenser Water.

.2 Piping:

.1 To ASTM A53/A53M, Grade B.

.2 DN 15 to DN 50: Schedule 40, seamless, screwed ends.

.3 DN 65 to DN 250: Schedule 40, Seamless or ERW, bevel ends.

.4 DN 300 and over: 9.6 mm wall thickness, seamless or ERW, bevel ends.

.3 Pipe Joints:

.1 DN 50 and under: screwed fittings with PTFE tape or lead-free pipe dope.

.2 DN 65 and over: welded fittings and flanges to CSA W48.

.4 Fittings:

.1 DN 15 to DN 50: Class 3000, 20 MPa forged steel, screwed ends, to ASTM A105/A105M.

.2 DN 65 to DN 250: Schedule 40, seamless or ERW, bevel ends, to ASTM A234/A234M, Grade WPB.

.3 DN 300 and over: 9.6 mm wall thickness, seamless or ERW, bevel ends, to ASTM A234/A234M, Grade WPB.

.5 Unions:

.1 DN 15 to DN 50: Class 3000, 20 MPa forged steel, screwed ends, steel-to-steel ground joints, to ASTM A105/A105M.

.6 Flanges:

.1 DN 65 and over: Class 150, raised face, bored to match pipe, slip on, to ASTM A105/A105M.

.7 Gaskets:

.1 1.6 mm thick, rated for pressure, temperature, and fluid of system.

.8 Couplings, Caps, Plugs:

.1 DN 15 to DN 50: Class 3000, 20 MPa forged steel, screwed ends, to ASTM A105/A105M, dimensions as per ANSI/ASME B16.11.

.9 Nipples for drains, vents, pressure gauges, similar items:

.1 DN 15 to DN 50: Schedule 40, seamless or ERW, screwed ends, to ASTM A53/A53M, Grade B.

.10 Studs, Bolts and Nuts:

.1 Alloy steel studs and bolts, to ASTM A193/A193M, Grade B7, with semi-finished heavy hex head nuts, to ASTM A194/A194M, Grade 2H.

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01– Common Work Results for Mechanical, supplemented as noted herein.

3.2 PIPING INSTALLATION

.1 Install pipework in accordance with Section 23 05 15 – Common Installation Requirements for HVAC Pipework.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 – Common Work Results for Mechanical.

.2 Section 23 05 15 – Common Installation Requirements for HVAC Pipework

.3 Section 23 05 16 – Expansions Fittings and Loops for HVAC Piping.

.4 Section 23 21 13.02 – Hydronic Systems: Steel.

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME Boiler and Pressure Vessel Code (BPVC), Section VIII-2019.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Prior to commencement of new work, submit the following information in accordance with Section 21 05 01 – Common Work Results for Mechanical:

.1 Product Data, for:

.1 Air vents.

.2 Circuit balancing valves.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 21 05 01 – Common Work Results for Mechanical.

.2 Submit O&M data as part of O&M manual for:

.1 Air vents.

.2 Circuit balancing valves.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 21 05 01 – Common Work Results for Mechanical.

.2 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.3 Store and protect hydronic specialties from nicks, scratches, and blemishes.

.4 Replace defective or damaged materials with new.

Part 2 Products

2.1 GENERAL

.1 Refer to Section 23 21 13.02 – Hydronic Systems: Steel for operating pressures, temperatures, and ASME/ANSI Codes of Construction.

2.2 EXPANSION JOINTS

.1 Refer to Section 23 05 16 – Expansions Fittings and Loops for HVAC Piping.

2.3 CIRCUIT BALANCING VALVES

.1 General: each valve shall have two 6mmφ NPT brass metering ports with check valves and gasketed caps located on both sides of the valve seat. Two additional 6mmø NPT connections with brass plugs provided on opposite side of metering ports for use as a drain connection. “Y” pattern, modified, equal percentage glove valve.

.1 50mmø and under: bronze body, threaded.

.2 Over 50mmø: cast iron body, bronze disc, EPDM seat, Buna N “O” rings.

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 01 – Common Work Results for Mechanical, supplemented as noted herein.

3.2 GENERAL

.1 Run drain lines and blow off connections to terminate above nearest drain.

.2 Maintain adequate clearance to permit service and maintenance.

.3 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.

.4 Check shop drawings for conformance of tappings for ancillaries and for equipment operating weights.

3.3 AIR VENTS

.1 In accordance with Section 23 05 15 – Common Installation Requirements for HVAC Pipework.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 23 07 16 – HVAC Equipment Insulation

.2 Section 23 21 16 – Hydronic Piping Specialties

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME):

.1 ASME BPVC Section VIII Div. 1 - Pressure Vessels.

.2 Air-Conditioning, Heating and Refrigeration Institute (AHRI)

.1 AHRI-550/590-2018, Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle.

.3 ASTM International (ASTM)

.1 ASTM C547-19, Standard Specification for Mineral Fiber Pipe Insulation.

.4 CSA Group (CSA)

.1 CSA B52-18, Mechanical Refrigeration Code.

.5 The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

.1 ANSI/ASHRAE STANDARD 15, Safety Standard for Refrigeration Systems.

.6 Environment Canada/Environmental Protection Services (EPS)

.1 EPS 1/RA/2-1996, Environmental Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit the following for work of this section in accordance with Section 21 05 00 – Common Work Results for Mechanical:

.1 Shop drawings.

.2 This project is for existing chiller replacement. Contractor shall field verify the existing conditions including available space/clearances, pipe connection configurations, and isolation valves' location etc. prior to shop drawing submission.

1.4 CLOSEOUT SUBMITTALS

.1 Submit the following for work of this section in accordance with Section 21 05 00 – Common Work Results for Mechanical:

.1 Operation data.

.2 Maintenance data.

Part 2 Products

2.1 GENERAL

.1 Provide complete packaged unit including: centrifugal compressor; evaporator; water cooled condenser; motor and motor starters; controls; control centre; piping; wiring; refrigeration and oil charge; mounted on isolated steel base ready for connection to system chilled water piping; condenser cooling water; external control circuitry and electrical power source.

.2 The unit shall be water-cooled centrifugal magnetic bearing frictionless chiller operate on HFC-134a refrigerant only. No other refrigerants shall be accepted. Units shall be Canadian UL listed and is constructed to readily receive drop-in replacement refrigerants such as R-513A (A1).

.3 Construction and ratings shall be in accordance with the latest AHRI Standard 550, ANSI/ASHRAE 15, CSA B52 and ASME.

.4 The unit shall be assembled on a rugged steel base and shall be shipped with a full operating charge of refrigerant and oil.

.5 The chiller shall be completely run tested at the factory. All operations, safeties and starter functions shall be checked. The manufacturer shall provide documentation indicating the chiller was factory tested.

.6 Chiller shall be able to turn down to 17.5% of its capacity with AHRI ambient relief and shall be able to turn down to 25% of its capacity with a constant entering condenser water of 29.4 °C (85 °F).

2.2 CAPACITY

.1 Certified ratings based on AHRI 550:

.1 Capacity: as per equipment schedule on drawing.

.2 Power input, including compressor motor, purge compressor motor, oil pump motor, oil heater power and control centre power: 575/3/60.

.3 Fouling resistance coefficient: 0.000045 m^2K/W

.4 Refrigerant: R134A.

2.3 COMPRESSORS

.1 Oil-free, magnetic bearing, semi-hermetic centrifugal compressors. Impellers shall be mounted on a single shaft, levitated during rotation by a digitally controlled, magnetic bearing system consisting of two radial and one axial magnetic bearing.

.2 Centrifugal compressor statically and dynamically balanced, motor-gear-compressor assembly balanced to vibration levels less than one mil at operating speed.

.3 Designed for no-load start, automatic capacity control through electric operation of variable speed compressor and inlet vanes, providing modulation capability from 10 to 100% of full load as per AHRI 550.

.4 The chiller shall be equipped with an integrated Variable Frequency Drive (VFD) to automatically regulate compressor speed in response to cooling load and the compressor pressure lift requirement. Movable inlet guide vanes and variable compressor speed shall

provide unloading. The chiller controls shall coordinate compressor speed and guide vane position to optimize chiller efficiency.

.5 VFD shall be refrigerant cooled. Manufacturers of condenser water cooled VFD's must include two sets of water filters with a bypass valve and a pressure differential switch factory wired to the chiller control panel which shall generate an alarm when service is required. Provide a separate dry contact to alert BAS of filter service requirement. Condenser cooling circuits with intermediate heat exchangers must be provided with shell and tube serviceable heat exchangers, Brazed plate will not be accepted.

.6 Each compressor circuit shall be equipped with a line reactor to help protect against incoming power surges and help reduce harmonic distortion.

.7 On dual compressor units, the evaporator and condenser refrigerant sides, and the expansion valve shall be common. The chiller shall be capable of running on one compressor with the other compressor or any of its auxiliaries inoperable or removed. Single compressor chillers will be accepted in lieu of dual compressor chillers providing two (2) complete package single compressor chillers are provided for every dual compressor chiller, including duplicate pumps. Each single compressor chiller shall produce one half of the tonnage of a dual compressor chiller.

2.4 COMPRESSOR MOTOR

.1 The motor shall be liquid refrigerant cooled with internal thermal sensing devices in the stator windings and be equipped with an integrated Variable Frequency Drive (VFD) to automatically regulate compressor speed.

2.5 EVAPORATOR AND CONDENSER

.1 Labelling: to ASME, CSA B52 and provincial requirements. Provide CRN number for each shell.

.2 Horizontal steel shell and finned copper tubes with steel intermediate supports and tube sheets.

.1 Removable water boxes with flange connection permitting individual tube cleaning and removal.

.3 Distribution and baffles arranged to prevent direct high velocity impingement on tubes and uniform heat exchange through whole of heat exchanger surface.

.4 Evaporator condenser and water boxes shall be designed for 1 1/2 times working pressure but not less than 1 MPa (150 PSI) on water side.

.1 Design refrigerant side for working pressure suitable for refrigerant used and leak tested using refrigerant trace gas.

.5 Provide an electronic or thermal expansion valve to meter refrigerant flow and to provide stable operation at low loads. Superheat shall be maintained at or below 0.55°C under all load conditions.

.6 Complete evaporator water circuit shall be rated at 1034 kPag. Complete condenser water circuit shall be rated at 1034 kPag.

.7 Provide 40mm thick vinyl nitrate polymer insulation factory applied to evaporator, non-connection water head, suction piping, compressor inlet, motor housing and motor

coolant suction line. Factory paint all insulation with a resilient epoxy finish. Evaporator connection water box shall be field insulated by the contractor after pipe connections have been made.

.8 Provide thermal-dispersion flow switches for the chilled water and condenser water circuits.

2.6 PURGE UNIT

.1 Equip chillers with high efficiency purge units to automatically remove non-condensable and water vapour and return refrigerant pass-through.

.1 Unit to be factory mounted, piped and wired.

.2 Vent in accordance with CSA B52.

.2 Unit to emit no more than 0.8 kg of refrigerant per kg of air consistently across chiller load ranges.

2.7 PRESSURIZATION DEVICE

.1 Equip chillers with device to achieve chiller pressurization on demand in 3 hours, when chiller is not operating, by circulating heated water between chilled water inlet and outlet of evaporator, increasing pressure in evaporator to 35 kPa.

2.8 REFRIGERANT PIPING

.1 Refrigerant piping, valves, fittings and related parts: to CSA B52 include:

.1 Thermal expansion valve.

.2 Suction and discharge regulators.

.3 Combination filter/dryer complete with replaceable core .

.4 Solenoid stop valves.

.5 Liquid sight glasses complete with moisture indicator.

.6 High side pressure relief device.

.2 Comply with requirements of EPS 1/RA/2.

2.9 SOUND

.1 Do not exceed sound pressure levels as indicated below. All sound testing must be in accordance with ARI Standard 575 "Method of Measuring Machinery Sound Within Equipment Rooms".

Octave Band

63	125	250	500	1000	2000	4000	8000	dba
37.5	51.5	59.5	72	75	72.5	76.5	75	81.5

2.10 CONTROL PANEL

.1 Provide a unit mounted, factory prewired DDC microprocessor-based control system with super VGA colour monitor with touch screen data entry. Control system shall have all necessary temperature and pressure sensors factory mounted and wired. Temperature

sensors shall be mounted in factory installed wells. Password security shall prevent access by unauthorized personnel.

.2 To EEMAC standard and include:

.1 Safety controls with cutout, indicator lights and manual reset and contacts for an alarm to include:

.1 High condenser pressure.

.2 Low oil pressure.

.3 High oil temperature.

.4 High hermetic motor temperature.

.5 High discharge temperature.

.6 Motor over current.

.7 Low evaporator temperature.

.2 Alarm for refrigerant leakage.

.3 The following operating data shall be displayed:

1. Entering and leaving, chilled and condenser (and heat recovery) water temperatures.
2. Evaporator, suction, discharge, condensing and liquid refrigerant temperatures.
3. Evaporator, condenser and lift pressure.
4. Actual motor amps and motor amps as a percent of RLA.
5. Oil feed and sump temperature. Oil pressure (N/A with magnetic bearing machine)
6. Total hours of operation and number of starts.
7. Hours since last start.
8. Unit Status including Start-up and shut-down sequence, and Operational status.
9. Ent. water reset Off/On.
10. Remote reset Off/On.
11. Soft loading Off/On (N/A with magnetic bearing machine)
12. Low pressure unloading Off/On.
13. Max. AMP limit Off/On.
14. Remote AMP limit Off/On.
15. Manual AMP limit.
16. Leaving evaporator setpoint.
17. Reset leaving setpoint.
18. Remote reset signal.
19. Fault history (last 25 faults) with time and related operating conditions.
20. Critical sensor values at time of fault.
21. Trend log data in graphic format.

.4 The following alarm conditions shall be monitored and displayed:

1. No starter transition.
2. Low/High oil sump temperature (N/A with magnetic bearing machine)
3. Low evaporator pressure.

4. High discharge pressure/temperature.
5. Compressor surge.
6. Low refrigerant charge.
7. No evaporator/condenser flow.
8. Low oil pressure. (N/A with magnetic bearing machine)
9. High motor current.
10. Sensor failure.

.5 The microprocessor shall employ P.I. control algorithms to ensure precise leaving water temperature control without hunting, drooping or overshooting the setpoint.

.6 The microprocessor shall have the option of limiting the amp draw to a user-selected value from 30 to 100% of rated load amps. The controller shall use a softload function to prevent the chiller from operating at full load during initial pull down.

.7 The microprocessor shall have the option of resetting the chilled water setpoint and demand limiting from 4-20mA remote signals. In addition, the chilled water setpoint shall be resettable by return water temperature if so programmed. The control panel shall be capable starting the chiller from a remote signal.

.8 The microprocessor shall include Surge Guard protection. Upon recognition of a surge situation the controller shall shutdown the chiller and announce an alarm condition.

.9 Chiller plant optimization software for up to 2 chillers shall also be included to provide automatic control of: evaporator and condenser pumps (primary and standby), up to 3 stages of cooling tower fans and a cooling tower modulating bypass valve and/or cooling tower fan variable frequency drives. There shall be five possible tower control strategies:

1. Tower fan staging only – up to 3 stages controlled by either the entering condenser water temperature or lift differential temperature between the condenser and evaporator saturated temperatures.
2. Tower fan staging plus low limit - controlled as in # 1 plus tower bypass valve set at a minimum entering condenser water temperature
3. Tower staging with staged bypass control – similar to # 2 with additional control of the bypass valve between fan staging to smooth control and minimize fan staging.
4. VFD staging only – in this mode, a variable speed drive controls the first fan with up to 3 more fans to be staged on and off and there is no bypass valve.
5. VFD and Valve Staging – same as # 4 plus bypass valve control

.10 The microprocessor shall include a time clock for chiller operation including programmable holiday schedule to override weekly schedule. Provide manual override time period.

.11 Provide for auto-restart after a power failure. Microprocessor memory shall be non-volatile requiring no battery back-up while maintaining programmed data during an extended shut down or power failure.

.12 Input/Output boards shall be optically isolated to prevent transients or incorrect voltage from entering the microprocessors. All field wiring shall terminate at a separate terminal strip.

.13 The microprocessor shall have an auto-logging feature that will automatically log chiller functions at time of daily peak load or at present time and store up to six weeks of accumulated data. Data shall be downloadable via on board floppy drive.

.14 The microprocessor shall have pre-alarm logic for high and low pressure controls. Logic shall take corrective action to avoid an alarm trip. The unit shall display pre-alarm warnings for low and high superheat, low oil temperature and high oil temperature.

.15 The microprocessor shall inhibit loading and activate unloading to control low evaporator pressure conditions.

.16 The centrifugal chiller shall be factory installed with a microprocessor based DDC controller capable of communications with Building Automation System or Temperature Control Company via LonMark, BACnet MS/TP, BACnet IP or Modbus protocols.

2.11 ACCESSORIES

.1 Provide thermometer wells for liquid refrigerant condensing and evaporating temperatures.

.2 Sight glasses for monitoring refrigerant change level, and oil change level and compressor rotation.

.3 Provide control devices (flow switch and/or temperature sensors) as required for chiller control panel operation for field installation.

2.12 REFRIGERANT ALARM PANELS

.1 The refrigerant monitoring system shall be comprised of three main components: one main control panel, a minimum of one remote alarm panel, and a minimum of one remote alarm sensor. The main panel shall be located inside the machinery room near the main entrance. The remote panel(s) shall be located outside of each entranceway to the machinery room.

.2 Alarm panels shall be equipped with a visual flashing amber beacon, audible buzzer and a user interface touch screen display. The display on the main panel shall have a full color 6 inch screen. Remote panels shall be complete with a monochrome 4 inch display. Keypad menu entry touch keys shall also be provided for quick access to panel configuration settings and also to silence audible alarms.

.3 The following menus shall be accessible via the touch screen displays:

.1 System configuration

.2 Diagnostic information

.3 Alarm setup

.4 Sensor setup

.5 System test

.4 The monitoring panel shall allow for two alarm settings. A low level alarm shall warn (flashing yellow screen) that refrigerant gas has been detected but the room is still at a safe level. The screen shall display the gas ppm concentration. A high level alarm shall automatically activate audio / visual alarms, and initiate mechanical ventilation. Three high level alarm relays shall be provided for customer interlocks; boiler alarm, fan relay and chiller relay.

.5 All panels shall also include Ventilation ON and Chiller OFF switches. Switches shall be password protected on all remote panels.

.6 The refrigerant sensor shall use non-dispersive infrared technology to selectively target the refrigerant gas. Sensor shall continuously monitor the air and must send a signal proportional to the refrigerant ppm concentration, back to the main control panel. Sensor shall have a life expectancy of 10 years.

.7 Control panel relay outputs shall be configurable for Failsafe or Non-Failsafe modes of operation.

.8 The master panel shall be powered from a 120 volt circuit. The remote panel and refrigerant sensor(s) shall be powered through this master panel.

.9 Provide R134a refrigerant sensor(s) mounted in close proximity to the chillers and wired to the master panel. The refrigerant sensor shall be calibrated to detect refrigerant levels equal to or less than the TLV-TWA for the refrigerant used. The alarm system shall be activated when the refrigerant concentration in the MER equals the TLV-TWA for the refrigerant used.

.10 The Refrigerant monitoring system shall meet the requirements of CSA - B52 Mechanical Refrigeration Safety Code (latest version).

2.13 OPERATING ENGINEERS ACT

.1 Chiller to meet provincial standards and to be exempt from Operating Engineers Act of TSSA.

Part 3 Execution

3.1 PERFORMANCE OF WORK

.1 Perform work in accordance with Section 21 05 00 – Common Work Results for Mechanical, supplemented as noted herein.

3.2 STARTUP SERVICE AND WARRANTY

.1 Manufacturer shall furnish a factory trained service technician to perform the leak testing, evacuation, dehydration, charging and start-up of the unit. Units that are factory charged or shipped with a refrigerant holding charge shall not require field evacuation and dehydration. Manufacturer shall provide instruction of the Departmental Representative's personnel on the operation and maintenance of the unit.

.2 The warranty period shall commence at the date of initial start-up and shall continue according to PSPC GC3.13. Manufacturer's warranty shall include all parts and labour to install parts. Refrigerant shall not be included in the warranty.

.3 Provide a complete one-year Preventative Maintenance program including spring start-up, winter shutdown and five monthly inspections during the warranty period. All work shall be performed by factory-trained mechanics. Preventative Maintenance work shall include, but not be limited to, the following items: Operator log review; Purge unit overhaul (once per year, low pressure chiller only); Leak check and repair of leaks; Check and adjustment of gauges, switches, lights, electrical connections, safety controls; Inspection of starter; Check and adjustment of oil pressure regulator, water regulator and

hot bypass valve; Check and adjustment of refrigerant level (add if necessary), water flows, refrigerant temperatures; Clean condenser tubes at end of operating season; Provide free emergency service (2 hour maximum per call) to diagnose trouble, adjust controls and do minor repairs. Major repairs shall be done during regular working hours. The following items are specifically not to be included as part of the Preventative Maintenance program: Thermographic analysis; Dielectric absorption test; Refrigerant and oil analysis.

3.3 INSTALLATION

.1 Provide appropriate protection apparatus.

.2 Install unit as indicated, to manufacturer's recommendations, and in accordance with EPS1/RA/2.

.3 Ensure adequate clearances for servicing and maintenance.

.4 Install units on a flat surface level within 3.2 mm and of sufficient strength to support concentrated loading with isolation spring assemblies under the units.

.5 Provide components furnished as per manufacturer's literature.

.6 Provide all water piping so centrifugal units and water circuits are serviceable, without having to dismantle excessive lengths of pipe.

.7 Provide valves in water piping upstream and downstream of the evaporator and condenser water boxes for isolating the shells for maintenance and to balance and trim the system.

.8 Provide drain valves and vent cocks to each water box.

.9 Provide all necessary auxiliary water piping for oil cooler in accordance with the manufacturer's recommendations.

.10 Provide pressure relief piping from relief valve to outside in accordance with manufacturer's instructions and CSA-B52-1992. Provide flexible connections between relief valve and relief piping.

.11 Provide certified wiring schematics to the electrical division for the chiller, associated equipment and controls.

.12 Provide all necessary control wiring as recommended by the manufacturer.

.13 Provide vapour proof flow switches in both chilled and condenser water piping interlocked to the control panel.

.14 Manufacturer to approve installation, to supervise start up and to instruct operators.

.1 Include 3 days minimum per unit.

END OF SECTION