HHAngus

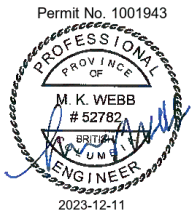
Mechanical Specifications

FOR

Residential Cooling Upgrade

Fort St. John Hospital

8407 112 Avenue
Fort St. John, BC.
VCJ 0J5



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MECHANICAL GENERAL REQUIREMENTS
20 01 01

1 GENERAL

1.1 General Contract Documents

.1 Comply with General Conditions of Contract, Supplementary Conditions and Division 1 - General Requirements.

1.2 Work Included

.1 Work to be done under Divisions 20, 21, 22, 23 and 25 to include furnishing of labour, materials and equipment required for installation, testing and putting into proper operation complete mechanical systems as shown, as specified, as intended, and as otherwise required. Complete systems to be left ready for continuous and efficient satisfactory operation.

1.3 Document Organization

.1 Applicable Divisions for Mechanical Work:

.1 Division 20 - Common Work for Mechanical

.2 Division 22 - Plumbing and Drainage

.3 Division 23 - Heating, Ventilation and Air Conditioning (HVAC)

.4 Division 25 - Building Automation System

.2 For clarity, any reference in the Contract Documents to Division 20 includes Divisions 21, 22, 23 and 25.

.3 The Specifications for these Divisions are arranged in Sections for convenience. It is not intended to recognize, set or define limits to any subcontract or to restrict Contractor in letting subcontracts.

.4 Contractor is responsible for completion of work whether or not portions are sublet.

1.4 Division 20, as it applies to Divisions 22, 23 and 25

.1 Articles that are of a general nature, applicable to each Section of these Divisions.

.2 Articles specifying materials, equipment, installation techniques and workmanship that are applicable to more than one Section of these Divisions.

.3 Articles that are to be read in context with and form part of relevant Sections of these Divisions.

1.5 Definitions

.1 The words "indicated", "shown", "noted", "listed" or similar words or phrases used in this Specification, mean that material or item referred to is "indicated", "shown", "listed" or "noted" on Drawings or in Specification.

.2 The words "approved", "satisfactory", "as directed", "submit", "permitted", "inspected", or similar words or phrases used in this Specification, mean that material or item referred to is to be "approved by", "satisfactory to", "as directed by", "submitted to", "permitted by", "inspected by", Engineer.

.3 Instructions using any form of word "provide" involves Contractor in furnishing labour, materials and services to supply and install referenced item.

1.6 Language

.1 The specification is written as a series of instructions addressed to the Contractor, and by implication to subcontractors and to suppliers. For clarity and brevity, use is made of numbered lists and bulleted lists. Where list follows a semi-colon (;) the punctuation is for clarity. Where a list follows a colon (:) the punctuation is to be read as a short-hand form of the verb “to be” or “to have” as context requires.

.2 It is not intended to debate with the Contractor the reasons for these instructions, and words associated with justification for an instruction or restatement of anticipated performance have been omitted to avoid possible ambiguities.

1.7 Examination

.1 Examine any existing buildings, local conditions, building site, Specifications, and Drawings and report any condition, defect or interference that would prevent execution of the work.

.2 No allowance will be made for any expense incurred through failure to make these examinations of the site and the documents prior to Tender or on account of any conditions on site or any growth or item existing there which was visible or known to exist at time of Tender.

.3 Examine work of other Divisions before commencing this work, and report any defect or interference.

1.8 Design Services

.1 Provide design services for elements of the Work where specified in other sections of Division 20, sealed by a professional engineer licensed in the applicable jurisdiction.

1.9 Standard of Material and Equipment

.1 Materials and equipment:

.1 new and of uniform pattern throughout work,

.2 of Canadian manufacture where obtainable,

.3 standard products of approved manufacture.

.4 labeled or listed as required by Code and/or Inspection Authorities,

.5 registered in accordance with the requirements of TSSA Boilers and Pressure Vessels Safety Division Guidelines for the Registration of Non-nuclear Fittings in the Province of British Columbia,

.6 in compliance with Standards and Regulations with respect to;

(a) chemical and physical properties of materials,
(b) design,
(c) performance characteristics, and
(d) methods of construction and installation.

.7 identical units of equipment to be of same manufacture.

.8 identical component parts of same manufacture in similar units of equipment, but various component parts of each unit need not be from one manufacturer.

.2 Materials and equipment are described to establish standards of construction and workmanship.

.1 Where manufacturers or manufacturers' products are identified in lists with the phrase "Standard of Acceptance", these are manufacturers and/or products which meet required standards with regard to performance, quality of material and workmanship.

.2 Manufacturers and or products used are to be chosen from these lists.

.3 Select materials and equipment in accordance with manufacturer's recommendations and install in accordance with manufacturer's instructions.

.4 Materials and equipment not satisfying these selection criteria will be condemned.

.5 Remove condemned materials from job site and provide properly selected and approved materials.

1.10 Substitutions

.1 Comply with specification section 01 25 13

1.11 Owner's Special Requirements for existing sites

.1 Provide a written list of names for employees and sub-trades entering the building, advising which areas they need access to at least 48 hours prior to expected time of arrival. This lead time is required to prearrange security passes.

.2 Security Passes must be visibly worn at all times by all employees.

.3 All trades people must strictly adhere to Building Security regulations or entrance into the building will be denied.

.4 All trades people are to enter the entrance identified by the Owner. Vehicles are to be parked in proper designated areas. Driveways are not to be blocked.

.5 Freight elevator must be used at all times to transport tools and material. Freight elevator door must be shut immediately after exiting the cab.

.6 Under no circumstances are any electrical or mechanical systems to be disabled or activated without prior knowledge and approval by the Owner's Project Manager. Prior to disabling or activation of any electrical or mechanical systems, Building Operations and Building Security must also provide approval.

.7 Prior notification must be forwarded to Building Security Staff before any construction activity can start which will result in heat, smoke, dust or fumes, such as sawcutting, soldering, spray painting, which can affect the sensitive fire protection equipment.

.8 Schedule work and meet the sub-trades daily on site, showing all trades people the work areas and work to be done.

.9 Trades-people are to supply and use their own tools. No tools, ladders or equipment, etc. will be loaned by the Owner.

.10 Contractor is responsible for all associated environmental cleaning to the job site, daily during construction and upon completion. This includes both under raised floor and above ceiling. No materials or garbage will be permitted to be stored on the loading dock.

.11 Special care and attention must be adhered to at all times when transporting equipment and materials to prevent accidental damage to the fire protection equipment and all furnishings and fixtures.

.12 "No Smoking" - smoke free building. Violators will be denied entry. Smoking is not allowed on the roof.

.13 If Building Operations deems that work on a particular system requires security escort, allow 48 hours to make appropriate arrangements.

.14 For any fire system isolation requests, allow for 24 hours notification to Building Operations.

.15 For any open flame work, a fire extinguisher and security fire watch is required, and will be provided and paid for by Owner. Provide 24 hour notice prior to work to allow Owner to make necessary arrangements.

.16 Storage of materials on site must be cleared through the Building Manager.

.17 Contractors must perform a daily cleanup prior to leaving the site.

.18 Oxygen and acetylene cylinders are to be secured at all times and capped nightly.

.19 Work performed on operating and redundant systems must be restored to their normal condition at the end of each work day unless otherwise approved by the Owner.

.20 At the conclusion of each work day, the Contractor's superintendent is to advise the Building Manager on the day's activities and plans for the next day's work. A security escort will be required for any work being done in secured areas, e.g. raised floor, computer room and mechanical/electrical rooms.

.21 Contractors and contractors sub consultants must wear masks while performing works within the HCF. Contractors to setup covid screens within the HCF if working in an area for an extend length of time. If the contractors or subtrades are working in an are of the long term care facility with vulnerable patients they must be supervised by a member of staff.

2 SUBMITTALS

2.1 Shop Drawings and Product Data Sheets

.1 Submit shop drawings, manufacturers and product data and samples in accordance with Section 01 33 05.

.1 Submit shop drawings in the same unit of measure as are used on the drawings. Both metric and imperial measures may be included.

.2 Submitted shop drawings by email to: shopdrawings@hhangus.com

.2 Include a H.H. Angus shop drawing cover sheet form prepared for this project, for each shop drawing, or, include the same information on the general or trade contractor's submittal cover sheet:

.1 Information required on each submission:

(a) Client/Architect name
(b) Project Name
(c) H.H. Angus project number
(d) Date
(e) Contractor name
(f) Contractor reference no.
(g) Manufacturer name
(h) Product type
(i) Specification section number
(j) Contractor trade: mechanical, electrical, elevators, or general trades

(k) If a re-submission, the previous submission H.H. Angus reference number.

.3 Submit shop drawings in PDF format;

.1 If submitted in hardcopy format, submit in 8.5 x 11 or 11 x 17 size, black and white originals of graphic quality suitable for photocopying. Allow one additional week for processing of shop drawings submitted in hardcopy format.

.2 for each item of equipment in following list;

(a) plumbing fixtures,
(b) pumps,
(c) air moving units,
(d) heating units,
(e) coils,
(f) motor controls centers
(g) motor starters, and
(h) special systems.

.4 Manufacturer's letter sized printed data sheets, as black and white originals of graphic quality suitable for photocopying, are acceptable in place of shop drawings for standard production items.

.5 Submit with manufacturers data sheets, typed schedules listing manufacturer's and supplier's name and catalogue model number for;

(a) valves,
(b) traps,
(c) expansion joints,
(d) pipe hangers

.6 For plumbing fixtures, submit fixture cuts with catalogue numbers for fixtures to be used on job. Identify and arrange fixture cuts in same sequence as specification fixture list.

.7 Shop drawings and product data to show;

(a) dimensioned outlines of equipment
(b) dimensioned details showing service connection points.
(c) elevations illustrating locations of visible equipment such as gauges, pilot lights, breakers and their trip settings, windows, meters, access doors.
(d) description of operation.
(e) single line diagrams.
(f) general routing of bus ducts and connecting services.
(g) mounting and fixing arrangements.
(h) operating and maintenance clearances, and
(i) access door swing spaces.

.8 Shop drawings and product data to be accompanied by;

(a) detailed drawings of bases, supports and anchor bolts,
(b) sound power data, where applicable, and
(c) performance curve for each piece of equipment marked with point of operation.

.9 Shop drawing and data sheet submission is taken as certification;

.1 that units are from Manufacturer's current production and

.2 in compliance with applicable Codes, Standards, and Regulations.

.10 Do not submit drawings showing internal construction details, component assemblies or interior piping and wiring diagrams. These may be necessary to understand correct functioning of equipment and should be submitted with operating and maintenance data.

.11 Check and stamp each shop drawing as being correct before submission. Shop drawings without such stamps will be rejected and returned.

.12 Keep one copy of each reviewed shop drawing and product data sheet on site available for reference purposes.

.13 Where equipment is delivered without reviewed shop drawing available on site, equipment will be condemned and is to be removed from site and replaced with new equipment after shop drawing has been submitted and reviewed.

2.2 Field, Fabrication, or Installation Drawings

.1 Contractor field, fabrication, installation, and/or sleeving drawings will not be reviewed as shop drawings. If submitted as a shop drawing, a transmittal only will be returned identifying the submitted drawings have not been reviewed.

.2 Maintain a copy on site of such drawings for reference by the Consultant.

.3 Provide a copy of such drawings to the Consultant for general information purpose only, upon request.

3 REFERENCE CODES STANDARDS AND REGULATIONS

3.1 Codes, Standards and Regulations

.1 Latest current versions in force at time of Tender.

.2 Where relevant documents applicable to this work exist, follow these criterion, recommendations, and requirements as minimum standards.

.3 In event of conflict between codes, regulations, or standards, or where work shown is in conflict with these documents, obtain interpretation before proceeding. Failure to clarify any ambiguity will result in an interpretation requiring application of most demanding requirements.

3.2 Permits, Tests and Certificates

.1 Arrange and pay for permits, tests, and Certificates of Inspection required by Authorities having jurisdiction.

.2 Submit applications requiring Owner's signature before commencing work.

.3 Obtain and submit Inspection Certificates for

(a) Electrical Inspection.
(b) Plumbing Inspection.

.4 Certificates to be renewed as to remain in force for guarantee period.

.5 Co-ordinate and perform testing required by Authorities having jurisdiction in accordance with Clause **TESTING** in this Section

4 EQUIPMENT

4.1 Manufacturers Nameplates

.1 Metal nameplate with raised or recessed lettering, mounted on each piece of equipment.

.2 On insulated equipment, mechanically fasten plates on metal stand-off bracket arranged to clear insulation and mount Underwriters Laboratories and/or CSA registration plates on same stand-off brackets.

.3 Manufacturer's nameplate to indicate equipment size, capacity, model designation, manufacturer's name, serial number, voltage, cycle, phase and power rating of motors, and approval listings.

4.2 Factory Applied Prime Painting

.1 Have prime paint factory applied to other equipment fabricated from iron or steel including access doors, registers, grilles, diffusers, dampers, metal radiation enclosures and fire hose cabinets.

4.3 Field Painting

.1 After equipment has been installed and piping and insulation is completed, clean rust and oil from exposed iron and steel work provided under this Division, whether or not it has been factory prime painted.

.2 In "occupied" areas of building touch up any damage to prime coat resulting from shipping or installation and leave ready for final painting under Finishes, Division 9.

.3 In "un-occupied" areas of the building such as mechanical equipment rooms, boiler rooms, fan rooms, crawl spaces, pipe tunnels and penthouses:

.1 paint exposed galvanized metal surfaces with one coat of zinc dust galvanized primer and one coat of 100% Alkyd base enamel in an approved colour; and

.2 paint exposed iron or steel work with one coat of chrome oxide phenolic base primer and one coat of 100% Alkyd base enamel in an approved colour.

.4 In "Unoccupied " areas of the building such as mechanical equipment rooms, boiler rooms, fan rooms, crawl spaces, pipe tunnels and penthouses, touch up any damage to prime coat resulting from shipping or installation and leave ready for final painting by Owner's forces.

4.4 Pre-purchased Equipment Damage and Ownership

.1 At time of receipt of pre-purchased or pre-tendered equipment at job site by the installing mechanical contractor, the manufacturer/Distributor/supplier technical representative to be present to inspect the equipment prior to unloading and report any damage to the Consultant. The technical representative to also witness the unloading and advise the contractor on the appropriate method for handling the equipment in order to avoid damage during the unloading, moving and setting in place phase of the equipment.

.2 In the event the equipment has been found to be damaged before unloading it is to be returned immediately to the factory for repairs and/or replacement by the manufacturer/supplier.

.3 In the event of damage occurring at any time during unloading and until the equipment is accepted by the Owner, the installing contractor is responsible for repairs and/or replacement to the satisfaction of the Owner.

5 COORDINATION

5.1 General

.1 Consultant drawings are diagrammatic and illustrate the general location of equipment, and intended routing of ductwork, piping, etc. and do not show every structural detail. In congested areas drawings at greater scale may be provided to improve interpretation of the Work. Where equipment or systems are shown as “double line”, they are done so either to improve understanding of the Work, or simply as a result of the use of a CAD drawing tool, and in either case such drawings are not represented as fabrication or installation drawings.

.2 Lay out and coordinate Work to avoid conflict with work under other Divisions.

.3 Make good damage to Owner's property or to other trade's work caused by inaccurate layout or careless performance of work of this Division.

.4 When equipment provided under other Sections connects with material or equipment supplied under this Section, confirm capacity and ratings of equipment being provided.

.5 Take information involving accurate measurements from dimensioned Architectural Drawings or at building.

.6 Install services and equipment which are to be concealed, close to building structure so that furring is kept to minimum dimensions.

.7 Location of pipes, ductwork, raceways and equipment may be altered without extra cost provided instruction is given or approval is obtained, in advance of installation of items involved. Changes will be authorized by site instructions and are to be shown on Record Drawings.

.8 Location of floor drains, hub drains, combination drains, plumbing fixtures, convectors, unit heaters, diffuser, registers grilles and other similar items may be altered without extra cost provided instruction is given prior to roughing in. No claim will be paid for extra labour and materials for relocating items up to 3 m (10 ft) from original location nor will credits be anticipated where relocation up to 3 m (10 ft) reduces material and labour.

.9 Include incidental material and equipment not specifically noted on Drawings or mentioned in Specifications but which is needed to complete the work as an operating installation.

.10 Contractor to submit a coordination drawing of the new coil in the existing air handling unit. Submittal is to be submitted as a shop drawing and will be used to verify the compatibility of the new coils and existing air handling units.

5.2 Field, Fabrication, and Installation Drawings

.1 Prepare field, fabrication, and/or installation drawings to show location of equipment and relative position of services, and to demonstrate coordination with works of other trades.

.1 Drawing scale: minimum 1:50 (1/4"=1'-0")

.2 Use information from manufacturer's shop drawings for each trade and figured dimensions from latest Architectural and Structural Drawings.

.3 Layout equipment and services to provide access for repair and maintenance.

.4 Submit drawings to other trades involved in each area and include note in drawing title block as follows;

.1 "This drawing was prepared and circulated for review and mark-up to related subcontractors as noted and initialed in the table below. Corrections and concerns identified through this coordination process have been addressed on this drawing. Areas that incorporate significant changes from layouts shown on Contract Drawings have been circled for Consultants' review".

5.3 Cutting and Remedial Work

.1 For details of cutting and patching and Division of Work refer to Division 1.

.2 Assume responsibility for prompt installation of work in advance of concrete pouring, masonry, roofing, finishing trades and similar work. Should any cutting or repairing of either unfinished or finished work be required because such installation was not done, employ the particular trade whose work is involved to do such cutting and patching. Pay for any resulting costs. Layout such work for approval by the Structural Engineer before undertaking same.

.3 Neatly cut or frill holes required in existing construction to accommodate cable, raceways, bus duct or cabletray.

.4 Division 20 contractor to be responsible for arranging and paying for all cutting and patching as required for own work. Before cutting, drilling, or sleeving structural load bearing elements, obtain the Consultant's approval of location and methods in writing. Employ original installer or expert in the finishing of material required to perform cutting or patching for weather exposed or moisture resistant elements or sight exposed surfaces.

.1 Layout cutting of structural elements, such as floors slabs, walls, columns or beams and obtain approval before starting work. Conduct an electromagnetic scan of reinforcing rods, such as Hilti PS200 Ferroscan, and review with Structural Engineer. Based on these results, arrange and pay for supplemental x-ray examination to locate concrete reinforcement and embedments where required. Submit x-rays and obtain approval before starting work Relocate core drilling location if steel or conduit is found in the proposed location and repeat procedure. Reroute any circuits damaged by core drilling.

5.4 Anchors and Inserts

.1 Supply anchor bolts and locating templates for installation in advance of concrete pouring.

6 PROTECTION OF WORK AND PROPERTY

6.1 General

.1 Protect this work and work of other trades from damage.

.2 Cover floors with tarpaulins and provide plywood and other temporary protection.

.3 Assume responsibility for repairing damage to floor and wall surfaces resulting from failure to provide adequate protection.

.4 Protect equipment, pipe and duct openings from dirt, dust and other foreign materials.

7 WORK IN EXISTING BUILDING

7.1 General

.1 During the tender period, the Contractor shall perform a site inspection of the place of work and surroundings including the accessible ceiling spaces and other areas where access could be considered reasonable. Make a thorough investigation of As Built conditions to determine scope of renovation or demolition work required prior to submitting tender.

.2 Work includes changes to existing building and changes at junction of old and new construction. Route pipes, ducts, conduits and other services to avoid interference with existing installation.

.3 Relocate existing pipes, ducts, conduits, bus ducts and any other equipment or services required for proper installation of new work, including as required for temporary removal and re-installation to suit new installation work.

.4 Remove existing plumbing fixtures, lighting fixtures, piping, ductwork, wiring, and equipment to suit new construction. Cut back and cap drain, vent and water outlets, conduits and electrical outlets, not being used.

.5 Plumbing fixtures, piping, ductwork, conduit and wiring shown to be removed and not shown relocated, to become property of Contractor and to be taken from site.

.6 On completion of relocations, confirm relocated equipment are in proper working order.

.7 Where Owner wishes to take over renovated areas ahead of project completion date and these areas are to be fed from new distribution systems, make temporary connections to existing services in these areas. Reconnect to permanent services, at later date, when new distribution systems are available.

7.2 Continuity of Services

.1 Make connections to existing systems at approved times. Obtain written approval recording times when connections can be made. Arrange work so that physical access to existing buildings is not unduly interrupted.

.2 Be responsible for and make good any damages caused to existing systems when making connections.

.3 Keep existing buildings in operation with minimum length of shutdown periods. Include overtime work to tie-in piping or wiring at night or on weekends.

.4 AHU's must not be fully shut down for over 4 hours. Contractor can keep AHU exhaust fan on at a reduced capacity to ensure that the HCF air change rate is maintained.

8 FINAL CLEANING AND ADJUSTMENTS

8.1 General

.1 Conduct final cleaning as specified herein.

.2 Thoroughly clean exterior surface of exposed piping, and vacuum external surfaces of exposed ducts and interior surfaces of air handling units. Clean strainers in piping systems and install clean filters in air handling systems.

.3 Remove tools and waste materials on completion of work and leave work in clean and perfect condition.

.4 Calibrate components and controls and check function and sequencing of systems under operating conditions.

.5 Supply lubricating oils and packing for proper operation of equipment and systems until work has been accepted.

9 RECORD DRAWINGS

9.1 Record drawings

.1 Provide record drawings as specified herein.

.2 A set of design drawings in AutoCad on CD or DVD ROM will be provided by the Consultant. Make sets of white prints for each phase of Work, and as Work progresses and changes occur mark white prints in coloured inks to show revisions. Dimension locations of drains, pipes, ductwork, conduit, manholes, foundations and similar buried items within the building, with respect to building column centres. Mark level with respect to an elevation which will be provided.

.3 Survey information from excavation and backfill of site services to be held on site, after approval, and to be similarly transferred to white prints.

.4 Retain these drawings and make available to Consultant for periodic review.

.5 At 50%, 75% and 90% project completion, scan marked-up drawings to Adobe .pdf format and submit copy to the Consultant, or to the project on-line document service if one is used.

9.2 As-built drawings

.1 Prior to testing, balancing and adjusting, transfer site record drawing information to AutoCad (CAD) files, to record final as-built condition. Obtain a current set of CAD files from the Consultant.

.1 Drawings are to remain set to and follow Consultants AutoCad Standards. Do not alter drawing scales, X-refs, colours, layers or text styles.

.2 The Consultant's CAD files may not reflect all or any construction changes.

.2 Where items have been deleted, moved, renumbered or otherwise changed from contract drawings, revise the CAD files to record these changes. “Bubble” these revisions, and place these annotations on a separate and easily identified drawing layer.

.3 Show on mechanical as-built drawings final location of piping, ductwork, switches, starters, Motor Control Centres, thermostats, and equipment.

.4 Show on site services as-built drawings survey information provided by British Columbia Land Surveyors (ABCLS) monitoring services installation.

.5 Identify each drawing in lower right hand corner in letters at least 12 mm (½ in) high as follows "AS-BUILT DRAWINGS. This drawing has been revised to show systems as installed" (Signature of Contractor) (Date). The site services drawings are to include signature and stamp of OLS surveyor attached to note.

.6 Submit one (1) set of white prints of the draft as-built Cad files for Consultant’s review.

.7 Once “AS BUILT DRAWINGS” white prints are reviewed, transfer Consultant's comments to the CAD files. Return AutoCad drawings modified to “As Built” condition to Consultants on CD or DVD Rom.

.8 Submit three (3) sets of white prints and three (3) copies of CAD files with Operating and Maintenance Manuals.

10 OPERATING AND MAINTENANCE INSTRUCTIONS

10.1 Operating and Maintenance Manuals

.1 Provide operation and maintenance data bound in 210 mm x 300 mm x 50mm thick (8½ in x 11 in x 2 in thick) size, vinyl covered, hard back, three-ring covers.

.1 Organize material in volumes generally grouped by Trade Section; Site services, Plumbing, Fire Protection, Heating and Cooling Plant and Distribution, Air Handling, and Controls and Instrumentation.

.2 Title sheet in each volume to be labeled "Operating and Maintenance Manual" and to bear Project Name, Project Number, Date, Trade Section, and List of Contents.

.2 In addition, provide Adobe PDF files for each document, produced from original direct-to-digital file creations.

.1 Organize documents into separate PDF files for each Trade Section identified above, and apply Adobe Bookmarks to create Table of Contents.

.3 Operating data to include;

.1 control schematics for each system,

.2 description of each system and associated control elements,

.3 control operating sequences at various load conditions, reset schedules and anticipated seasonal variances,

.4 operating instructions for each system and each component,

.5 description of actions to be taken in event of equipment failure,

.6 valves schedule and flow diagram,

.7 service piping identification charts.

.4 Maintenance data to include;

.1 manufacturer's literature covering, servicing, maintenance, operating and trouble-shooting instructions for each item of equipment,

.2 fault locating guide,

.3 manufacturer's parts list,

.4 reviewed shop drawings,

.5 equipment manufacturer's performance sheets,

.6 equipment performance verification test results,

.7 voltage and ampere rating for each item of electrical equipment,

.8 spare parts list and an itemized cost,

.9 name and telephone numbers of service organization and technical staff that will provide warranty service on the various items of equipment.

.5 Approval procedure

.1 Submit one set of first draft of Operating and Maintenance Manuals for approval.

.2 Make corrections and resubmit as directed.

.3 Review contents of Operating and Maintenance Manuals with Owner's operating staff or representative to ensure thorough understanding of each item of equipment and its operation.

.4 Hand-over two copies of Operating and Maintenance Manuals to Owner's operating staff and obtain written confirmation of delivery.

10.2 Operating and Maintenance Instructions

.1 Provide instructions to Owners operations staff to thoroughly explain operation and maintenance of each system, incorporating specialized instruction by manufacturers as described under other Sections in these Divisions. Include classroom instruction and hands-on instruction, delivered by competent instructors.

.2 Submit an outline of the training program for review, adjustment and approval by the Owner.

.3 Structure each session to start with the classroom instruction for the overall system, followed by hands-on instruction for each equipment, utilizing the services of the manufacturers' representative as required.

.4 Organize and schedule each training session to deliver the required instruction in an efficient and effective manner on a schedule agreed upon with the Owner. Allow for two (2) training sessions for each training session, separated by approximately one week each. Develop the proposed training plan and obtain approval from the Owner before commencing training.

.5 Complete the training as close to Substantial Performance as possible, so that the operations staff are prepared to operate the systems after Substantial Performance is certified.

.6 Organize each training sessions as follows:

.1 HVAC – Division 23

.2 Building Management System – Division 25

.7 Keep record of date and duration of each instruction period together with names of persons attending. Submit signed records at completion of instruction.

.8 For each training session, include the following topics:

.1 General purpose of system (design intent),

.2 Use of O&M manuals,

.3 Review of control drawings and schematics,

.4 Start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, control set-up and programming troubleshooting, and alarms,

.5 Interaction with other systems,

.6 Adjustments and optimizing methods for energy conservation,

.7 Health and safety issues,

.8 Special maintenance and replacement sources,

.9 Occupancy interaction issues, and

.10 System response to different operating conditions.

.9 Develop and provide training material, including printed documents and electronic presentation aids (e.g. MS PowerPoint) for each session. Submit three (3) copies of materials in both hardcopy and electronic format, in accordance with article on Operating and Maintenance Manuals.

.10 Sessions may be videotaped by the Owner as an aid to ongoing training of Owners staff.

11 START-UP AND TESTING

11.1 Care, Operation and Start-up

.1 Arrange and pay for services of manufacturer's factory service technician to supervise start-up of installation, check, adjust, balance and calibrate components.

.2 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with every aspect of the operation, care and maintenance thereof.

11.2 TESTING - General

.1 Methods to comply with following references:

(a) The British Columbia Building Code
(b) CAN/CSA B139-Installation Code for Oil Burning Equipment;
(c) CSA B149.1 Natural Gas and Propane Installation Code

.2 Conduct tests, during progress of Work and at its completion to show equipment and systems meet contract. Submit details of test methods in writing and obtain approval before commencing work.

.3 Supply test equipment, apparatus, gauges, meters and data recorders, together with skilled personnel to perform tests and log results.

.4 Submit written notice 24 hours in advance of each test series, setting out the time, place and nature of the tests, the Inspection Authority and personnel witnessing tests.

.5 Conduct tests before application of external insulation and before any portion of pipes, ducts or equipment is concealed.

.6 Do not subject expansion joints, flexible pipe connections, meters, control valves, convertors, and fixtures, to test pressures, greater than stated working pressure of equipment. Isolate or remove equipment or devices during tests when prescribed test pressure is greater than working pressure of any piece of equipment or device.

.7 Should section of pipe or duct fail under test, replace faulty fittings or duct with new fittings, pipe or duct, repair and retest. Do not repair screwed joints by caulking nor welded joints by peening. Repeat tests until results are satisfactory.

.8 Where it is necessary to test portions of duct or piping system before system is complete, overlap successive tests so that no joint or section of duct or pipe is missed in testing.

.9 Upon completion of work and testing of same, submit logs to demonstrate that tests have been carried out satisfactorily. Repeat any tests if requested.

11.3 Testing - Other Piping

.1 Hydraulically test other water piping systems at 1½ times system design pressure (relief valve setting) or 1000 kPa (150 psi), whichever is greater, for 24 hours. Pressure must remain essentially constant throughout test period without pumping. Make allowance for correction of pressure readings for variations in ambient temperature between start and finish of test. Hammer test welded joints during hydrostatic test.

.2 Test natural gas system to CSA B149.1

.3 Test fuel oil systems to CSA B139

.4 Test drainage, waste and vent piping for tightness and grade as required by The British Columbia Building Code.

.5 Test special service piping as detailed.

.6 Test high pressure steam piping and compressed air piping in accordance with requirements of local and Provincial Authorities.

11.4 Testing - Ventilation

.1 Test ductwork in accordance with procedures detailed.

.2 Test low pressure ductwork with an air pressure of 1 kPa (4 in wg for 10 minutes.

.3 Test medium pressure ductwork with an air pressure of 2 kPa (8 in wg) for 10 minutes.

.4 Test high pressure ductwork with an air pressure of 3 kPa (12 in wg) for 10 minutes.

.5 Examine construction joints for damage or weakening. Reduce pressure to maximum working pressure or 1 kPa (4 in wg), whichever is larger, and check joints for audible leaks. Mark each leak and repair after pressure is released. Retest repaired section of duct.

11.5 Testing - Electrical

.1 Make tests of equipment and wiring.

.2 Tests to include meggered insulation values, voltage and current readings to determine balance of panels and feeders under full load and examination of each piece of equipment for correct operation.

.3 Test electrical work to standards and function of Specification and applicable Codes.

.4 Replace defective equipment and wiring with new material.

.5 Connect single phase loads to minimize unbalance of supply phases.

12 TEMPORARY AND TRIAL USAGE

12.1 General

.1 Temporary and trial usage by Owner of any mechanical or electrical device, machinery, apparatus, equipment or any other work or materials before final completion and written acceptance is not to be construed as evidence of acceptance by Owner.

.2 Owner to have privilege of such temporary and trial usage, as soon as that said work is claimed to be completed and in accordance with Contract Documents, for such reasonable length of time as is sufficient for making complete and thorough test of same.

.3 No claims will be considered for damage to or failure of any parts of such work so used which may be discovered during temporary and trial usage, whether caused by weakness or inaccuracy of structural parts or by defective materials or workmanship of any kind whatsoever.

.4 Defects in workmanship and materials identified during temporary and trial usage are to be rectified under guarantee.

13 SPECIAL TOOLS AND SPARE PARTS

13.1 General

.1 Furnish spare parts as follows

.1 One glass for each gauge glass.

.2 1 spare condensing unit compressor for the condensing units.

14 CONSULTANT REVIEWS

14.1 General

.1 Consultant's attendance at site including but not limited to site meetings, demonstrations, site reviews and any resulting reports are for the sole benefit of the Owner and the local authority have jurisdiction.

14.2 Site Reviews

.1 General reviews and progress reviews do not record deficiencies during the course of the Work until such time as a portion or all of the work is declared complete. In some instances before the work is completed, deficiencies may be recorded where the item is indicative of issues such as poor workmanship, incorrect materials or installation methods, or may be difficult to correct at a later date. Any such reported items, or lack thereof, shall not be relied on in any way as part of the Contractors quality assurance program nor relieve the Contractor in the performance of the Work.

.2 Deficiency reviews conducted by the Consultant are performed on a sampling basis, and any deficiency item is to be interpreted as being indicative of similar locations elsewhere in the Work, unless otherwise shown.

14.3 Milestone Reviews

.1 Specific milestone reviews may be conducted at key stages by the Consultant, including;

.1 before installing roof mounted condensing units,

.2 before cutting the ahu's to install the heating & cooling coils,

.3 before patching the AHU's,

.4 before insulating all new pipework,

.5 equipment demonstration,

.6 Substantial Performance deficiency review,

.7 Total Performance deficiency review.

.2 Coordinate with the Consultant the type and quantity of milestone reviews required and incorporate these requirements in the construction schedule.

.3 Notify the Consultant in writing seven (7) calendar days in advance of work to be concealed to arrange a site review prior to the Work being concealed where required by the Consultant. Any noted deficiencies are to be corrected before being concealed. Failure to provide notification can result in the Work being exposed for review at the Contractor's cost.

14.4 Substantial Performance Review

.1 At the time of applying for project Substantial Performance, submit to Consultant a comprehensive list of items to be completed or corrected.

14.5 Final Review

.1 At project completion submit written request for final review of mechanical and electrical systems.

.1 Refer to section 20 08 19 Project Close-Out.

.2 Include with the request a written certification that:

.1 reported deficiencies have been completed,

.2 systems have been balanced and tested and are ready for operation,

.3 completed maintenance and operating data have been submitted and approved,

.4 tags are in place and equipment identification is completed,

.5 cleaning is finished in every respect,

.6 all mechanical equipment surfaces have been touched up with matching paint, or re-finished as required,

.7 spare parts and replacement parts specified have been provided and receipt acknowledged,

.8 As-built and Record drawings are completed and approved,

.9 Owner's operating personnel have been instructed in operation and maintenance of systems,

.10 fire protection verification is 100% completed and Verification Certificates have been submitted and accepted.

15 CORRECTION AFTER COMPLETION

15.1 General

.1 At completion, submit written guarantee undertaking to remedy defects in work for a period of one year from date of substantial completion. This guarantee is not to supplant other guarantees of longer period called for on certain equipment or materials.

.2 Guarantee to encompass replacement of defective parts, materials or equipment, and to include incidental fluids, gaskets, lubricants, supplies, and labour for removal and reinstallation work.

.3 Submit similar guarantee for one year from date of acceptance for any part of work accepted by Owner, before completion of whole work.

16 ATTACHEMENTS

16.1 Shop Drawing Submittal Form

.1 Attached sample of shop drawings submittal form.

HHAngus

1127 Leslie Street
Toronto, Ontario
M3C 2J6 Canada

T 416 443 8200
F 416 443 8290
hhangus.com

SHOP DRAWING SUBMITTAL

Include this cover page with each shop drawing submission.
Submissions without this form will be returned without review.
Submit one submittal form per shop drawing; do not group under one submittal sheet

Client/Architect: **[Client/Architect name]**

Project Name: **[Project name]**

HHA Project No: **[HHA Project No]**

Contract: **General**

Contractor to complete the following for each submission.

Date: _____

Contractor Name: _____ Ref No:_____

Manufacturer Name: _____

Product Type: _____

Specification Section No: _____

Contractor Trade:

☐ Mechanical ☐ Electrical ☐ Elevators ☐ General Trades

If this is a resubmission, check here: ☐

Previous submission HHA reference no.: _____

HHA distribution - for internal use only:	
Mechanical review:	[Mechanical designer name]
Electrical review:	[Electrical designer name]
Elevators review:	[Elevator designer name]

Document1

END OF SECTION

QUALIFICATIONS AND AUTHORITIES – BRITISH COLUMBIA
20 01 02

1 GENERAL

1.1 Scope

.1 The specification section:

.1 describes the qualification requirements for tradesmen in the province of British Columbia ("B.C.");

.2 defines the applicable authorities having jurisdiction related to construction in B.C.; and

.3 describes the responsibilities of the contractor and/or Owner for registration and inspection of systems and application for construction or installation permits.

1.2 Definitions

.1 ***BCSA***: British Columbia Safety Authority

2 QUALIFICATIONS

2.1 Trades Qualification and Apprenticeship

.1 Tradesmen to hold a certificate of competency for the following applicable trades including but not limited to:

.1 Boilermaker, B.C.Reg. 324/2003

.2 Industrial Mechanic (Millwright), B.C.Reg. 324/2003

.3 Industrial and Construction Electricians, B.C.Reg. 324/2003

.4 Instrumentation and Control Technician, B.C.Reg. 324/2003

.5 Electrician, B.C.Reg. 100/2004

.6 Oil Heat System Technician, B.C.Reg. 324/2003

.7 Plumber, B.C.Reg. 324/2003

.8 Refrigeration and air-conditioning mechanic, B.C.Reg. 324/2003

.9 Sheet metal worker, B.C.Reg. 324/2003

.10 Sprinkler and fire protection installer, B.C.Reg. 324/2003

.11 Steamfitter-pipefitter, B.C.Reg. 324/2003

.12 Pressure Welder, B.C.Reg. 104/2004

2.2 Work-Specific Qualification Licenses

.1 Fabricators and installers of pressure piping and equipment which are subject to B.C.Reg. 104/2004 *Power Engineers, Boilers, Pressure Vessels and Refrigeration Safety* regulation shall hold the required certificate of competency for performing such work, unless otherwise exempt by the regulation.

.2 Contractors performing work on liquid or gaseous fuel piping systems and related equipment shall hold certificates of competancy to perform work within the scope of the following regulations:

.1 Gaseous Fuels, B.C.Reg. 103/2004

.2 Propane Storage and Handling, B.C.Reg. 103/2004

.3 Compressed Natural Gas, B.C.Reg. 103/2004

3 AUTHOURITIES

3.1 Authorities having Jurisdiction

.1 When referenced in specification sections in Division 20 to 25, the authority-having-jurisdiction ("AHJ") over regulated portions of the work are identified in the following table.

Work Element	Authority	AHJ Abbreviation
Fire Protection	Municipal Building Department or Fire Department	None
Plumbing	Municipal Building Department	None
HVAC	Municipal Building Department	None
Flammable and Combustible Liquids	Fire Department	None
Liquid fuels (for vehicle refueling)	BCSA	BCSA (FS)
Heating Oil and Diesel Fuel	BCSA	BCSA (FS)
Propane	BCSA	BCSA (FS)
Pressure Piping	BCSA	BCSA (BPV)
Refrigeration	BCSA	BCSA (BPV)
Licensed Plant Operators	BCSA	BCSA (OE)
Electrical	BCSA	BCSA (ES)

4 PERMITS, REGISTRATION AND INSPECTION

4.1 Building Code Permits

.1 Mechanical Building Permit Required.

.2 Electrical Building Permit Required.

.3 Structural Building Permit Required.

4.2 Other Work Permits, Registration and Inspection

.1 If applicable, arrange, provide documentation, and pay for registration and inspection of the following work elements:

.1 Boilers, pressure vessel and pressure piping,

.2 Electrical work performed under Division 20 to 25, and

.3 Where described elsewhere in Division 20 to 25.

.2 If applicable, arrange, provide documentation, and pay for variance approvals and field inspections where specified elsewhere in Division 20 to 25.

END OF SECTION

MECHANICAL COORDINATION AND INSTALLATION DESIGN SERVICES
20 01 03

1 GENERAL

1.1 Scope

.1 Provide detailed coordination, fabrication, and installation design drawings for the services provided under Division 20. Integrate the coordination drawings provided under Division 26 into the design drawings provided under Division 20.

.2 Provide the services of an experienced mechanical and electrical coordination supervisor to manage these contractors' design services. The supervisor is responsible for leading a multi-trade coordination effort including but not limited to: detailed inspection of existing conditions, layout and finalize routing of services, setting sleeves for structural openings and sequencing of service installation.

1.2 Document Ownership

.1 Ownership and copyright of Contractors coordination, fabrication, and installation design drawings remains with the Contractor producing these documents, subject to the requirements of the project agreement. In the absence of any requirements in the project agreement, the Contractor will provide the Owner with a royalty-free, transferrable, and irrevocable license to copy and use the materials for the purpose of operating and maintaining the building and building systems.

1.3 Consultant Drawings

.1 Consultant drawings are diagrammatic and illustrate the general location of equipment, and intended routing of ductwork, piping, bus duct, etc, and do not show every structural detail. In congested areas drawings at greater scale may be provided to improve interpretation of the Work. Where equipment or systems are shown as "double line", they are done so either to improve understanding of the Work, or simply as a result of the use of a CAD drawing tool, and in either case such drawings are not represented as fabrication or installation drawings.

1.4 Design Commentary

.1 The following design commentary is provided to assist the contractor in developing an appreciation for the potential complexities and level of risk which may impact the preparation of a bid price for the Work. This commentary does not limit the scope of work nor does it address all potential risk factors associated with the Work.

.1 restricted access to ceiling spaces for coordination with existing services

.2 unknown structural conditions

.3 hidden conduit in slabs and walls

1.5 Requests for Information

.1 Requests for Information (RFI's or similar type of document) concerning coordination are to be submitted with sketch drawings indicating proposed solution for review by the Consultant. RFI's submitted without such proposals will be returned for re-submission.

1.6 Itemized Price

.1 Include costs associated with this Section as an Itemized Price in the Bid documents.

2 INTERFERENCE CO-ORDINATION DRAWINGS

2.1 General

.1 Make good damage to Owner's property or to other trade's work caused by inaccurate layout or careless performance of work of this Division.

.2 Take information involving accurate measurements from dimensioned Architectural Drawings or at building.

.3 Install services and equipment which are to be concealed, close to building structure so that furring is kept to minimum dimensions.

.4 Location of pipes, ductwork, raceways and equipment may be altered without extra cost provided instruction is given or approval is obtained, in advance of installation of items involved. Changes will be authorized by site instructions and are to be shown on Record Drawings.

.5 Location of floor drains, hub drains, combination drains, plumbing fixtures, convectors, unit heaters, diffuser, registers grilles and other similar items may be altered without extra cost provided instruction is given prior to roughing in. No claim will be paid for extra labour and materials for relocating items up to 3 m (10 ft) from original location nor will credits be anticipated where relocation up to 3 m (10 ft) reduces material and labour.

.6 Include incidental material and equipment not specifically shown but which is needed to complete the work as an operating installation.

2.2 Interference Coordination Drawings

.1 Prepare interference coordination drawings to show location of equipment and relative position of services, and to demonstrate coordination with works of other trades. Drawings shall be prepared by a specialist firm experienced in CAD mechanical and electrical interference drawing production. Interference drawings are to include coordination with all mechanical and electrical services.

.2 Mechanical contractor is to consult and co-operate with electrical contractor to identify electrical services which are to be incorporated into interference drawings. Contractor shall perform site survey work to document all existing mechanical and electrical services that are to remain and are to be included in the interference drawings.

.3 Conduct weekly meetings to discuss and resolve interference issues discovered during interference drawing production.

.4 Submit drawings to other trades involved in each area and include note in drawing title block as follows;

.1 “This drawing was prepared and circulated for review and mark-up to related subcontractors as noted and initialed in the table below. Corrections and concerns identified through this coordination process have been addressed on this drawing. Areas that incorporate significant changes from layouts shown on Contract Drawings have been circled for Consultants’ general review”

.5 Drawing scale to be minimum 1:50 (1/4"=1'-0").

.6 Produce coordination drawings, preferably in 3D AutoCad MEP or Revit MEP format, and keep a set of drawings on site for Consultant’s general review.

.7 Obtain architectural and consultant's drawing files for background information, pending completion and return of any electronic file waiver forms.

2.3 Coordination with Other Trades

.1 Lay out and coordinate Work to avoid conflict with work under other sections of this Division and other Divisions.

.2 When equipment provided under other Sections or Divisions connects with material or equipment supplied under this Section, confirm capacity and ratings of equipment being provided.

2.4 Interconnecting Control and Power Wiring

.1 Provide wiring block diagrams and detailed termination drawings for controls wiring connections to equipment and instrumentation, for both Building Automation System control and hard-wired interlock wiring. Provide wiring terminal numbers specific for each equipment connection.

3 FABRICATION AND INSTALLATION DRAWINGS

.1 On an as-needed basis, prepare fabrication, spooling, and/or installation drawings based on the completed interference coordination drawings. CAD drawing system is in accordance with Contractor's company standards.

.2 Drawing scale: same as the interference coordination drawings or at larger scale as needed.

.3 Use information from manufacturer's shop drawings for each trade and figured dimensions from latest Architectural and Structural Drawings.

.4 Layout equipment and services to provide access for repair and maintenance.

END OF SECTION

DEFINITIONS AND ABBREVIATIONS - MECHANICAL
20 01 13

1 GENERAL

1.1 Scope

.1 This specification provides definitions and abbreviations of terms which may apply to one or more specification sections under Division 20, 21, 22, 23 and 25.

.2 Additional definitions and/or abbreviations may also be included in other specification sections where they apply only to one specification section.

1.2 Definitions

Authourity having Jurisdiction ("AHJ"): the designated government body or regulatory agency responsible for enforcement of applicable statute.

Bronze: a copper alloy with a minimum copper content of 84%.

Class XXX: a numerical pressure-temperature designation "XXX" in accordance with ANSI/ASME B16 series of standards.

Canadian Registration Number ("CRN"): as defined in accordance with CSA B51.

Certificate of competency: a license, certificate or other document which attests to the qualifications of a construction tradesperson and which is recognized and/or required under prevailing provincial, territorial or federal statutes in the location of the project as an authorization to perform such work.

Cold Working Pressure ("CWP"): the maximum non-shock cold working pressure at temperatures as stated in a MSS valve standard.

Design Criteria: criteria that states the requiree performance of equipment or a system, and is also the minimum design basis for equipment, systems and contractor's design responsibilities.

Design Pressure: (in reference to a pressure piping system) - the maximum allowable internal pressure in a piping system at the indicated coincident Design Temperature that the piping system may be subjected under normal operating conditions and is the basis for determining the piping system hydrostatic or pneumatic test pressure requirements.

Design Temperature: (in reference to a pressure piping system) – the maximum allowable in-service temperature of the piping system.

Double Regulating Valve ("DRV"): a calibrated manual flow balancing valves with pressure test ports (also referred to as circuit balancing valve),

Dezincification Resistant ("DZR"): a brass copper alloy which by means of its alloy and method of manufacture is certified as being resistant to the process of dezincification.

Flow Limiting Regulating Valve ("FLRV"): an automatic calibrated flow control device which limits the maximum flow to a branch piping network.

Minimum Component Pressure Rating ("MCPR"): the minimum pressure at the indicated coincident temperature at which the component must be capable of withstanding, remain functional and not exceed its maximum allowable stress in accordance with its referenced standard.

National Pipe Taper ("NPT"): a pipe thread in accordance with ANSI/ASME B1.21.1

Operating Pressure: the estimated maximum expected internal operating pressure of a fluid in a pipe or equipment for the purpose of establishing a piping system Design Pressure; actual in-service gauge pressures may be lower. The operating pressure may be specified as a single value, or it may vary by location in the system. "Working pressure" has the same meaning.

Operating Temperature: the estimated maximum normal temperature of the fluid in a piping system

Potable water: has the same meaning as defined in the applicable plumbing code or building code in the jurisdiction of the project. "Domestic water" has the same meaning.

Steam Working Pressure ("SWP"): the maximum steam pressure at the indicated maximum steam temperature or it is the saturated steam pressure if a coincident temperature is not specified.

Service rooms: means a room provided in a building to contain equipment associated with building services, and which includes but is not limited to: boiler rooms; furnace rooms; incinerator rooms; garbage handling rooms; rooms to accommodate HVAC appliances, pumps, compressors and other related equipment; rooms containing electrical distribution equipment; and rooms containing telecommunications and data equipment.

Service space: means space provided in a building to facilitate or conceal the installation of building service facilities such as chutes, ducts, pipes, shafts or wires.

1.3 Abbreviations

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineers
ASTM	ASTM International (formerly American Society for Testing and Materials)
CSA	Canadian Standards Association
FM	Factory Mutual Approvals
MSS	Manufacturers Standardization Society
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSF	NSF International (formerly National Sanitary Foundation)
SMACNA	Sheetmetal and Air Conditioning Contractors' National Association
UL	Underwriters Laboratory (USA)
ULC	Underwriters Laboratory Canada

End of Section

BASIC MATERIALS AND METHODS
20 05 01

1 GENERAL

1.1 Scope

.1 Articles that are of a general nature, applicable to each Section of Division 20.

2 ACCESS DOORS

.1 Provide access doors to be installed at locations where equipment requiring inspection, service, maintenance or adjustment is "built-in" to work of other trades.

.2 Access is required at;

- .1 expansion joints,
- .2 dampers,
- .3 fire dampers,
- .4 air valves,
- .5 air terminal units,
- .6 isolation and control valves ,
- .7 pressure reducing valves,
- .8 heating or cooling coils,
- .9 control wiring junction boxes.

.3 Submit shop drawings showing access door size, type and location.

.4 Construction:

- .1 constructed of steel, prime coated,.
- .2 flush mounted with 180° opening door, round safety corners, concealed hinges, plaster lock and anchor straps
- .3 600 mm x 600 mm (24 in x 24 in) for personnel entry,
- .4 300 mm x 450 mm (12 in x 18 in) for hand entry, and
- .5 constructed of stainless steel in areas finished with tile or marble surfaces
- .6 constructed of stainless steel with neoprene gasketed door in damp and high humidity areas
- .7 generally fitted with screwdriver operated latches, except in areas subject to security risks (Public Corridors, Psychiatric Patient Areas, Public Washrooms). In these areas doors to be fitted with keyed cylinder locks with similar keys.

Standard of Acceptance

- Baird - ABCO
- Stelpro - Type 700
- Williams Brothers - GP
- LeHage
- Acudor Acorn
- Mifab

.5 Installation:

.1 Supply access doors and make arrangements and pay for installation by Division in whose work they occur.

.2 Size and locate access doors in applied tile, block or in glazed or unglazed structural tile to suit joint patterns.

.3 Access doors in ceilings, where acoustic tile is applied to plaster or gypsum board, to be dish type designed to receive tile insert.

.4 Access doors are not required in removable ceilings. Provide coloured marking devices after completion of ceilings, at four corners of each panel below point requiring access. Colour code markers to show service or device above.

.5 At time of instruction of owners operating staff, hand-over and obtain signed receipt for 4 sets of each type of key used to lock access doors in secure areas.

3 DIELECTRIC COUPLINGS

.1 Provide dielectric isolation between pipes of dissimilar metals with suitable couplings, insulating dielectric unions, insulating flanges, or insulating gaskets between flanges.

.1 Place dielectric isolation between steel piping and bronze or brass valves.

.2 Do not use bronze or brass valves as dielectric fittings.

.2 Insulating unions for pipe sizes NPS 2 and under

Standard of Acceptance
- Epco - Dielectric
- Watts

.3 Insulating flanges for pipe or tube from NPS 2 to NPS 4

Standard of Acceptance
- Watts No. 3100 or 3200

.4 Insulating gaskets for flanges NPS 5 and over:

.1 compatible with pressure and temperature service,

.2 flange bolts run in insulating sleeves with insulating washers under nuts.

4 DRAIN VALVES

.1 Provide drain points for piping systems with drain valves at low points and at section isolating valves.

.2 Drain valves: minimum NPS 2 straight pattern bronze with hose end male thread, cap and chain.

5 SLEEVES

5.1 General

.1 Sleeve pipes, ducts and conduits passing through masonry walls, concrete floors, and fire rated gypsum board ceilings and partitions.

.2 Maintain fire rating integrity where pipes and ducts pass through fire rated walls, floors and partitions.

5.2 Floor and Wall Sleeves

.1 Sleeves in fire separations:

.1 sized to suit fire stopping methods employed for bare pipes, conduits, insulated pipes, and bare and insulated ducts without fire dampers, and

.2 sized to suit conditions of approval given in manufacturers installation instructions for fire and smoke dampers.

.2 Sleeves in other construction:

.1 sized to clear insulated pipes and ducts by 13 mm (½ in) all round, and

.2 sized to clear conduits, bare pipes, and bare ducts by 6 mm (¼ in) all round.

.3 Sleeves for pipes, conduits and ducts smaller than 0.4 m^2 (4 sq ft) through solid walls and floors:

.1 Schedule 40 steel pipe or 1 mm (20 ga) (minimum) sheet metal, lapped and spot welded.

.2 Sleeves for pipes, conduits and ducts smaller than 0.4 m^2 (4 sq ft) through gypsum board partitions:

(a) 1 mm (20 ga) minimum sheet metal, lapped and spot welded with 20 mm (¾ in) lip flange at one and.

.4 Sleeves for ducts 0.4 m^2 (4 sq ft) and larger through walls and floors:

.1 1.6 mm (16 ga) minimum sheet metal, lapped and spot welded with 20 mm (¾ in) lip flange at one end.

6 FIRE STOPPING AND SMOKE SEALS

6.1 General

.1 Provide fire stopping and smoke seals where ducts, pipes or conduits penetrate fire separations. Materials to be supplied, worker training to be arranged, and installation to be supervised, by a specialist firm with an established reputation in this field.

.2 Fire stop materials to be impervious to water when installed in a horizontal separation, including waterproof service sleeves.

6.2 Products

.1 Materials to form ULC listed or cUL listed/classified assemblies.

Standard of Acceptance
- 3M
- Nelson Firestop Products
- Hilti Firestop Systems
- Eastern Wire + Conduit (Royal Quickstop)

.2 Other manufacturers having products with explicitly similar characteristics, listings or classifications and approvals are acceptable.

6.3 Installation

.1 Submit a complete fire stopping and smoke seal schedule to the Consultant for review. Include details, cut sheets, system description and location for each proposed fire stopping and smoke sealing application.

.2 Install firestopping and smoke seals in accordance with the manufacturer's recommendations and in accordance with the ULC or cUL listing.

.3 Firestopping and smoke seals to be installed only by personnel trained by the manufacturer on the installation of such systems.

.4 Firestop and smoke seal system manufacturer's training and inspection services:

.1 Provide the services of the manufacturer to provide training to trades performing the fire stopping. Create and maintain a log of those personnel who obtain training.

.2 Provide the services of the manufacturer to inspect the installation while in progress and a final inspection at completion of work. Provide a manufacturer's inspection report to the Owner and Engineer declaring that the installed firestop systems are in conformance to the manufacturer's system listing requirements.

.5 Seal space between penetrating service and sleeve or opening in in fire rated floors and walls with a firestop and smoke sealing system.

.6 Select thickness and arrangement of back-up materials to suit size of service, length of sleeve and anticipated movement.

.7 At time of application of materials, surfaces to be clean, dry and free from dust, oil, grease, loose or flaking paint and foreign materials.

.8 Select firestopping system to allow insulation and vapour barrier to pass un-broken through assembly.

.9 Do not apply fire stopping materials to fire or smoke dampers.

7 WALL AND FLOOR PLATES

.1 Fit pipes passing through walls, floors and ceilings in finished areas with escutcheon, wall or floor plates.

.2 Plates:

.1 at floor; chrome plated two piece split type with hinge.

.2 at walls and ceilings; similar to floor plate but with set screw to fasten plate to pipe.

7.2 Installation

.1 Plates:

.1 sized to cover sleeves

.2 secured tight against finished surfaces, and

.3 fitted to cover sleeve extensions where sleeves extend above finished floor.

8 PLATFORMS, LADDERS, COVERS, PIPE SUPPORTS, EQUIPMENT SUPPORTS, AND BASES

8.1 Supports for mechanical and electrical work

.1 Fabricate platforms, gratings, ladders, piping and equipment supplementary supporting steel, and trench and pit covers, from steel and provided by this Division.

.2 Concrete housekeeping bases for mechanical and electrical equipment which are in direct contact with floor slab, to be provided by this Division.

.3 Concrete bases for equipment supported on vibration isolation materials (inertia pads), to be provided by this Division.

.4 Work to be done by firms specializing in these fields.

.5 Submit shop drawings for steel and concrete work, prepared by licensed Professional Engineers.

8.2 Applicable codes and standards;

.1 Ministry of Labour

.1 Engineering Data Sheets

.2 Health and Safety Guidelines

.3 Industrial Alert Bulletins

.2 Regulations made under the Occupational Health and Safety Act;

.1 Regulations for Industrial Establishments

.2 Regulations for Health Care and Residential Facilities

.3 The British Columbia Building Code

.4 American Society for Testing and Materials (ASTM)

.1 ASTM A 53/A53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

.2 ASTM A 269, Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

.3 ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.5 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.40, Anti-corrosive Structural Steel Alkyd Primer.

.2 CAN/CGSB-1.108, Bituminous Solvent Type Paint.

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

.6 Canadian Standards Association (CSA)

.1 CAN/CSA-G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel.

.2 CAN/CSA-G164, Hot Dip Galvanizing of Irregularly Shaped Articles.

.3 CAN/CSA-S16.1, Limit States Design of Steel Structures.

.4 CSA W59, Welded Steel Construction (Metal Arc Welding).

8.3 Supplementary supports and support brackets:

.1 Fabricated from structural grade steel with anchor bolts and fastenings.

.2 Designed in consultation with building structural consultant to transfer live loads and dead loads to building structural elements,

.3 Constructed as frames bracketed from walls, and/or supported from building structure above, and/or floor below.

8.4 Installation - Equipment subject to thermal expansion

.1 Applicable to hot equipment which is not supported on spring vibration isolators, including but not limited to:

.1 boilers, hot water heaters,

.2 heat exchangers,

.3 expansion tanks,

.4 dearators and condensate tanks,

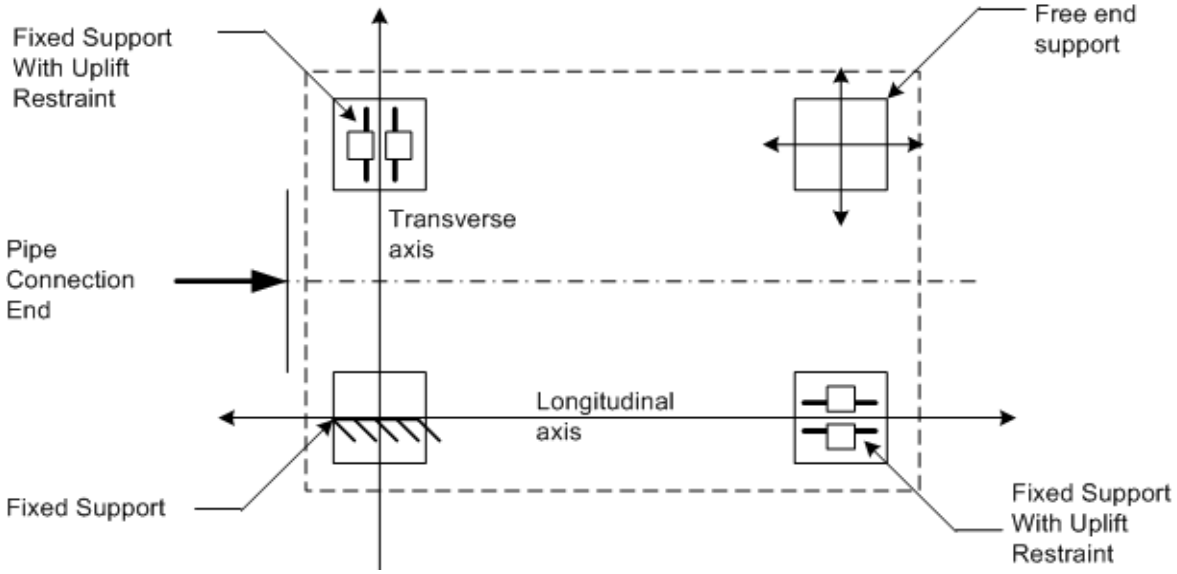
.5 diesel exhaust SCR emission control units.

.2 Fasten equipment to building structure to accommodate thermal expansion in accordance with manufacturer's instructions. In the absence of such instructions, fasten equipment support legs as follows unless otherwise shown;

.1 rigidly fasten one support point which is closest to piping connections,

.2 for supports located on the same transverse or longitudinal axis, provide guides with vertical restraint tabs, aligned in direction of fixed support point,

.3 for other support points, do not fasten or guide.



.3 Provide 3mm (1/8") thick PTFE (teflon) glide pads beneath each support leg.

END OF SECTION

MECHANICAL WORK IN EXISTING HOSPITALS
20 05 02

1 GENERAL

1.1 Scope

.1 Contractor is responsible to review all documents for all divisions to co-ordinate phasing and services required at end of each phase.

.2 Portion of the New Work and all of the work in existing areas will be phased. Rework of services will impact on the existing hospital. Notify the Owner and the Consultant, in writing, at least one week in advance of the work where work requires shut-down or isolation of existing services.

.3 Except as identified, shut downs of existing services will be restricted from 8PM to 7AM and on Sundays.

.4 All work outside area of renovation and/or outside of IPAC hoarding to be coordinated in advance with the consultant and the owner. Work to be done in accordance with Hospital's IPAC procedures. Work in corridors must be pre-arranged with the owner and contractor must maintain a level of site access at all times.

.5 Either AHU cannot be completely shut off for four consecutive hours. Contractor to consider hoarding off the work area within the AHU to allow the exhaust system to continue to operate to allow air changes in the long term care facility to be maintained at all times.

1.2 Ventilation

.1 All new and existing ductwork serving the area of renovation is to be professionally cleaned at end of project.

1.3 Core Drilling and Scanning

.1 Unless stated otherwise all core drilling and scanning for mechanical services is to be coordinated in advance with the consultant and the owner.

1.4 Work in Occupied Areas

.1 Work in Owner occupied areas outside of the construction site to be schedule with the Hospital.

.2 Projects having multiple phases in and around occupied spaces will require work outside of the current phased area. This work shall be scheduled with the Owner. Contractor for this division to coordinate associated general trades work required to complete the work outside of the immediate construction area with appropriate infection control measures and pay for general trades work if not shown on the architectural drawings.

.3 Access to these areas will be coordinated in advance with the consultant and the owner as noted above at the discretion of the Hospital

1.5 Equipment Maintenance and Operation during Construction

.1 The Mechanical Contractor to ensure equipment, systems and all related services are operational for each phase of construction.

.2 The mechanical contractor will be responsible to maintain and operate the new equipment (and systems) supplied under this project until the project is formally handed over to the Owner. Maintenance shall include all manufacturer recommended maintenance, filter changes, bearing lubrication, fan belt adjustment, chemical treatment, cleaning of coils. Maintenance and system downtime to be minimized and scheduled to suit the Hospital.

.3 The mechanical contractor shall operate the systems to the Owners benefit to ensure that the occupied phases are fully serviced to the Owners schedule and needs and to maintain occupiable environmental conditions. The mechanical contractor to provide a list of emergency contacts so they can respond 24/7 to issues with their system. Service calls and repairs to be made quickly to minimize disruption to the Hospital and at the contractor's expense.

1.6 Training of Equipment and Systems

.1 Training of Owners maintenance personnel to be done at end of project prior to formal turnover to Hospital. Training will not be required at the end of each phase as the contractor will be maintaining and operating the equipment/systems installed under this project until the systems are formally turned over to the Owner.

1.7 Equipment Warrantee

.1 Equipment and system warrantees to start after substantial performance even though equipment may be operating during early phases. Notify equipment supplier of this situation during bidding and include any additional costs related to operating the equipment during the construction period or include extended equipment warrantee to cover contract duration plus the standard warrantee period starting after substantial performance

1.8 Fire Watch and access to fire protection equipment

.1 In situations where fire protection and monitoring systems are taken out of service within the construction area, the Contractor will provide fire watch services for the duration of time when the fire protection and monitoring system are out of service.

.2 For situations where fire protection and monitoring systems for the building are taken out of service outside of the construction area, the Contractor will provide fire watch services for the duration of time when the fire protection and monitoring system are out of service.

.3 Hoarding will not restrict access to fire hose cabinets. If hoarding cannot be constructed without blocking access, the contractor shall temporarily relocate fire hose cabinet of provide a temporary cabinet near the existing that is blocked.

END OF SECTION

ROOFTOP SUPPORTS FOR BUILDING SERVICES AND EQUIPMENT
20 05 04

1 GENERAL

1.1 Scope

.1 Provide manufactured rooftop supports for building services and equipment, and access walkways.

1.2 Related Work

.1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:

.1 20 05 29 Common Hanger and Support Requirements for Piping

1.3 Manufacturer Services

.1 Manufacturer or authorized vendor of rooftop supports to provide design, product selection and installation details specific to the project and include:

.1 number and spacing of supports based on supported weights and dynamic loads,

.2 selection of roof adhesion pads applicable to the roof membrane type,

.3 production of installation details and instructions specific to the project.

1.4 Design Criteria

.1 Maximum load transferred to roof: each rooftop support and associated supported load not to exceed a distributed vertical load of 35 kPa (5 psi) per support location.

.2 Roofing pads are to be designed for all roof membrane types including single-ply and multi-ply roofs.

.3 Dynamic loads: rooftop support assemblies to withstand the following dynamic loads:

.1 wind-loads from any direction acting on the supported equipment, based on the design wind speed in accordance with the building code at the place of the Work, but not less than 200 kph (125 mph),

1.5 Submittals

.1 Submit manufacturer product data sheets for rooftop support components, and include:

.1 load ratings,

.2 typical composite detail drawings for complete support and hanger assembly, including roof bases, insulation pads, equipment support elements, and load ratings,

.3 calculated distributed load at each support pad in kPa (psi) units.

.2 In addition, for equipment supports, include drawings indicating support spacing plan specific to the supported equipment.

.3 In addition, for service walkways, include plan and elevation drawings for each walkway including access stairs or ladders, and guards. Include uniform distributed design loads and concentrated loads.

2 PRODUCTS

2.1 Rooftop Supports for Building Services

.1 For the support of piping, conduit, and equipment located on roofs.

.2 Prefabricated rooftop pipe and conduit supports:

.1 supported without penetrations of the roof membrane or flashings,

.2 high density polypropylene roof bases or similar, with UV-resistant protection,

.3 roof pads suitable for roof membrane type,

.4 minimum 2.5 mm (12 ga) formed channel structure,

.5 minimum 1.9 mm (14 ga) supplementary support,

.6 galvanized steel pipe support mounting channels.

.3 Pipe supports variant:

.1 for pipe size: NPS ½ to NPS 12,

.2 clevis, roll and trapeze pipe support element: in accordance with Specification section 20 05 29,

.3 single pad support with adjustable roll support,

.4 dual support pad with adjustable height-cross-over bar for clevis hanger or suspended roll hanger.

.4 Conduit support variant:

.1 for conduit Ø12 mm to Ø100 mm,

.2 trapeze type support, with U-clamps for rigid restraint of conduit.

.3 modular mounting channels and clips for conduit.

.5 Equipment variant:

.1 for rooftop mounted equipment including packaged HVAC units, fans, and related equipment,

.2 connection supports to equipment including high-stiffness pad isolators,

.3 cross-bracing by use of channels or threaded rod to resist dynamic loads.

Standard of Acceptance

- Portable Pipe Hangers
- Miro Industries (Unistrut)]
- Taylor Walraven

3 EXECUTION

3.1 Installation - General

.1 Install rooftop supports in accordance with the manufacturer's instructions.

.2 Provide supports for pipes and conduit at span lengths as shown on manufacturer installation drawings. Notwithstanding the identified support spacing, provide a support within 300 mm (12 in.) of each pipe or, pipe tee and piece of line equipment including valves, strainers, etc.

.3 Rooftop supports may be used to support both piping and electrical conduit, provided the combination of loads does not exceed the manufacturer's service limits.

.4 Provide roofing pads for each support base, of the type required to suit the roofing membrane or insulation.

3.2 Pipe Support installation

.1 Use clevis or roller hanger based on pipe service requirements in accordance with Specification section 20 05 29. For gas piping, only use roller supports with integral top-restraint arm.

.2 Install gas piping at constant elevation (no slope). For all other piping, adjust pipe supports to meet the required slope value and direction in accordance with applicable specifications for each piping system.

.3 Unless otherwise shown, bottom of pipe (or pipe insulation where applicable) to be at least 300 mm (12 in.) above the finished roof, but not more than 450 mm (18 in.).

.4 Adjust pipe supports to equalize hanger loads, to support piping true to line and grade, and to minimize loads transferred through connections to equipment and outlets.

3.3 Schedules

.1 The following appended schedules form part of this Specification section. These pipe support spans are maximum permitted and are subject to actual pipe support manufacturer layout requirements; such instructions may required shorter support spans.

.1 Schedule A1 Support Spacing Guide for Horizonal Pipe Support Loads and Support Spans – Schedule 20 to 80 Pipe – Single Pipe Support

.2 Schedule A2 Support Spacing Guide for Horizonal Pipe Support Loads and Spans – Schedule 10/10S Stainless Steel Pipe – Two Pipes of Same Size

Schedule A1

Support Spacing Guide for
Horizontal Rooftop Pipe Support Spacing
for
Carbon Steel, Galvanized Steel, Stainless-steel Piping
Schedule 20 to 80 Inclusive
For Single Pipe Support Only

Pipe Size NPS	Number Of Roof Bases	Maximum Support Spacing, Liquids m (ft)	Maximum Support Spacing Steam, Gases m (ft)
½	1	1.8 (6)	1.8 (6)
¾ to 1¼	1	2.1 (7)	2.1 (7)
1½	1	2.7 (9)	2.7 (9)
2	1	3.0 (10)	4.0 (13)
2½	1	3.3 (11)	4.3 (14)
3	1 or 2	3.3 (12)	4.6 (15)
4	2	4.2 (14)	5.2 (17)
6	2	5.1 (17)	6.4 (21)
8	2	5.7 (19)	7.3 (24)
10	2	6.7 (22)	7.9 (26)
12	2	4.3 (14)	8.5 (28)

Schedule A2

**Support Spacing Guide for
Horizontal Rooftop Pipe Support Spacing
for
Carbon Steel, Galvanized Steel, Stainless-steel Piping
Schedule 20 to 80 Inclusive
For Two Pipe Support of Same Size**

Pipe Size NPS	Number Of Roof Bases	Maximum Support Spacing, Liquids m (ft)	Maximum Support Spacing Steam, Gases m (ft)
½	1	1.8 (6)	1.8 (6)
¾ to 1¼	1	2.1 (7)	2.1 (7)
1½	1	2.7 (9)	2.7 (9)
2	1	3.0 (10)	4.0 (13)
2½	2	3.3 (11)	4.3 (14)
3	2	3.3 (12)	4.6 (15)
4	2	4.2 (14)	5.2 (17)
6	2	5.2 (17)	6.4 (21)
8	2	4.3 (14)	7.3 (24)
10	2	6.1 (20)	7.9 (26)
12	2	2.1 (7)	4.3 (14)

END OF SECTION

WIRING REQUIREMENTS FOR MECHANICAL SERVICES
20 05 12

1 GENERAL

1.1 Scope

.1 Provide wiring, conduit, fittings, supports, disconnect switches, service lights, and related devices and equipment for mechanical trades work, to the extent specified herein.

.2 As an alternative, specification section 20 05 29 may also be used for support of conduits.

1.2 Related Sections

.1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:

.1 20 05 29 Hangers and Supports

1.3 Definitions

.1 The following definitions apply to this section and referenced sections:

.1 ***Breaker panel (BP)*** - a 120/208 V mechanical power panel with overcurrent protection circuit breakers provided by Division 26.

.2 ***Control panels –*** an electrical device that controls or monitors mechanical equipment, or that interfaces with instrumentation devices.

.3 ***Control wiring*** - wiring for the purpose of communication or control of equipment and instrumentation.

.4 ***Electrical safety code -*** the edition with amendments of CSA C22.1 as adopted by applicable legislation at the location of the Work.

.5 ***Mechanical breaker panel (MBP)*** means a 120/208 V mechanical power panel with overcurrent protection circuit breakers provided as part of a MCC.

.6 ***Mechanical Power Panel (MPP) -*** 208 V or 600 V, 3 phase, power distribution equipment with branch circuit overcurrent protection devices provided by Division 26, and dedicated to supply power for equipment provided by mechanical trades work.

.7 ***Mechanical trades work -*** equipment and systems provided under Divisions 20 to 25.

.8 ***Motor controllers -*** constant speed motor controllers of the manual, magnetic or solid-state type in accordance with specification section 20 05 14.13.

.9 ***Motor Control Center –*** has the meaning as specified in section 20 05 14.13.

.10 ***Packaged equipment -*** equipment containing some or all of: motor(s), controls and/or other electrically powered equipment, such as but not limited to: electric heating equipment, water treatment equipment, packaged HVAC equipment, electric boiler, electric domestic water heaters, etc.)

.11 ***Power Panel (PP)***: 208 or 600 V, 3 phase, power distribution equipment with branch circuit overcurrent protection devices provided by Division 26, which serves general building loads and may also serve equipment provided by mechanical trades work.

.12 ***Power wiring*** means wiring that provides electrical power to equipment.

.13 ***VFD***: variable frequency drives in accordance with specification section 20 05 14.16.

.14 ***Wiring*** means conductors, cable, conduit, fittings, supports and accessories.

.2 With respect to these definitions, for equipment provided by Division 26 the actual terminology used in the Division 26 drawings and specification may differ but the intent remains the same.

.3 For clarity, any reference herein to Division 20 means Divisions 20 to 25.

1.4 Applicable Codes and Standards

.1 Legislation:

.1	B.C.Reg 50/2017	Electrical Safety Regulation

.2 Installation standards and codes:

.1	CSA C22.1	Canadian Electrical Code, Part 1, with BC Amendments
.2	CSA C22.1	Canadian Electrical Code Part 1

.3 Product standards:

.1	CSA C22.2 No. 4	Enclosed and Dead-Front Switches
.2	CSA C22.2 No. 38	Thermoset-Insulated Wires and Cables
.3	CSA C22.2 No. 39	Fuseholder Assemblies
.4	CSA C22.2 No. 106	HRC – Miscellaneous Fuses
.5	CSA C22.2 No. 124	Mineral Insulated Cable
.6	CSA C22.2 No. 131	Type TECK 90 Cable
.7	CSA C22.2 No. 208	Fire Alarm and Signal Cable
.8	CSA C22.2 No. 239	Control and Instrumentation Cables

1.5 Quality Control

.1 Electrical wiring for mechanical trades work to be performed by a specialist electrical contractor firm with an established reputation in the field of wiring of mechanical equipment and controls.

1.6 Permits, Fees and Inspections

.1 Arrange and pay for electrical permits and any required inspections for electrical work for mechanical equipment and systems.

.2 Submit to the electrical safety authority the required number of drawings and specifications for examination and approval prior to commencement of work.

.3 Notify Consultant of changes required by the electrical safety authority prior to making changes.

.4 On completion of the Work, furnish certificates of acceptance (or similar report) from the electrical safety authority to the Consultant.

1.7 Standard Details

.1 Device legend with list of abbreviations and schematic wiring diagrams are included at the end of this section that delineate the scope of work between Division 20 and Division 26 and as further specified herein.

.2 This material is to be used in the interpretation of specification requirements for power wiring and control wiring of Division 20 to 25 equipment.

1.8 Submittals

.1 Submit manufacturer catalogue cut-sheets for the following materials;

.1 service lights.

1.9 Storage of Materials

.1 Store wire and cable in a clean, dry, well-ventilated area.

.2 Protect white insulated wire from exposure to NOx gas (eg: exhaust from propane fuelled equipment) by wrapping with shrink wrap, by locating away from sources of NOx and by maintaining adequate ventilation to minimize NOx levels.

.3 Where white insulated wire has discoloured:

.1 do not install,

.2 dispose of the wire,

.3 remove and replace wire that has been installed.

2 PRODUCTS

2.1 Motor Feeder and Control Wiring ("Building Wires")

.1 Application:

.1 motor and equipment power feeders that do not include VFD drives,

.2 control wiring including control valve and damper actuators, panel control wiring, motor controller interlock wiring, BAS control wiring, and switch-type instrumentation,

.3 convenience power outlets and service lights.

.2 Conductors:

.1 solid copper for No. 12 and 14 AWG,

.2 stranded conductors for 10 AWG and larger.

.3 Minimum wire size:

.1 No. 12 AWG for equipment power,

.2 No. 14 AWG, for control wiring at 120 VAC or lower.

.4 Insulation:

.1 chemically cross-linked thermosetting polyethylene (XLPE) material, RW90 or RWU90,

.2 1000 V insulation for 600 V systems,

.3 600 V insulation for 100 VAC to 480 VAC systems.

.4 300 V insulation for systems less than 100 VAC, and for systems 24 VDC and less.

.5 Colour coded conductors:

.1 colour impregnated into insulation at time of manufacture,

.2 phase conductors No. 8 AWG and larger with black insulation, may be colour coded with adhesive colour coding tape.

.6 Listed to CSA C22.2 No. 38.

Standard of Acceptance

- Aetna Insulated Wire
- General Cable
- Nexans Canada Inc.
- Prysmian Cables & Systems Ltd.
- Southwire

2.2 Instrumentation and Control Cabling

.1 Application: instrumentation and control wire suitable for analogue 4-20 mA and 0-10 VDC signaling.

.2 Conductors:

.1 solid copper wire,

.2 twisted-multipair, shielded cables with individually shielded pairs, overall shield, drain wires and overall rated jacket,

.3 insulation: XLPE, colour coded or numbered wires,

.4 minimum wire size: as specified by equipment manufacturer or controls vendor, unless otherwise shown.

.3 Shield: provide 100% shield coverage complete with drain wire.

.4 Armour:

.1 corrugated steel, or

.2 none required if installed in conduit or approved wireway.

.5 Jacket:

.1 FT4 flame retardant,

.2 FT6 when installed in open style cable trays in ceiling spaces that are used as return air plenums.

.6 Listed to CSA C22.2 N0. 239,

Standard of Acceptance
- General Cable (Carol)
- Belden
- Nexans Canada Inc.

2.3 Fire Rated Mineral Insulated Cable

.1 Application – power feeders:

.1 conductors: solid annealed copper,

(a) 2 conductors, minimum 14 AWG for power wiring for Division 20 to 25 control equipment including dampers and terminal units,
(b) 2 or 3 conductor as applicable, size as shown but not less than 12 AWG for power wiring to Division 20 to 25 mechanical equipment (other than control equipment)

.2 insulation: compacted magnesium oxide (“MI”)

.3 sheath: seamless annealed copper.

.4 voltage rating: 600 V

.5 terminations: as supplied by the cable manufacturer.

.6 fire rating: listed for 2 hour fire-resistance rating with hose stream test to ULC-S139 cables labelled accordingly.

.7 ship cables with ends sealed.

.8 listed to CSA C22.2 No. 124 and ULC-S139.

Standard of Acceptance
- Pentair/Pyrotenax System 1850

.2 Application - communication wiring:

.1 conductors: solid annealed copper, single twisted pair 18 AWG.

.2 insulation: compacted magnesium oxide (“MI”)

.3 shield: seamless annealed copper.

.4 secondary insulation: compacted magnesium oxide (“MI”).

.5 sheath: seamless annealed copper.

.6 voltage rating: 300 V.

.7 terminations: as supplied by the cable manufacturer.

.8 listed for fire alarm cabling CSA FAS 105.

.9 fire rating: 2 hour fire-resistance rating with hose stream test to ULC-S139.

.10 ship cables with ends sealed.

.11 listed to CSA C22.2 No. 208 and ULC-S139.

Standard of Acceptance

- Pentair/Pyrotenax System 1850 Twisted Pair

2.4 Fire Rated Ceramifriable Silicone Rubber Insulated Cable

.1 Application: controls and communications wiring.

.1 No of conductors:

(a) single twisted pair for control and BAS MSTP communication,
(b) 4x shielded twisted-pair for Ethernet communications.

.2 conductors: annealed copper, 18 AWG, with flame retardant tape cover,

.3 insulation: thermoset ceramifriable silicon rubber, colour coded red/black,

.4 drain wire: 20 AWG copper,

.5 shield: copper/polyester tape,

.6 jacket: low smoke, zero halogen polyolefin, red colour,

.7 voltage rating: 72 V maximum,

.8 fire rating: 2 hour fire-resistance rating with hose stream test to ULC-S139,

.9 listed to CSA C22.2 No. 208 and ULC-S139.

Standard of Acceptance

- Vitalink (Marmon, Comtran) FAS 105

2.5 Conduits and Fittings

.1 Conduits:

.1 rigid hot dipped galvanized steel threaded conduit,

.2 electrical metallic tubing (EMT), hot dipped galvanized with couplings,

.3 PVC coated hot dipped galvanized rigid steel conduit: with 40 mil PVC exterior coating, 2 mil urethane interior and thread coating,

.4 flexible metal conduit and liquid-tight flexible metal conduit.

.2 Conduit fastenings:

.1 single hole steel straps to secure surface conduits 50 mm (2") and smaller,

.2 two hole steel straps for conduits larger than 50 mm (2"),

.3 beam clamps to secure conduits to exposed steel work,

.4 channel type supports for two or more conduits,

.5 Ø6 mm threaded rods to support suspended channels.

.3 Conduit fittings:

.1 manufactured for use with conduit specified including coatings,

.2 factory "ells" where 90° bends are required for 25 mm (1in.) and larger conduits,

.3 insulated throat steel set screw or raintight insulated throat steel compression connectors and couplings for EMT,

.4 threaded or compression type raintight/concrete tight insulated throat zinc plated steel connectors and couplings for rigid steel conduit,

.5 raintight insulated throat steel connectors at all surface equipment enclosures and other electrical equipment in sprinklered areas for all conduit terminations.

2.6 Outlet Boxes

.1 Construction:

.1 hot dipped galvanized steel single and multi-gang flush device boxes for flush installation,

.2 Size:

.1 76 mm x 50 mm x 38 mm (3" x 2" x 1½") or as indicated,

.2 102 mm (4") square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

2.7 Safety (Disconnect) Switches

.1 Construction:

.1 listed to CSA C22.2 No. 4m

.2 fuseholder assemblies listed to CSA C22.2 No. 39,

.3 fused unless shown as unfused,

.4 fuseholders suitable for Class J fuses, sized to suit the fuse sizes without the use of adaptors,

.5 horsepower rated,

.6 type 3R painted metal enclosure,

.7 one, two or three pole as required for single phase or polyphase circuits,

.8 two pole with solid neutral or three pole with solid neutral for three wire and four wire circuits with neutral,

.9 six pole for two speed motor applications,

.10 provision for padlocking in the Off switch position,

.11 mechanically interlocked door to prevent opening when handle is in the ON position,

.12 heavy duty, quick-make, quick-break action,

.13 ON-OFF switch position indication on switch enclosure cover.

.2 Fuses:

.1 HRC Class J time delay up to 600A,

.2 HRC Class L for ratings above 600A,

.3 product of one manufacturer,

.4 ampere rating as indicated, where not indicated, the maximum rating permitted by the electrical code.

.3 Special requirements for disconnect switch located between a VFD and the controlled equipment:

.1 auxiliary status switch;

(a) rating: 10 A at 120 VAC,
(b) switch contacts open when disconnect switch is Not-Closed.

.4 Ratings:

.1 IEC 90 rotary switch for motors up to 18.6 kW (25 HP),

.2 NEMA flange mount for all ratings.

Standard of Acceptance

- Square "D"/Schneider Electric Company (Canada) Ltd.
- Eaton
- Siemens Canada Ltd.
- Klockner Moeller/Eaton

2.8 Equipment Service Lights (Marine Lights)

.1 Copper-free aluminium base, Pyrex globe, wire guard, stainless steel hardware, and watertight seal,

.2 100 watt incandescent or 18 watt compact fluorescent lamp.

.3 Power: 120 VAC.

.4 Wall or ceiling mount.

Standard of Acceptance

- Crouse Hinds - Type Pauluhn 700 series

2.9 Switches

.1 Toggle switch, with neon pilot light – light is On when switch is Off.

.2 Rating: 20 A at 120 Vac.

.3 Switch cover: weatherproof with silicone rubber gasket, and clear bubble over toggle.

Standard of Acceptance

- Hubbell - HBL1795

2.10 Receptacles

.1 Class A GFCI type, 15 A at 120 VAC indoors, and 20 A T-slot for outdoors.

.2 Receptacle outlet hood:

.1 in-use weatherproof, for both indoor and outdoor locations,

.2 die cast aluminum base and cover with gasket,

.3 vertical mount.

.4 self-closing lift cover.

.5 CSA 3R rated.

Standard of Acceptance

- Bryant Electric – WPB26EH

2.11 Conduit and Equipment Supports

.1 Carbon steel supports, hot dipped galvanized after fabrication,

.2 Manufacturer standard products suitable for support load rating of conduit and conductors,

Standard of Acceptance

- Burndy Canada Ltd.
- Canstrut
- Electrovert Ltd.
- E. Myatt & Co. Ltd
- Steel City Electric Ltd.
- Pilgrim Technical Products Ltd.

.3 Upper attachment – concrete inserts

.1 galvanized wedge inserts to MSS SP-58 type 18.

.2 maximum tension load rating: 4.4 kN (1000 lbs),

Standard of Acceptance

- Anvil - fig. 281
- Unistrut - fig. P-3245

.4 Upper attachment – existing concrete:

.1 surface mount clevis plate, for mounting to concrete,

.2 carbon steel plate with clevis and malleable iron socket with bolt, and weldless eye nut.

Standard of Acceptance

- Anvil - fig. 49 clevis plate, Fig. 290 weldless eye nut
- Myatt - fig. 535 socket, Fig. 480 weldless eye nut

.3 threaded inserts for drilled holes.

Standard of Acceptance

- Hilti - fig. HDI, Kwick Bolt, HSL

.5 Upper attachment – steel beams:

.1 carbon steel beam clamp (top flange), hook rod with locking jaw, fasteners and lockwashers, to MSS SP-58, type 25,

Standard of Acceptance

- Anvil - fig. 227
- Myatt - fig. 504, 505

.6 Upper attachment - steel joists:

.1 for installation of support rod in the interstice space of double-ell steel joists and open-web steel joints for support on the lower chord,

.2 carbon steel washer plate with double locking nuts on top-side of washer,

.3 second steel washer plate on underside of joist with nut where supported equipment is subject to vibration.

Standard of Acceptance

- Anvil - fig. 60
- Myatt - fig. 545

.7 Hanger rods:

.1 continuous threaded rod, carbon steel, USS national course thread,

.2 tension load ratings to MSS SP-58,

Standard of Acceptance

- Anvil - fig. 146
- Myatt - fig. 434

.8 Horizontal Pipe Support – Swivel Ring Hanger

.1 swivel ring hangers, carbon steel ring strap, zinc plated, adjustable knurled swivel nut, to MSS SP-58 Type 10,

.2 nominal conduit size: 12mmC to 100 mmC.

Standard of Acceptance

- Anvil - fig. 69, CT-69
- Myatt - fig. 41, 42, 43
- Unistrut

.9 Rooftop conduit supports:

.1 conform to specification section 20 05 29.

2.12 Wire Markers

.1 Printed, self-laminating vinyl wire and cable labels and sleeve-labels.

Standard of Acceptance

- Brady BMP21 Plus series

3 EXECUTION

3.1 General

.1 Install electrical wiring work under this specification section in accordance with the applicable electrical safety code and regulations applicable at the location of the Work.

.2 Support conduit from building structure in accordance with specification section 20 05 29.

3.2 Conduit Support and Hanger Installation

.1 Support conduit directly from or on structural building elements. Do not support conduit directly from other services.

.2 Provide all miscellaneous materials including nuts, washers, and backing plates to make a complete support installation.

.3 Where wall brackets are used, select brackets and size mounting bolts and backing plates to suit the supported load, allowing for a safety factor by not loading the bracket more than 80% of its published load rating.

.4 In steel framed construction, support conduit from structural members. Where structural members are not suitably located for upper hanger attachment locations, and where inserts of adequate capacity cannot be installed in concrete slabs, provide supplementary steel framing members;

.1 fabricate supplementary steel from standard HSS sections, single EL section, double C "strongback" sections, or pipe rolls,

.2 size supporting steel to limit span deflection to 1/250 (0.4%) between support points,

.5 Support horizontal conduit at intervals not exceeding 3 m (6 ft).

.6 Support vertical conduit at intervals not exceeding 3 m (6 ft).

.7 Where trapeze hangers are used, secure conduit to trapeze with U-bolts.

.8 Mechanically fasten supplementary steel to structural steel.

3.3 Installation of Power and Control Wiring – General Requirements

.1 Wiring methods and standards to conform with those specified in Electrical Division 26 for the area of building in which installation is to be made, except as otherwise specified in this section.

.2 Except where fire rated cables or VFD Inverter duty cables are required, use building wire for:

.1 power wiring for motors and packaged equipment,

.2 power wiring to control panels, heat tracing and other non-motorized packaged equipment, and

.3 non-analog control wiring at 120 VAC or less, and 24 VDC or less.

.3 Provided polyphase motor and equipment power conductors' with the following colour coding:

.1 Phase A – Red,

.2 Phase B – Black,

.3 Phase C – Blue ,

.4 Neutral - White,

.5 Ground - Green,

.6 Control - Orange.

.7 Where colour coded tape is utilized, apply at least 50 mm (2") at terminations, junction boxes and pull boxes. Do not paint conductors.

.4 Provide single-phase motor and control wiring conductors with the following colour coding:

.1 Line – Red,

.2 Neutral – White,

.3 Ground – Green.

.5 Install all wiring in conduit or approved raceway.

.6 Conduit selection type:

.1 EMT: Use thin wall conduit up to and including 32 mm (1 ¼ in) size for wiring in ceilings, furred spaces, in hollow walls and partitions and where not exposed to mechanical injury, and as otherwise shown.

.2 Rigid : Use rigid galvanized steel conduit for wiring in poured concrete, where exposed, and for conduit 40 mm (1½ in) size and larger.

.3 Liquid-tight flexible: use only for the last 1000 mm (3 ft) of motor feeder at connection to motor, and for instrumentation wiring to equipment subject to vibration.

.4 Select conduit size to be of sufficient size to allow easy removal of conductors at any time. Conduit sizes, where shown, are minimum and shall not be reduced.

.7 Provide separate conduit for power wiring for each motor or starter. Do not install control wiring in the same conduit as power wiring.

3.4 Installation of Instrumentation, Communications and Control Cabling

.1 Install wiring in conduit.

.2 Neatly train circuit wiring in cabinets, panels, pullboxes and junction boxes and hold with nylon cable ties.

.3 Run instrumentation, communication and control cabling point to point and terminate on terminal strips. Do not splice communication or control cabling. Where long runs make a continuous point to point installation impractical, make splices on labelled terminal blocks in an accessible labelled terminal cabinet, installed at 1200 mm (48") above floor, and indicate cabinet location, terminal and wire numbers on the As-built drawings.

.4 Terminate control cables in equipment with suitable connectors.

.5 Clearly identify cables/conductors at both ends, with permanent wire markers, indicating device/panel identification and terminal numbers on the device/panel (refer to standard detail 20 15 12-021 at the end of this specification section):

.1 Use applicable reference name or ID tag for the device or control panel.

.2 Print the labels such that the applicable panel/device identification is closest to the end of the cable.

.3 Where individual wires are run in conduit, collect wires associated to the same control panel/device and apply a label to the group of wires inside each control panel/device. Where there is insufficient space inside a device (such as a transmitter), the label may be applied to the conduit at the point of connection to the device.

.4 Where there are multiple conductors, individually identify each wire by its termination reference on the panel or device to which it connects.

.5 Where there are only two wires and it is readily understood where each wire is to be terminated (i.e. white neutral, green ground), individually marking of the wires is not required.

3.5 Grounding

.1 Ground electrical equipment and wiring in accordance with the applicable electrical safety code and regulations applicable at the location of the Work except where greater requirements are specified herein.

.2 Provide insulated green bonding conductor in each power and control conduit sized per Table 16 of the Electrical Safety Code. Minimum bonding conductor size #12AWG copper.

.3 Install grounding conductors, outside electrical rooms and electrical closets, in conduit.

.4 Make connections to neutral and equipment with brass, copper or bronze bolts and connectors.

.5 Except for VFD Inverter Duty cables, ground all motors with separate green insulated copper ground conductor installed in power feeder conduit, wired from ground terminal in the motor controller to a

ground lug bolted directly to the motor frame, located inside the motor terminal box. Size the ground conductor per Table 16 of the electrical safety code. Minimum conductor size to be #12 AWG.

.6 Ground VFD Inverter Duty cables using all three integral ground conductors, from the ground terminal in the VFD enclosure to the ground lug bolted directly to motor frame inside the motor terminal box.

3.6 Disconnect Switches

.1 For Type 3, 3R and 4 enclosures, provide watertight connectors complete with O rings for conduit connections.

.2 Motorized equipment:

.1 Provide disconnect switches for motor driven equipment provided under the mechanical trades work.

.2 Locate the disconnect switches as follows;

(a) within 9 m (29 ft) and in the line-of-site of motors serving non-refrigeration motorized equipment, and within 9 m (29 ft) of the motor controller or VFD controlling the equipment,
(b) within 3 m (9.5 ft) and in the line-of-site of equipment containing refrigeration compressors and related motorized equipment that forms part of a refrigerant circuit.

.3 Disconnect switch types:

(a) fused type for motor controllers and VFD's,
(b) fused type for motorized packaged equipment.

.4 Exception: a separate disconnect switch is not required where;

(a) a motor controller or VFD is provided with an integral disconnect switch with overcurrent protection and is located with respect to the controlled equipment as specified above, or
(b) packaged equipment is provided with an integral disconnect switch with overcurrent protection.

.5 Where a disconnect switch is required between a VFD and the driven motor due to distance limitations being exceeded or the VFD is not in site from the motor, provide an unfused disconnect switch with integral limit switch, at the motor. Wire the limit switch back to the VFD digital input for drive output protection.

.3 Non-motor equipment:

.1 Provide unfused disconnect switch for the following equipment provided under the mechanical trades work.

(a) terminal unit boxes,
(b) reheat coils,

.2 Locate disconnect switch immediately adjacent to equipment served.

(a) exception: for terminal unit boxes, a separate unfused disconnect switch is not required where a fused disconnect switch is provided as part of the terminal unit box control panel.

.4 Where fuse protection is specified, install fuses of the correct rating in fused disconnect switches,

.5 Where fuse protection is specified, provide a set of six spare fuses of each size used in the disconnect switches. Turn spare fuses over to the Owner and submit a copy of the receipt signed by the Owner.

3.7 Outlet Boxes

.1 Size boxes in accordance with CSA C22.1. Use 102 mm (4") square or larger outlet boxes as required for special devices.

.2 Gang boxes where wiring devices are grouped. Use combination boxes with barriers where outlets for more than one system are grouped.

.3 Provide nlank cover plates for boxes without wiring devices.

3.8 Service Lights, Switches and Receptacle

.1 Provide service lights inside of air plenums and as otherwise shown. Provide minimum of one service light per 3 m (10 ft) width or length of plenum.

.2 Mount switches for service lights in accessible location on outside of plenum and air handling units. Provide one switch for each fan system.

.3 Provide one receptacle wired ahead of each service light switch, located between 300 mm (12 in) and 1200 mm (4 ft) above the floor.

3.9 Coordination and Division of Responsibility – Division 20 and Division 26

.1 The following electrical work shall be provided under Division 20, including termination of conductors. For clarity;

.1 the Division 20 work may be performed by the Division 26 contractor, but the work is managed and paid for by Division 20.

.2 related work performed under Division 26 is listed in this table for reference.

.2 Coordinate power requirements for mechanical trades equipment with the contractor under Division 26 of the work, including;

.1 provide a list of all planned and ordered mechanical trades equipment with motor horsepower ratings or electrical power requirements, prior to the Division 26 contractor procuring their power distribution equipment,

.2 periodically update this power requirements list as mechanical trades equipment is ordered, and review with the Division 26 contractor to allow them to revise breaker ratings in a timely manner,

.3 Where the branch circuit breaker rating requirements change as a result of the actual ordered mechanical trades equipment, coordinate and pay for any breaker and feeder changes required whether the affected work is in Division 20 or Division 26 scope of work.

Reference	Work Element	Div. 20	Div. 26
All	Motor Control Centers, motor controller racks, motor controllers, VFDs, and disconnect switches	●	
Dedicated Power Panels for Mechanical Equipment (Note 1)	Mechanical Power Panels (MPP) and Mechanical Breaker Panels (MBP), including branch overcurrent protection devices.		●
	Power wiring from MPPs and/or MCCs to: - motors, including between motors and motor controllers, VFDs and/or disconnect switches as applicable, - packaged equipment, including disconnect switches as applicable, - equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc)	●	
	Power wiring from BP and/or MBP to: - motors, including between motors and motor controllers, - packaged equipment, including disconnect switches as applicable, - equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc)	●	
Non-dedicated	Non-dedicated Power Panels (PP) and breaker panels (BP), including branch overcurrent protection devices.		●

Reference	Work Element	Div. 20	Div. 26
Power Panels (Note 2)	Distribution splitters		●
	Power wiring from PPs and/or distribution splitters to: - motor controller, - disconnect switch ahead of VFD, - disconnect switch for package equipment, - packaged equipment (with integral disconnect switch) - equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc)		●
	Power wiring from BP to: - motor controller or disconnect switch, - disconnect switch for package equipment, - packaged equipment (with integral disconnect switch), - equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc)		●
	Power wiring from: - disconnect switch to a VFD, - motor controller or VFD to the motor, - disconnect switch to packaged equipment	●	
Terminal Unit Boxes	Control power of 120 V, single phase terminating adjacent to designated building automation control panels.		●
	Control power of 120 V, single phase terminating in a junction box for each group of terminal boxes with maximum of 12 terminal unit boxes fed from one junction box [Note 3].		●
	Control power at 24 VAC/DC, from building automation control panels to terminal unit box controller [Note 3].	●	
	Control power of 120 VAC power wiring to each terminal unit box controller (from junction box provided by Division 26 for each group of controllers [Note 3].	●	
	3 phase, 208 V and higher voltage wiring direct to terminal unit box.		●
	Power wiring for controls in service rooms: fed from dedicated power panels to the BAS and OEM control equipment.	●	
	Power wiring for controls other than in service rooms: fed from dedicated power panels and/or allocated breakers	●	
	120 V, single phase power supply with a junction box at specific control devices as shown.		●
	Breaker tamper-protection locks.	●	
	Instrumentation and actuator power and control wiring, for both BAS controls and OEM controls.	●	
	Control wiring to interlock motor controllers and to connect safety and operating controls.	●	

Reference	Work Element	Div. 20	Div. 26
	Wiring from adjacent junction box or pull box to plumbing fixtures requiring control power	●	
	Control transformers and extra-low voltage wiring	●	
Equipment Service Lights	120 VAC, 15A power circuits for equipment service lights, terminated in an outlet box on an adjacent wall, column or ceiling.		●
	Power wiring from adjacent junction boxes to light switches/service convenience outlets and fixtures	●	
	Equipment service lights, switches and convenience outlets.	●	

Notes:
[1] MPP and MBP will be located in mechanical services rooms.
[2] PP and BP are not dedicated for mechanical equipment and may be located in any type of service room or space.
[3] Refer to specification section 20 05 01 for specific wiring methods.

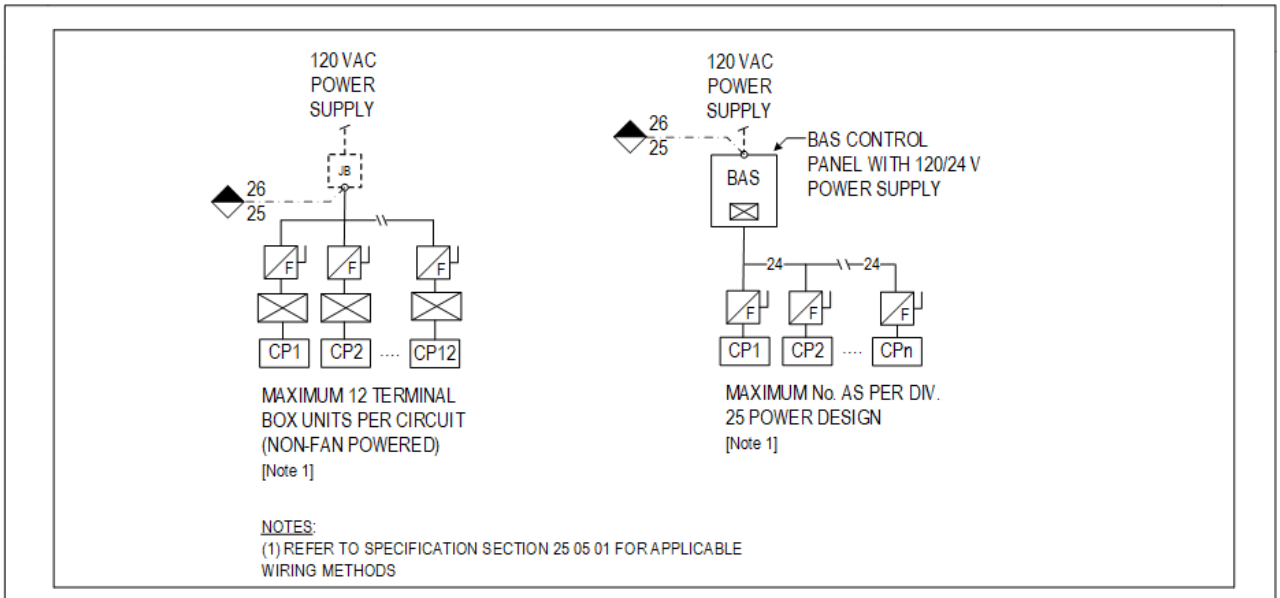
3.10 Wiring Diagrams

.1 Wiring diagrams following at end of this section:

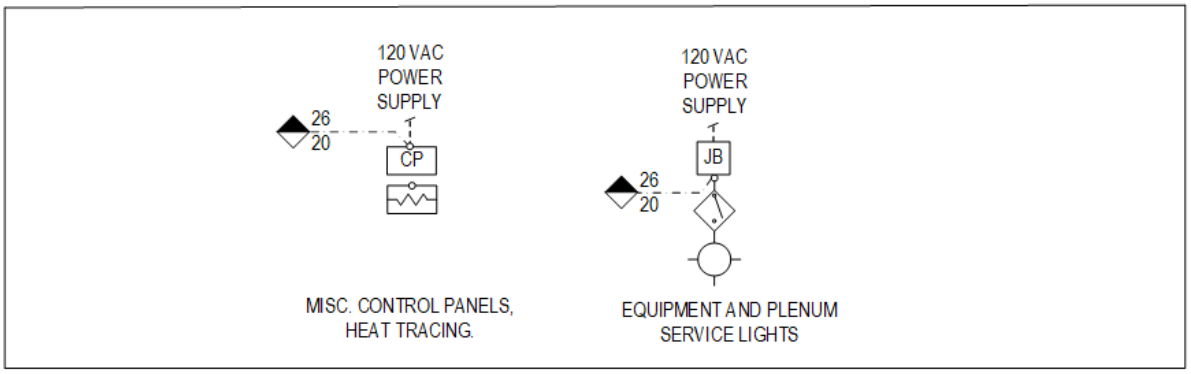
.1 20 05 12 - 01 Mechanical – Electrical Coordination (Sheet 1 of 2)

.2 20 05 12 - 02 Mechanical – Electrical Coordination (Sheet 2 of 2)

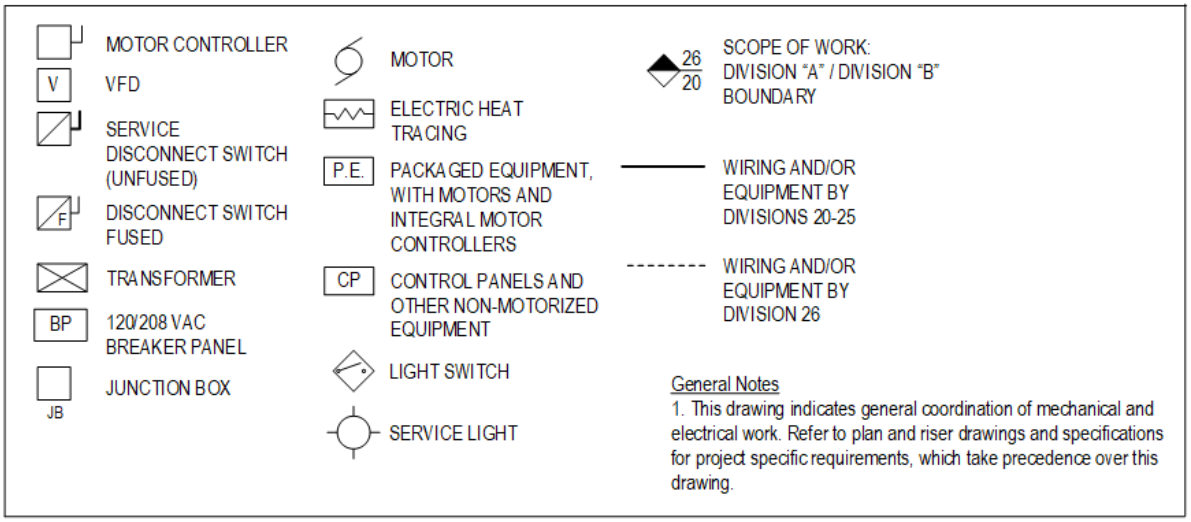
END OF SECTION



TERMINAL BOX UNITS



MISCELLENOUS NON-MOTORIZED EQUIPMENT



LEGEND

HHAngus	Sheet Title: MECHANICAL – ELECTRICAL COORDINATION (SHEET 1 OF 2)	Date: 12-NOV-2019	Rev. No.: 01 / Checked: PS
		Standard Detail No. 20 05 12-001	

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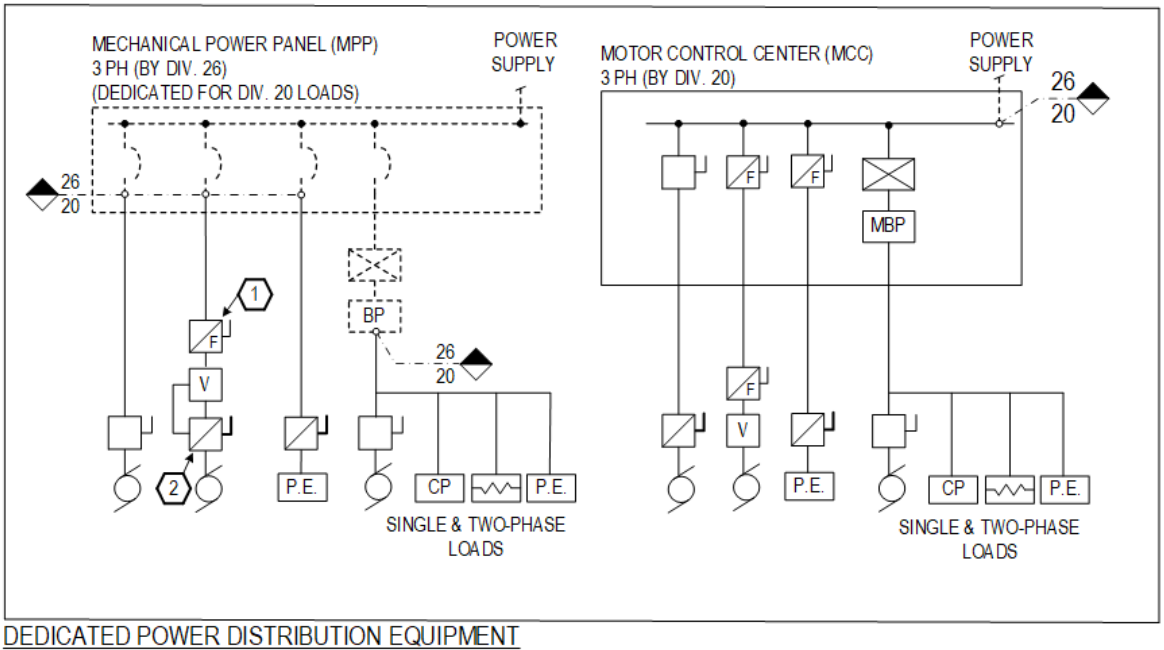
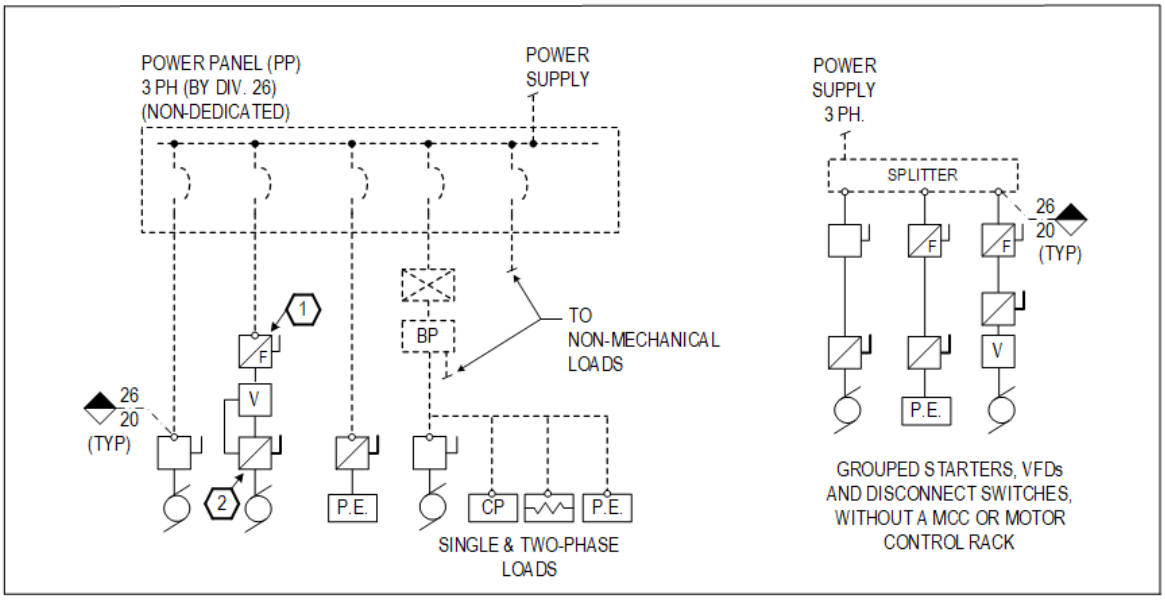


DEDICATED POWER DISTRIBUTION EQUIPMENT



NON-DEDCATED POWER DISTRIBUTED EQUIPMENT

KEY NOTES:

(1) SEPARATE FUSED DISCONNECT WHEN NOT PROVIDED INTEGRAL TO THE V.F.D. (TYP)

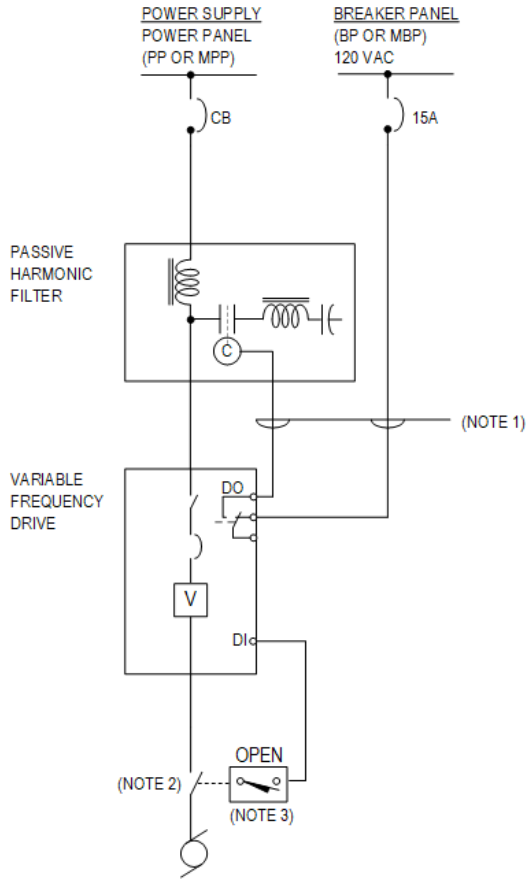
(2) SEPARATE UNFUSED DISCONNECT WHERE V.F.D. IS REMOTE FROM THE MOTOR. PROVIDE DISCONNECT SWITCH POSITION INTERLOCK WIRED BACK TO THE V.F.D. (TYP)

General Notes

1. This drawing indicates general coordination of mechanical and electrical work. Refer to plan and riser drawings and specifications for project specific requirements, which take precedence over this drawing.

2. Dedicated power distribution equipment is only located in mechanical service rooms.

HHAngus	Sheet Title: MECHANICAL – ELECTRICAL COORDINATION (SHEET 2 OF 2)	Date: 12-NOV-2019	Rev. No.: 01	Checked: PS
		Standard Detail No. 20 05 12-002		

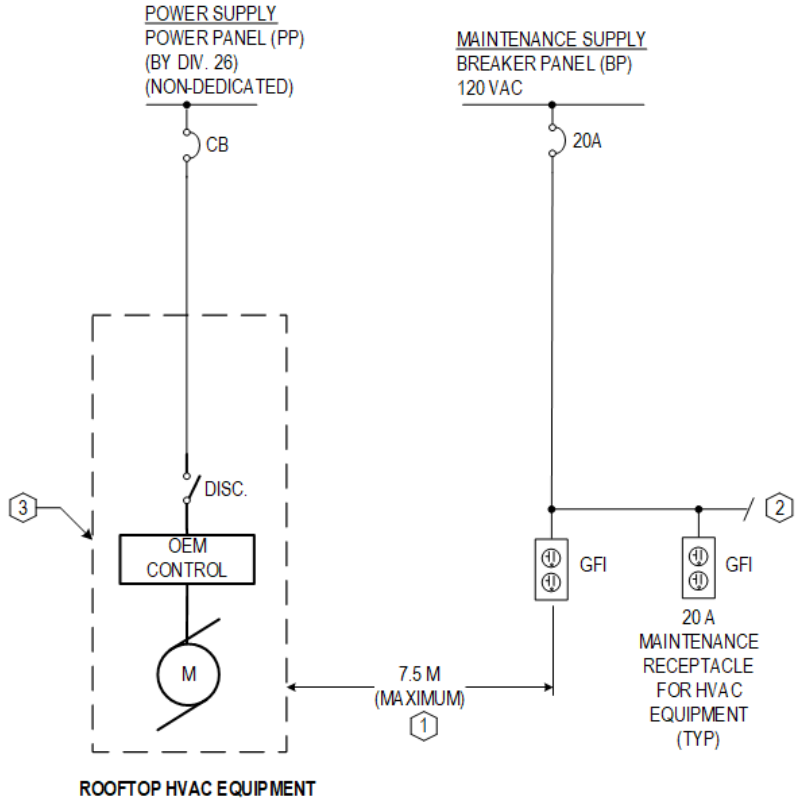


NOTES:

1. 120 VAC CONTROL POWER TO HARMONIC FILTER CONTACTOR, 2#14-15mmC
2. DISCONNECT SWITCH AT MOTOR WHEN VFD IS LOCATED MORE THAN 9 M AND/ OR IS OUT-OF-SITE FROM THE MOTOR.
3. POSITION SWITCH WIRED TO VFD, 2#14-12mmC

THIS DRAWING ILLUSTRATES AUXILIARY POWER AND MINIMUM INTERLOCK REQUIREMENTS. REFER TO SPECIFICATION AND DRAWING DETAILS FOR OTHER CONTROL REQUIREMENTS. SEE ALSO STANDARD DETAIL 20 05 14-005.

HHAngus	Sheet Title: VARIABLE FREQUENCY DRIVE SINGLE LINE SCHEMATIC	Date: 08-DEC-2019	Rev. No.: 01	Checked: PS
		Standard Detail No. 20 05 12 - 003		



ROOFTOP HVAC EQUIPMENT

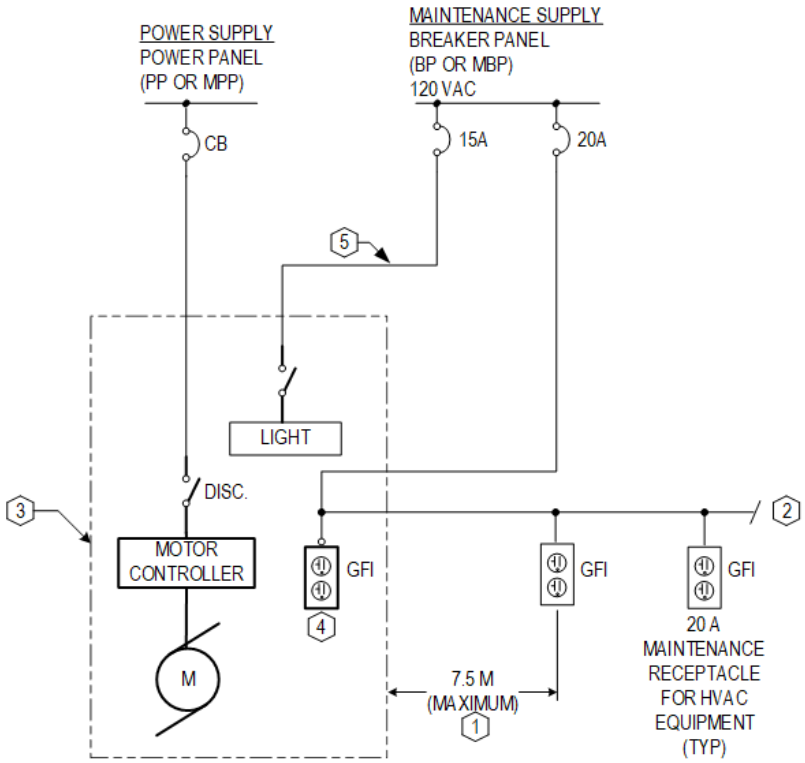
KEY NOTES:

1. ONE MAINTENANCE RECEPTACLE CAN SERVE MULTIPLE HVAC UNITS, PROVIDED MAXIMUM DISTANCE TO EACH UNIT IS MAINTAINED.
2. ONE BRANCH CIRCUIT MAY SERVE MULTIPLE MAINTENANCE RECEPTACLES DEDICATED TO HVAC EQUIPMENT..
3. "ROOFTOP HVAC EQUIPMENT"; DOES NOT INCLUDE ROOF FANS WHICH DO NOT HAVE AN INTEGRAL CONTROLLER.

General Notes

1. This drawing indicates general wiring requirements for rooftop equipment power wiring and maintenance service wiring. Refer to specifications for coordination of work under Division 20 and 26.

HHAngus	Sheet Title: ROOFTOP HVAC EQUIPMENT MAINTENANCE RECEPTACLES	Date: 16-NOV-2019	Rev. No.: 00	Checked: PS
		Standard Detail No. 20 05 12-004		



ROOF TOP A.H.U. WITH SERVICE LIGHTS AND RECEPTACLES

KEY NOTES:

1. ONE MAINTENANCE RECEPTACLE CAN SERVE MULTIPLE HVAC UNITS, PROVIDED MAXIMUM DISTANCE TO EACH UNIT IS MAINTAINED.
2. ONE BRANCH CIRCUIT MAY SERVE MULTIPLE MAINTENANCE RECEPTACLES DEDICATED TO ROOFTOP EQUIPMENT MAINTENANCE.
3. "ROOFTOP HVAC EQUIPMENT" DOES NOT INCLUDE ROOF FANS WHICH DO NOT HAVE AN INTEGRAL MOTOR CONTROLLER.
4. MAINTENANCE RECEPTACLE MAY BE LOCATED INSIDE AIR HANDLING UNIT SERVICE CORRIDOR; SEPARATE EXTERNAL RECEPTACLE NOT REQUIRED.
5. MAINTENANCE LIGHTS INSIDE HVAC EQUIPMENT ON SEPARATE BRANCH CIRCUIT THAN MAINTENANCE RECEPTACLES.

General Notes

1. This drawing indicates general wiring requirements for rooftop equipment power wiring and maintenance service wiring. Refer to specifications for coordination of work under Division 20 and 26.

HHAngus	Sheet Title: ROOFTOP CUSTOM A.H.U. MAINTENANCE RECEPTACLES	Date: 16-NOVE-2019	Rev. No.: 00	Checked: PS
		Standard Detail No. 20 05 12-005		

GENERAL REQUIREMENTS FOR VALVES
20 05 23

1 GENERAL

1.1 Scope

.1 Provide valves in piping systems for shut-off service, manual flow balancing, check-stops and valve bodies for automatic flow control.

.2 This specification section provides general requirements for valves.

1.2 Related Sections

.1 Refer to the following valve specification sections for requirements for general-duty valves in addition to the general requirements specified herein.

23 05 23.13 General-Duty Valves for HVAC Water Piping

.2 Refer to the following specifications sections for requirements for specific-duty valves in addition to the general requirements specified herein.

23 61 07 Refrigeration Piping – HVAC

25 35 01 B.A.S – Instrumentation and Actuators

1.3 Submittals

.1 Submit manufacturer product data-sheets for valves, including pressure-temperature ratings with confirmation that the valve meets the required MCPR rating specified for each valve.

.2 Where valves are specified to be listed (certified) to a standard, include the following information for each affected product:

.1 applicable standard by name and reference number,

.2 name of accredited testing organization or their mark who certified the product, and

.3 the testing organization file reference number.

.3 Where valves are required to have a CRN, include the CRN and its expiry date on each valve submittal.

.4 Where manufacturer pre-printed data-sheets do not include this information, a schedule may be submitted which includes the manufacturers name, model number and the required listing and/or CRN information described above. Where the product is name-branded for a manufacturer, include the name of the source manufacturer.

1.4 Applicable codes and standards

.1 Legislation:

.1 Valves installed in piping systems which are subject to provincial or federal pressure piping legislation shall have current Canadian Registration Numbers (“CRN”) in accordance with CSA B51.

.2 Installation standards, codes and guidelines:

.1 CSA B51 Boiler and Pressure Vessel Code.

.2 Refer to applicable piping specification sections for any other specific requirements.

.3 Product standards:

.1 ANSI/ASME B1.20.1 Pipe Threads, General Purpose, Inch

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

.3	ASME B16.5	Pipe Flanges and Flanged Fittings
.4	ASME B16.10	Face-to-Face and End-to-End Dimensions of Valves
.5	ASME B156.24	Cast Copper Alloy Pipe Flanges and Flanged Fittings
.6	ASME B16.34	Valves Flanged, Threaded and Welding Ends
.7	ASME B16.47	Large Diameter Steel Flanges: NPS 26 Through NPS 60
.8	ISO 5211	Industrial Valves – Part-turn Actuator Attachments
.9	MSS SP-25	Standard Marking System for Valves, Fittings, Flanges, and Unions
.10	MSS SP-42	Corrosion-Resistant Gate, Globe, Angle, and Check Valves with Flanged and Butt Weld Ends (Classes 150, 300, & 600)
.11	MSS SP-67	Butterfly Valves
.12	MSS SP-68	High Pressure Butterfly Valves with Offset Design
.13	MSS SP-70	Cast Iron Gate Valves, Flanged and Threaded Ends
.14	MSS SP-71	Cast Iron Swing Check Valves, Flanged and Threaded Ends
.15	MSS SP-72	Ball valves with Flanged or Butt-Welding ends for General Service
.16	MSS SP-78	Cast Iron Plug Valves
.17	MSS SP-80	Bronze Gate, Globe Angle and Check Valves
.18	MSS SP-85	Cast Iron Globe and Angle Valves, Flanged and Threaded Ends
.19	MSS SP-110	Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
.20	MSS SP-125	Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves
.21	MSS SP-126	In-Line, Spring-Assisted, Center-Guided Check Valves (Carbon, Alloy Steel, Stainless Steel, & Nickel Alloys)
.22	MSS SP-136	Ductile Iron Swing Check Valves
.23	MSS SP-139	Copper Alloy Gate, Globe, Angle, and Check Valves for Low Pressure/Low Temperature Plumbing Applications
.24	NSF/ANSI 61	Drinking Water System Components – Health Effects
.25	NSF/ANSI 372	Drinking Water System Components – Lead Content (formerly NSF/ANSI 61- Annex G).

1.5 Quality and Equivalence

.1 Valve selections are in general identified by model designations taken from manufacturers catalogues to indicate physical properties and quality requirements not otherwise described.

2 PRODUCTS

2.1 General

.1 Refer to related specification sections.

.2 Manufactures and/or trade names listed in Table 1 are acceptable for various indicated valve types, where products offered are essentially similar to those identified by manufacturer or model number under “Standard of Acceptance” designation in the related specification sections.

.1 Refer to the General-duty valve specification sections and specific-duty valve requirements contained in the related piping system specification sections.

.2 Additional specification requirements and/or certification requirements may be required by those sections.

Manufacturer	Gate, Globe, Angle, Check	Silent Check	DRV	Butterfly	Plug	Ball
A-Chem Valves & Controls	●			●		●
American Valve						●
APCO		●				
Apollo				●		●
Bonney Forge	●					
Beric	●					
Bray				●		●
Canadian Worcester Controls						●
Challenger				●		
Couplox				●		
Crane	●			●		●
Crane Centreline				●		
Crane Flowseal				●		
Dahl Bros	●					●
Demco				●		
DeZurik				!		
Durabla		●				
Grinnell				●		
Gruvlok				●		●
Hattersley Milliken (Crane)					●	
Jenkins	●			●		●
Keystone				●		
Kitz	●			●		●
Milwaukee Valve				●		●
Mueller		●		●	●	
Neo Valves	●					●
Nibco	●	●		●		●
Nordstrom					●	
Powell	●					
Preso			●			
S.A. Armstrong	●		●			
Shurjoint				●		●
Sure Seal				●		
Tour & Anderson			●			

Manufacturer	Gate, Globe, Angle, Check	Silent Check	DRV	Butterfly	Plug	Ball
Toyo Valve (Red &White)	●					●
Triad				●		
Trueline	●					●
Valmatic		●				
Velan	●			●		●
Victaulic				●		●
Watts	●			●		●
WKM				●		

3 EXECUTION

3.1 Valve Selection Criteria

.1 Select valves in accordance with function criteria as shown in Table 2.

Table 2: Valve Function Selection

Function	Gate	Butterfly	Ball	Globe	Plug	DRV
Shut-Off	●	●	●		●	
Flow balancing and shut-off					● [1] [2]	●
Flow Balancing only (excluding pumps)				●		●

Notes:

[1] Gear operator with position limit memory stops.

[2] Non-lubricated plug valve designed for flow balancing.

3.2 Piping System Drain Valves

.1 Provide drain valves on piping and at equipment as follows unless otherwise shown on drawings:

.1 On pipe mains and branches NPS 3 and under, and for equipment with pipe connections NPS 4 and smaller:

(a) NPS ¾ ball valve in accordance with pipe system specification with integral NPSH ¾ hose end with cap and chain.

.2 On pipe mains NPS 4 to NPS 6, and for equipment with pipe connections NPS 6 and larger:

(a) NPS 1 ball valve, with a NPT threaded brass Cam and Groove female coupler fitting with dust-plug

.3 On pipe ains NPS 8 and larger:

(a) NPS 2 ball valve, with a NPT threaded brass Cam and Groove female coupler fitting with dust-plug.

3.3 Valve Installation - General

.1 Install shut off valves at:

.1 branch take-offs,

.2 to isolate piping to each piece of equipment, and

.3 in locations shown.

.2 Remove internal parts of valves before soldering, welding or brazing pipe to valve body.

.1 Exception: where valve is provided with tube end extensions to allow soldering or brazing without removal of internal parts.

.2 For valves which do not permit disassembly including ball valves and inline check valves, comply with valve manufacturer instructions to protect valve internal components during soldering, brazing or welding.

.3 Install triple duty or throttling valves where shown in pump discharge piping with ten pipe diameters of straight pipe on the inlet side and two pipe diameters on outlet side.

.4 Install butterfly valves between weldneck or slip-on flanges.

3.4 Valve Orientation and Accessibility

.1 Arrange valve hand-wheels and operating levers to be accessible.

.2 In equipment rooms and service spaces provide chain operators for valves mounted more than 2m (6 ft) above floor or access platform. Provide sufficient chain length to extend to 1.5m (4 ft-6 in) above floor or platform and to be hooked on clips secured to building structure, clear of walking aisles.

.3 In horizontal piping (see figure 1);

.1 For OS&R valves, install the valve with stem vertical where the valve centerline is not more than 1200 mm above the adjacent floor or access platform. For greater heights, install the valve with stem horizontal. Where space is restricted, the valve may be installed with the valve spindle at a 45° angle from the vertical where the valve centerline is not more than 1500 mm above the floor or access platform.

.2 For gear operated valves, install with gear-box on top of the valve and hand-wheel shaft in the horizontal position.

.3 For lever operated valves, install with handle on top of valves where the valve centerline is not more than 1500 mm above the floor or access platform. Where spaces is restricted, the valve may be positioned with the lever handle shaft in the horizontal position. For greater heights, install valves with handle shaft in the horizontal position.

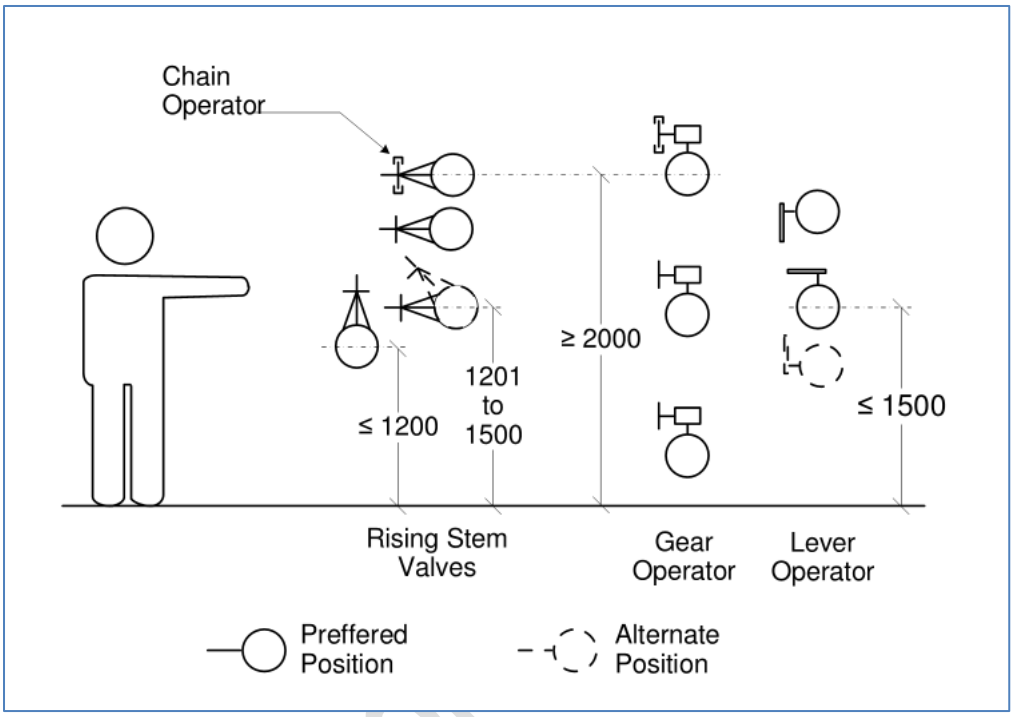


Figure 1: Valve Spindle Arrangement

.4 In vertical piping, install with valve stem facing directly towards the means of access. Where access space in front of the valve is less than 900 mm (36 in), rotate the valve 45° from the straight forward position.

END OF SECTION

WELDING AND BRAZING
20 05 24

1 GENERAL

1.1 Scope

.1 Weld or braze pipe and fittings for work of Division 20.

1.2 Definitions

.1 The following definitions apply to this specification section:

AHJ (BPV): *the authority having jurisdiction which is responsible for boiler, pressure vessel and pressure piping safety in the province of the project.*

.2 In this specification,

.1 the word “piping” also includes tubing as the case applies.

.2 the words “welding” or “welder” shall be read as to also refer to “brazing” or “brazer”

1.3 Applicable Standards

.1	CSA B51	Boiler, Pressure Vessel, and Pressure Piping Code
.2	ASME B31.1	Pressure Piping
.3	ASME B31.3	Process Piping
.4	ASME B31.9	Building Services Piping
.5	ASME BPVC Section V	Nondestructive Examination
.6	ASME BPVC Section IX	Welding and Brazing Qualifications

2 PRODUCTS

2.1 Not used

3 EXECUTION

3.1 Welding and Brazing Qualification and Welding Procedures

.1 Welding of piping systems which have specified design pressures greater than 100 kPa (15 psi) to be carried out using approved welding procedures by welders certified for pressure piping by the AHJ (BPV), whether or not the piping system is subject to registration as pressure piping.

.1 Welding procedures shall be registered with the AHJ (BPV), in accordance with CSA B51 and as qualified in accordance with ASME BPVC Section IX.

.2 Welders shall be certified for welding of pressure piping in accordance with the requirements of the AHJ (BPV). Welders shall be qualified by their employer on the employers welding procedures.

.2 For piping systems which have specified design pressure of 100 kPa (15 psi) or less, welding procedures and welders shall be qualified by the Contractor in accordance with the requirements of ASME B31.9.

.3 Welding, both shop and field, to be electric arc in accordance with recommendations of Canadian Welding Bureau unless other welding methods are specified in the piping specification sections.

3.2 Weld Quality

.1 Welds to be solid homogeneous part of metals joined and free from pits and incorporated slag and scale.

.2 Weld surfaces to be smooth and regular and weld metal deposition to achieve full penetration grove weld fused to the base metal throughout joint thickness.

3.3 Welded Connections to Existing Pressure Piping Systems

.1 At the commencement of the Work, where registration and/or inspection of the piping system is required in accordance with provincial boiler and pressure vessel regulations, review with the AHJ (BPV) inspector to determine their weld testing requirements to validate the proposed welding procedures for connecting to existing piping, including but not limited to:

.1 acceptable dimensional misalignment between old and new pipe;

.2 requirements, if any, for metallurgical analysis of exiting piping;

.3 sample guided bent test; and

.4 sample fillet weld test.

.2 After testing requirements are determined, provide a proposed schedule for tie-in connections and required existing service shut-down periods, for approval prior to commencing work.

.3 Prior to shut-down of existing piping systems for tie-ins, inspect the existing pipe O.D. dimensions to confirm their suitability for pipe attachment. Specifically, where the work requires a complete transection of an existing pipe, check the existing pipe for excessive out-of-roundness which would otherwise exceed the allowable misalignment as defined in the applicable ASME piping code. Where necessary, trim the pipe ends in accordance with the referenced piping code.

3.4 Welding Examination

.1 For piping systems which are specified to be constructed to ASME B31.1 or ASME B31.3, examination of piping, including both visual and other nondestructive examination performed in accordance with those piping codes shall be arranged and paid for by the Contractor, and are to be performed by a specialist testing company whose personnel are qualified to perform such examinations in accordance with ASME BPVC Section V.

.2 For piping systems which are specified to be constructed to ASME B31.9, examination of piping in accordance with that piping code shall be performed by the Contractor using personnel with suitably experienced for such examinations.

.3 Acceptance criteria for weld examination shall be in accordance with the specified ASME piping code.

3.5 Welding Inspection

.1 Arrange and pay for any required inspection of welds by the AHJ (BPV).

.2 Welders certificates and welding procedures used on the propject to be made available for inspection by the AHJ (BPV) on demand. Each weld to be stamped with welder's identifying numbe or a log may be used to record and identify each welders work.

END OF SECTION

COMMON HANGER AND SUPPORT REQUIREMENTS FOR PIPING
20 05 29

1 GENERAL

1.1 Scope

.1 Provide hangers and supports for piping.

.2 The requirements of this specification section apply to all piping systems, except where required otherwise by specific piping specification sections including:

.1 21 05 01 for fire protection piping,

.2 Division 22 sections for plumbing and drainage piping,

1.2 Related Work

.1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:

.1 20 05 48 Vibration Isolation

.2 20 07 19 Piping Insulation

.2 The following definitions apply to this section.

.1 ***Cold piping***: piping with a service temperature at or below 16°C (61°F).

.2 ***Ambient piping***: piping with a service temperature greater than 16°C (61°F) and up to 40°C (104°F).

.3 ***Hot piping***: piping with a service temperature greater than 40°C (104°F).

.4 ***Service temperature***: the fluid maximum operating temperature.

1.3 Applicable Codes and Standards

.1 Product and installation codes and standards:

.1	ANSI/MSS SP-58	Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation
.2	ULC/ORD-S203	Pipe Hanger Equipment for Fire Protection Service
.3	UL 203	Pipe Hanger Equipment for Fire Protection Service

.2 Refer to each applicable piping specification section for supplemental requirements for pipe supports.

1.4 Design Criteria

.1 The support spacing and hanger rod size specified herein is based on supporting a single pipe directly from the structure in accordance with MSS SP-58. If multiple pipes are supported from trapeze hangers (or similar), or from common hanger rods supporting a tier of multiple piping, then;

.1 the total load on the support rods or similar elements shall not exceed 75% of its published tension load rating data,

.2 a trapeze hanger deflection shall not exceed 1/240th of the support span, and not exceed 60% of the trapeze material yield strength, under all static and dynamic loads.

.2 Provide complete engineered design services in accordance with the requirements of MSS SP-58 for support of vertical piping for the following parts of the Work:

.1 vertical piping located in vertical services spaces (shafts) where;

(a) piping is NPS 8 and larger,
(b) the vertical pipe length exceeds 20 m (65 ft),
(c) pipe expansion joints are shown, or
(d) variable spring supports or constant load supports are shown.

.2 horizontal piping is supported on;

(a) trapeze hangers or supported on/suspended from horizontal structural elements, or
(b) pipe racks.

.3 Pipe support spacing and/or selection of pipe support types may be other than as specified herein provided the pipe supports are determined by a completely engineered system in accordance with the requirements of MSS SP-58 and as follows:

.1 custom engineered systems are restricted to:

(a) service rooms or areas containing major equipment, including boilers, chillers, and cooling towers,
(b) piping supported on pipe racks,

.2 submit a materials substitution request in accordance with the requirements of Division 01 for review and approval by the Consultant,

.3 horizontal pipe vertical deflection at midpoint in the pipe span while in operation not to exceed 6.5 mm (0.25 in.),

.4 the supported loads do not exceed 90% of manufactured product published load data, or does not exceed 60% of the material yield strength for custom fabricated supports,

.5 rod hanger loads do not exceed 80% of the tabulated values in MSS SP-80,

.6 deflections of horizontal supporting elements does not exceed 1/240th of the span,

.7 maximum single point suspended tension load in concrete not to exceed [17 kN (3820 lbs)],

.8 operating pipe stress not to exceed the maximum allowable stress in accordance with the requirements of the piping code specified for the piping system,

.9 submit complete shop drawings sealed by a professional engineer licensed in the province of the Work.

.4 Where custom engineered support systems are used, submit shop drawings designed and sealed by a professional engineer licensed in the province of the Work, and include details for each support system including load calculations.

1.5 Submittals

.1 Submit manufacturer product data sheets for all hanger components, and include:

.1 load ratings,

.2 typical composite detail drawings for complete hanger assembly, including upper attachment, hanger rods, hanger rod swivels, pipe attachments, shields and saddles, and load ratings, for each pipe condition and size.

.2 Submit support details for glass, fibre-reinforced plastic, and other plastic piping systems which are coordinated with the piping material manufacturer installation instructions.

.3 Where variable spring supports or constant load supports are shown, provide completely engineered design and fabrication drawings, including any supplementary steel requirements, and loads transferred to the building structure.

.4 Submit engineered design drawings for custom supports:

.1 fabricated trapeze hangers, and completely engineered support systems, including

(a) construction detail drawings for each loading condition,
(b) span deflection calculations,
(c) building attachment load calculations and type.

.2 shop drawings to be sealed by a professional engineer licensed in the project location jurisdiction.

1.6 Quality Control

.1 Where custom engineered supports are used, provide the services of a professional engineer licensed in the location of the Work, to conduct an inspection of the completed installation and prepare a report of these custom engineered supports, that they have been installed in accordance with the sealed shop drawing requirements. Submit a copy of the inspection report to the Owner and Consultant.

2 PRODUCTS

2.1 General

.1 Hangers, supports, sway braces and associated components, to be fabricated from stock or production parts, manufactured and fabricated in accordance with MSS SP-58, and the requirements of the piping code specified for each piping system.

.2 Select elements of pipe support systems to provide adequate factors of safety under loads applied by gravity, by temperature induced expansion and contraction, by internal pressure in mechanically jointed plain end pipe, and by fluid flow pressure thrust.

.3 Product finishes (unless otherwise specified for each product):

.1 outdoors: hot dipped galvanized,

.2 in mechanical service rooms, pipe tunnels and pipe trenches: hot-dipped galvanized,

.3 other indoor locations: plain finish, zinc plated, or painted finish.

(a) exception: do not use any zinc coated or electro-plated products in data center rooms.

.4 Pipe support products to be selected from manufacturers standard product line.

Standard of Acceptance
- Anvil
- E.Myatt & Co
- Unistrut
- Taylor
- Acrow Richmond
- Portable Pipe Hangers
- Hilti
- nVent Caddy
- Pipe Shields

.5 Model designations from these manufacturer's catalogue are used to establish quality standards and construction details to permit assessment of products from other manufacturers.

2.2 Upper Attachments – Steel Structure

.1 Steel beam (bottom flange) - for cold and ambient piping NPS 2 and smaller:

.1 malleable iron or carbon steel, symmetrically loading beam clamp to MSS SP-58, type 30,

.2 listed to ULC/ORD-C203 or UL 203 for fire protection piping.

Standard of Acceptance

- Anvil - fig. 218
- Myatt - fig. 500

.2 Steel beam (bottom flange) - for cold and ambient piping NPS 2½ and larger, and hot piping:

.1 forged steel, symmetrically loading heavy duty beam clamp, to MSS SP-58, type 28 or 29.

.2 with weldless eye nut when used with clevis supports.

- Anvil - fig. 228 or 292
- Myatt - fig. 510 X-HEAVY, or 511 X-HEAVY.

.3 Steel joists (lower chord) – for cold and ambient piping NPS 2 and smaller:

.1 for installation of support rod in the interstice space of double-ell steel joists and open-web steel joints,

.2 carbon steel washer plate with locking nuts on top-side of washer,

.3 second steel washer plate on underside of joist with nut.

Standard of Acceptance

- Anvil - fig. 60
- Myatt - fig. 545

.4 Steel joists (lower chord) – for cold and ambient piping NPS 2½ and larger, and hot piping:

.1 for installation of support rod in the interstice space of double-ell steel joists and open-web steel joints,

.2 carbon steel washer plate with double locking nuts on top-side of washer, with carbon steel welded beam clevis attachment, and forged steel weldless eye nut.

Standard of Acceptance

- Anvil - fig. 60 with fig. 66 and fig. 290.
- Myatt - fig. 545 with fig. 530 and fig. 480.

2.3 Upper Attachments – Wall Brackets

.1 Medium and heavy-duty wall mounting brackets:

.1 welded carbon steel plate or channel assembly, designed to allow at least 75 mm (3 in.) of horizontal adjustment of hanger rod position, to MSS SP-58, Types 32 and 33,

.2 carbon steel backplates for through bolting of concrete walls where required by supported load and wall material,

.3 for bolting into concrete wall, concrete block, or welding to building structure (where permitted by structural engineer).

Standard of Acceptance

- Anvil - fig. 195 and 199
- Myatt - fig. 321 and 322

.2 Light-duty wall mounting brackets:

.1 welded carbon steel plate or channel assembly, single point rod support, to MSS SP-58, Types 31,

.2 with carbon steel backplates for through bolting of concrete walls where required by supported load,

.3 FM approved,

.4 for bolting into concrete wall, concrete block, or welding to building structure,

Standard of Acceptance
- Anvil - fig. 194
- Myatt - fig. 320

2.4 Upper Attachment - Swivels

.1 Clevis swivel:

.1 to allow rotation movement of suspended clevis hangers,

.2 forged steel clevis with hanger pin, threaded rod socket, to MSS SP-58 type 14,

.3 tension load capacity not less than the connected rod load capacity,

.4 threaded end connected to concrete insert, with clevis end connected to weldless eye nut or welded eye rod.

Standard of Acceptance
- Anvil - fig. 299
- Myatt - fig. 470

.2 Weldless eye nut swivel:

.1 to allow rotation movement of suspended clevis hangers,

.2 forged steel eye nut, threaded rod socket, to MSS SP-58 type 17,

.3 tension load capacity not less than the connected rod load capacity.

.4 for connection to top of rod hanger, suspended from a clevis.

Standard of Acceptance
- Anvil - fig. 290
- Myatt - fig. 480

2.5 Hanger Rod

.1 Continuous threaded rod:

.1 carbon steel, USS national course thread,

.2 tension load ratings to MSS SP-58,

Standard of Acceptance
- Anvil - fig. 146
- Myatt - fig. 434

.2 Welded eye rod:

.1 carbon steel, USS national course thread,

.2 tension load ratings to MSS SP-58,

.3 tension load rating to be the same as continuous welded rod.

Standard of Acceptance
- Anvil - fig. 278
- Myatt - fig. 440

2.6 Horizontal Pipe Support – Pipe Roller

.1 Suspended support - adjustable:

.1 adjustable, trapeze or yoke style, pipe roller support to MSS SP-58, type 41 or 43.

Standard of Acceptance
- Anvil - fig. 171 or fig. 181
- Myatt - fig. 261 or fig. 258

.2 Bottom support - adjustable:

.1 adjustable pipe roller with bottom support rods, to MSS SP-58, type 41.

.2 with mounting rods and upper/lower retention nuts at both ends.

Standard of Acceptance
- Anvil Fig. 177
- Myatt Fig. 262

.3 Bottom support – pipe roll stand:

.1 cast iron pipe roller with drilled cast iron stand, to MSS SP-58, type 44,

.2 fixed base and adjustable base.

Standard of Acceptance
- Anvil - fig. 271 (fixed), fig. 274 (adjustable)
- Myatt - fig. 264 (fixed), fig. 266 (adjustable)

2.7 Horizontal Pipe Support – Clevis

.1 Clevis support:

.1 carbon steel, adjustable clevis, with yoke bolt reinforcing tube, to MSS SP-58 Type 1,

.2 listed to ULC/ORD-C203 or UL 203 for fire protection piping,

.3 sized for outside dimension of pipe and insulation,

.4 nominal pipe size:

(a) steel pipe: NPS ½ to NPS 30
(b) ductile or cast iron pipe: NPS 3 to 24

Standard of Acceptance
- Anvil - fig. 260
- Anvil - fig. 590 (for ductile or cast iron pipe)
- Myatt - fig. 124
- Myatt - fig. 126 (for ductile or cast iron pipe)

.2 Clevis support with integral non-metallic insulation saddle:

.1 carbon steel, adjustable clevis to MSS SP-58, type 1, ULC listed, with yoke bolt reinforcing tube,

.2 with glass-reinforced polypropylene saddle, sized to allow up to 50 mm (2 in.) insulation thickness,

.3 sized for outside dimension of pipe and insulation,

.4 nominal pipe size: NPS ¾ to NPS 6,

.5 piping system design temperature limits: 4.4 to 93°C (40 to 200°F).

Standard of Acceptance
- Anvil - fig. 260 ISS

.3 Clevis support for copper pipe and tube:

.1 carbon steel yoke and clevis, adjustable clevis to MSS SP-58, type 1, copper plated finish,

.2 nominal pipe size: NPS ½ to NPS 4,

.3 sized for outside dimension of pipe/tube, or outside diameter of pipe and insulation as applicable.

Standard of Acceptance
- Anvil - fig. CT-65
- Myatt - fig. 151 CT

.4 Light-duty, side-opening clevis support:

.1 for fire protection service only,

.2 galvanized carbon steel, adjustable clevis with fixed yoke,

.3 listed to ULC/ORD-C203 or UL 203 for fire protection piping,

.4 sized for outside dimension of pipe (and insulation if applicable).

.5 sized for outside dimension of pipe (and insulation where applicable),

.6 nominal pipe size: NPS 2 to NPS 8.

Standard of Acceptance
- Hilti - fig. MH-SLC Speed Lock]

2.8 Horizontal Pipe Support – Slides

.1 Sliding pipe base supports – welded attachment:

.1 Tee or H shaped pipe support for welding to pipe, to allow axial and lateral movements,

.2 carbon steel, structural shape or fabricated, to ANSI/MSS SP-58 Type 35,

.3 PTFE bonded to underside of slide,

.4 matching lower steel plate with bonded PTFE element (for fastening to structural support beam),

.5 operating temperature range: -28 to 200°C (-20 to 400°F),

.6 pipe guide variants:

(a) lug restraints to limit lateral movement to 1.6 mm (1/6 in) or 25 mm (1 in),
(b) lug restraints to limit uplift movement to 1.6 mm (1/6 in),

.7 nominal pipe size: NPS ½ to NPS 30.

Standard of Acceptance
- Anvil - figs. 257, 436, 439
- Myatt - figs. 705, 706

2.9 Horizontal Pipe Support – Swivel Ring Hanger

.1 For non-insulated stationary piping and tubing only.

.2 Pipe swivel ring hangers:

.1 carbon steel ring strap, zinc plated, adjustable knurled swivel nut, to MSS SP-58 Type 10,

.2 copper plated or epoxy-coated for use on copper tubing,

.3 listed to ULC/ORD-C203 or UL 203 for fire protection piping,

.4 nominal pipe size: NPS ½ to NPS 4.

Standard of Acceptance
- Anvil - fig. 69, CT-69

- Myatt - fig. 41, 42, 43

2.10 Horizontal Pipe Support – Trapeze

.1 Manufactured trapeze support:

.1 load ratings as per manufacturers data sheets,

.2 carbon steel, double-C channel (strong-backs), HSS shape and equal-leg angles.

Standard of Acceptance
- Anvil - fig. 45, 46, and 50
- Myatt - fig. 173, 600, and 650

.2 Fabricated trapeze support:

.1 designed and sealed by a professional engineer licensed in the jurisdiction of the work.

.2 performance:

(a) maximum deflection between supports: 1/250 (0.4%) of span
(b) minimum factor of safety: five (5) times load to ultimate tensile or compressive strength, but not to exceed 60% of yield strength.

.3 carbon steel shapes, to suit load application,

(a) hollow steel section,
(b) equal leg El section, or
(c) double C channel “strong-back”, with welded clips.

.3 Hanger rods:

.1 minimum of two support rods per trapeze,

.2 rods selected for minimum factor of safety of 4 times load for tensile or compressive strength of the rod.

.4 Pipe restraint:

.1 restrain pipes from lateral movement with:

(a) bolt-on angle brackets or pipe U-bolts for manufactured hangers,
(b) welded-on angles for fabricated hangers,

.2 restraints to permit axial linear movement and axial-rotation, except where otherwise shown to be a guide or an anchor.

2.11 Horizontal Pipe Support – Drainage MJ

.1 For horizontal cast iron drainage piping, as an alternative to clevis hangers.

.1 carbon steel, plain finish,

.2 pipe size: NPS 2 to NPS 6

Standard of Acceptance
- Anvil - fig. 250

2.12 Vertical Pipe Riser Clamps

.1 Steel pipe, cast iron pipe:

.1 carbon steel clamps for carbon steel piping and cast iron piping,

.2 stainless steel clamps for stainless steel piping,

.3 listed to ULC/ORD-C203 or UL 203 for fire protection piping,

.4 supplied with field-welded pipe support lugs of same material as supported steel pipe (not including cast iron pipe).

.5 floor supported pipe riser clamps, to ANSI/MSS SP-58, type 8,

Standard of Acceptance
- Anvil - fig. 261
- Myatt - fig. 182 or 183

.6 suspended pipe riser clamps, 4 or 6 bolt patterns, to ANSI/MSS SP-58, type 42,

Standard of Acceptance
- Anvil - fig. 40, 40SS
- Myatt - fig. 190 or 191

.2 Copper pipe and tube:

.1 floor supported pipe riser clamps, carbon steel with copper plated finish, to ANSI/MSS SP-58, type 8,

Standard of Acceptance
- Anvil - fig. CT-121
- Myatt - fig. 150CT

2.13 Vibration Isolation Supports

.1 Provided under specification section 20 05 48.

2.1 Variable Spring Load Supports

.1 General:

.1 variable spring load supports to maintain supported load under pipe thermal movement conditions, so that the variation in supported load does not exceed 25% of the operating load.

.2 selected for piping loads and estimated travel under service conditions.

.2 Construction:

.1 carbon steel housing and spring, to MSS SP-58 types 51, 52 and 53.

.2 pre-compressed spring,

.3 load indicator,

.4 welding to ASME Section IX

.5 welded attachment points

.6 finish: semi-gloss primer coat.

Standard of Acceptance
- Anvil – fig 82, 268, 98
- Myatt - fig. Rigid-Spring

2.2 Cast Iron Pipe Joint Restraint

.1 Joint restraint rodding assembly for cast iron and asbestos cement drain waste and vent pipe, for each branch, tee, wye and clean-out fittings on drainage piping NPS 5 and over.

.2 Clamp and rod joint restraint:

.1 carbon steel pipe clamps with four bolt fasteners and rod washers, plain finish, to MSS SP-58, Type 8,

.2 carbon steel threaded rods and load nuts,

.3 two pipe clamps and two restraint rods required for each joint.

Standard of Acceptance
- Myatt - fig. 595 with 594 and 146.

2.3 Saddles and Shields at Pipe Supports

.1 Insulation shields:

.1 galvanized steel protection shield, thickness and length as applicable to pipe size, to MSS SP-58 type 40.

Standard of Acceptance
- Anvil - fig. 167 (up to NPS 24)
- Anvil - fig. 168 - Riblok (up to NPS 8)
- Myatt - fig. 251

.2 Pipe saddles:

.1 Carbon steel or stainless steel (to match pipe material) saddle welded to pipe with insulation inserted between saddle and pipe, to MSS SP-58 type 39.

Standard of Acceptance
- Anvil - fig. 160 to 166
- Myatt - fig. 210 to 240

3 EXECUTION

3.1 General

.1 Where the specific requirements for pipe supports are specified in other sections of Division 20 to 25, the requirements of those sections take precedence over the requirements of this specification section. Refer

3.2 Coordination with Concrete Work

.1 Supply and deliver concrete inserts to site in ample time to be built into the work of Division 03.

.2 Correctly position and set concrete inserts onto concrete formwork for pipes and equipment hangers. Secure inserts firmly to formwork before concrete is poured.

.3 Do not use explosive drive pins in any section of the Work without obtaining prior approval from the Consultant.

3.3 Horizontal Pipe Support Spacing and Hanger Rod Size

.1 Provide horizontal pipe supports at the spacing and hanger rod size as detailed in the following tables, unless specified otherwise in other sections of Division 20 to 25:

.1 copper tube, stainless steel tube: to Table 1C.

Table 1C: Horizonal Pipe Support Spacing for Copper Tube, and Stainless Steel Tube		
Pipe Size NPS	Rod Diameter	Maximum Spacing
½	M10 (3/8 in)	1.5 m (5 ft)
3/4 to 1¼	M10 (3/8 in)	1.8 m (6 ft)
1½	M10 (3/8 in)	2.4 m (8 ft)
2	M10 (3/8 in)	2.4 m (8 ft)
2½	M12 (½ in)	3.0 m (10 ft)
3	M12 (½ in)	3.0 m (10 ft)
4	M16 (5/8 in)	3.0 m (10 ft)

.2 Hanger spacing and hanger rod diameter for steel pipe or copper tube with flexible roll groove joints;

.1 to be as shown in the above tables for the appropriate pipe material, with not less than one hanger between joints, and

.2 provided with anchors and guides located to maintain piping true to line and grade.

.3 Support plastic and other special piping, including anchors and guides, in accordance with the pipe manufacturer's requirements.

3.4 Horizontal Pipe Hanger and Support Selection

.1 Swivel ring pipe hangers may only be used for;

.1 fire protection piping, NPS 4 and smaller,

.2 drain waste and vent (DWV) piping and tubing, NPS 4 and smaller,

.3 medical gas piping and laboratory gas piping, NPS 4 and smaller,

.4 compressed air piping and tubing located downstream of a refrigerated dryer, NPS 2 and smaller,

.5 chemical treatment piping NPS 2 and smaller

.2 For cast iron drainage and vent piping;

.1 use clevis hangers for suspended supports,

.2 drainage MJ type hangers may be used on hub-less cast iron piping,

.3 use roller or slide type supports for bottom supported piping. For slide supports, use a variant incorporating pipe band clamps in lieu of welded attachment.

.3 Do not use clevis hangers for piping subject to thermal movement, except under selected piping conditions specified herein.

.4 Select pipe support types in accordance with Table 2 based on pipe size, except where limited by Tables 3A or 3B based on pipe thermal movement.

.1 The following abbreviations apply to Table 2.

CL Clevis hanger

CL(Sa) Clevis hanger with integral polypropylene saddle

RL Roller support

SD(T) Slider, T shape

SD(H) Slider, H shape

TZ Trapeze

Table 2: Pipe Support Basic Selection, Based on Pipe Size
(except cast iron drainage pipe)

Pipe Size	Support Type					
	CL	CL(SaD	RL	SD(T)	SD(H)	TZ
¾ - 4	●	●	●	●		●
6	●	●	●	●	●	●
8	●		●	●	●	●[1]
10 – 14	●			●	●	●[1]
16-18				●	●	●[1]
20 – 24					●	●[1]

Notes:
[1] When used in conjunction with a slide support.

.2 For pipe size NPS 16 to 24, a clevis hanger may be used to support a concentrated load, provided it is used only to support the concentrated load and there is a separate pipe run support within one-third of the maximum allowable span on each side of the concentrated load.

.5 The support types of Table 2 are limited based on the expected thermal movement of piping as follows:

.1 where the length of the hanger rod is 300 mm (12 in.) or less measured between the upper attachment and the rod attachment point to the pipe support element, the selection of pipe support type is limited as follows:

(a) for hot piping, do not use clevis hangers,
(b) for cold piping, clevis hangers may be used for pipes NPS 4 and smaller.

.2 for cold piping and hot piping where the length of the hanger rod is greater than 300 mm (12 in.) measured between the upper attachment and the rod attachment point to the pipe support element, the selection of support types is limited to the following:

(a) carbon steel and galvanized steel pipe: to Table 3A.
(b) copper tube, and stainless steel pipe and tube: to Table 3B.
(c) select support type based on piping system maximum operating temperature and spacing between adjacent pipe anchors on each system. For intermediate values, use the next higher criteria; do not interpolate.

Table 3A: Suspended Carbon Steel and Galvanized Steel Pipe
Pipe Support Selection Based on Thermal Movement
Support Rod Length 300 mm or Longer

Pipe System Maximum Operating Temperature		Pipe Run Distance Between Anchors m (ft)					
°C	(°F)	5 (15)	10 (33)	15 (49)	20 (65)	25 (82)	30 (100)
10	(50)						
20	(68)						
30	(86)						
40	(104)			Clevis,			
50	(122)			Trapeze,			
60	(140)			Roller, or			
70	(158)			Slide			
80	(176)						
90	(194)						
100	(212)						
120	(250)						
150	(302)					Roller or Slide	
200	(392)						
250	(482)						

3.5 Support and Hanger Installation

.1 Support piping directly from or on structural building elements. Do not support pipe directly from other services.

.2 Provide all miscellaneous materials including nuts, washers, and backing plates to make a complete installation.

.3 Where wall brackets are used, select brackets and size mounting bolts and backing plates to suit the supported load, allowing for a safety factor by not loading the bracket more than 80% of its published load rating.

.4 Do not support piping or tubing in direct contact with hangers or supports of dissimilar metallic material.

.5 Coordinate location of pipe supports with pipe flexible connectors, pipe guides and pipe anchors provided under specification section 20 05 16.

.6 In steel framed construction, support piping from structural members. Where structural members are not suitably located for upper hanger attachment locations, and where inserts of adequate capacity cannot be installed in concrete slabs, provide supplementary steel framing members;

.1 fabricate supplementary steel from standard HSS sections, single EL section, double C "strongback" sections, or pipe rolls,

.2 size supporting steel to limit span deflection to 1/250 (0.4%) between support points,

.3 mechanically fasten supplementary steel to structural steel.

.7 Offset hangers so that rods are within 4° of vertical when in the operating position.

.8 Provide a pipe support within 300 mm (12 in.) of;

.1 an elbow or tee,

.2 a concentrated load, including but not limited to valves, strainers and flanges,

.3 a connection to equipment.

.9 Where hanger rods are used, provide load nuts on top and underside of attachment to the pipe support, including clevis hangers, roll supports, roll yoke hangers, and trapeze hangers.

3.6 Clevis Hangers

.1 Where clevis hangers are used for cold- or hot-piping, provide hanger rods with a clevis swivel and weldless eye nut at the building attachment connection, to allow free-rotation movement of the hanger rod in the same direction as axial movement of the associated pipe.

.2 Where clevis hangers are used for stainless steel pipe or tube and for copper tube;

.1 use copper or epoxy finished clevis hangers for copper pipe/tube,

.2 use stainless steel or alloyed steel clevis hangers (for stainless steel pipe/tube), or

.3 use a standard clevis hanger with integral non-metallic insulation saddles and hangers are sized for outside of the pipe and insulation.

3.7 Trapeze Hangers:

.1 Provide shim pipes on common trapeze hangers to slope each pipe in required direction, and mechanically fasten or tack-weld shim plates to the trapeze hanger,

.2 Provide U-bolts or fabricated angles to restrict lateral pipe movement; while allowing pipe thermal axial motion and rotation;

.1 fasten U-bolts or angles to the trapeze hanger,

.2 fabricated angles to extend vertically at least one-quarter the outside pipe/insulation diameter,

3.8 Pipe Saddles and Shields

.1 Provide pipe saddles and shields for insulated piping in accordance with the following table 4

Table 4: Insulation Hanger Protection

Pipe Service	Service Temperature °C (°F)	Pipe Size NPS	Pipe Saddle	Insulation Shield [Note 1]
Hot Piping	> 93 to ≤ 205 (> 200 to ≤ 400)	≥ 1-1/2	Yes	---
		≤ 1-1/4	---	Yes
	> 60 to ≤ 93 (> 140 to ≤ 200)	> 6	Yes	---
		≥ 1-1/2 and ≤ 6	---	Yes

Table 4: Insulation Hanger Protection				
Pipe Service	Service Temperature °C (F)	Pipe Size NPS	Pipe Saddle	Insulation Shield [Note 1]
		≤ 1-1/4	---	Yes
	> 40 to 60 (≥ 104 to ≤ 140)	≥ 1-1/2	---	Yes
		≤ 1-1/4	---	Yes
Ambient Piping (Insulated)	> 16 to ≤ 40 (> 60 to ≤ 104)	All	---	Yes
Cold Piping	≤ 16 (60)	≥ 1-1/2	---	Yes
		≤ 1-1/4	---	Yes

Notes:
[1] Refer to specification section 20 07 19 for high density insulation insert requirements.

.2 Provide pipe shields for uninsulated glass and plastic piping NPS 1-1/2 and larger.

.3 Where piping is insulated and requires pipe shields, install the shields between pipe insulation and pipe support. Provide high-density insulation insert between pipe and insulation shields in accordance with specification section 20 07 19.

.4 Where piping is not insulated and requires a pipe shield, install the shields between the pipe and the pipe support.

.5 Where clevis hangers with integral insulation saddles are used, apply insulation sealant to the polypropylene saddle in accordance with the pipe hanger manufacturer's instructions;

.1 for hot piping, coordinate with the pipe insulation contractor to apply sealant coating to the integral saddle at the time pipe insulation is installed,

.2 for cold piping, seal the saddle's pipe contact surfaces with vapour-barrier sealant before the piping is installed. Finish sealing the remainder of the saddles' exposed faces when pipe insulation is installed.

3.9 Vibration Isolation Supports

.1 Provide vibration isolation for vertical pipe supports as previously specified herein. In addition, coordinate with the work under specification section 20 05 48 to provide vibration isolation pipe supports where specified in that section.

.2 When installed with clevis hangers, install the vibration isolators below and separate from the upper attachment clevis; do not use the vibration isolator for the purpose of rotation movement of the support rod.

3.10 Variable Load Supports

.1 Provide variable load supports for vertical pipe supports as previously specified herein. In addition, in mechanical rooms, where piping transitions from horizontal to vertical where it enters a vertical service shaft, provide a variable load support adjacent to the elbow or tee, where the expected displacement due to thermal movement is not more than 6 mm (1/4 in.).

.2 Provide vibration isolation hangers for other locations in accordance with Section 20 05 48 Vibration Isolation.

3.11 Load Nut Retention

.1 For steel framed buildings, industrial buildings, and areas subject to high structure born vibration, provide double-nutting on pipe and equipment hangers in addition to use of Loctite 266, as follows:

.1 Double- nut the top load nut on the building attachment point.

.2 Double- nut the lower load nut on the pipe, duct or equipment hanger.

.3 Double- nut the clevis bolt nuts.]

3.12 Set-up After Installation

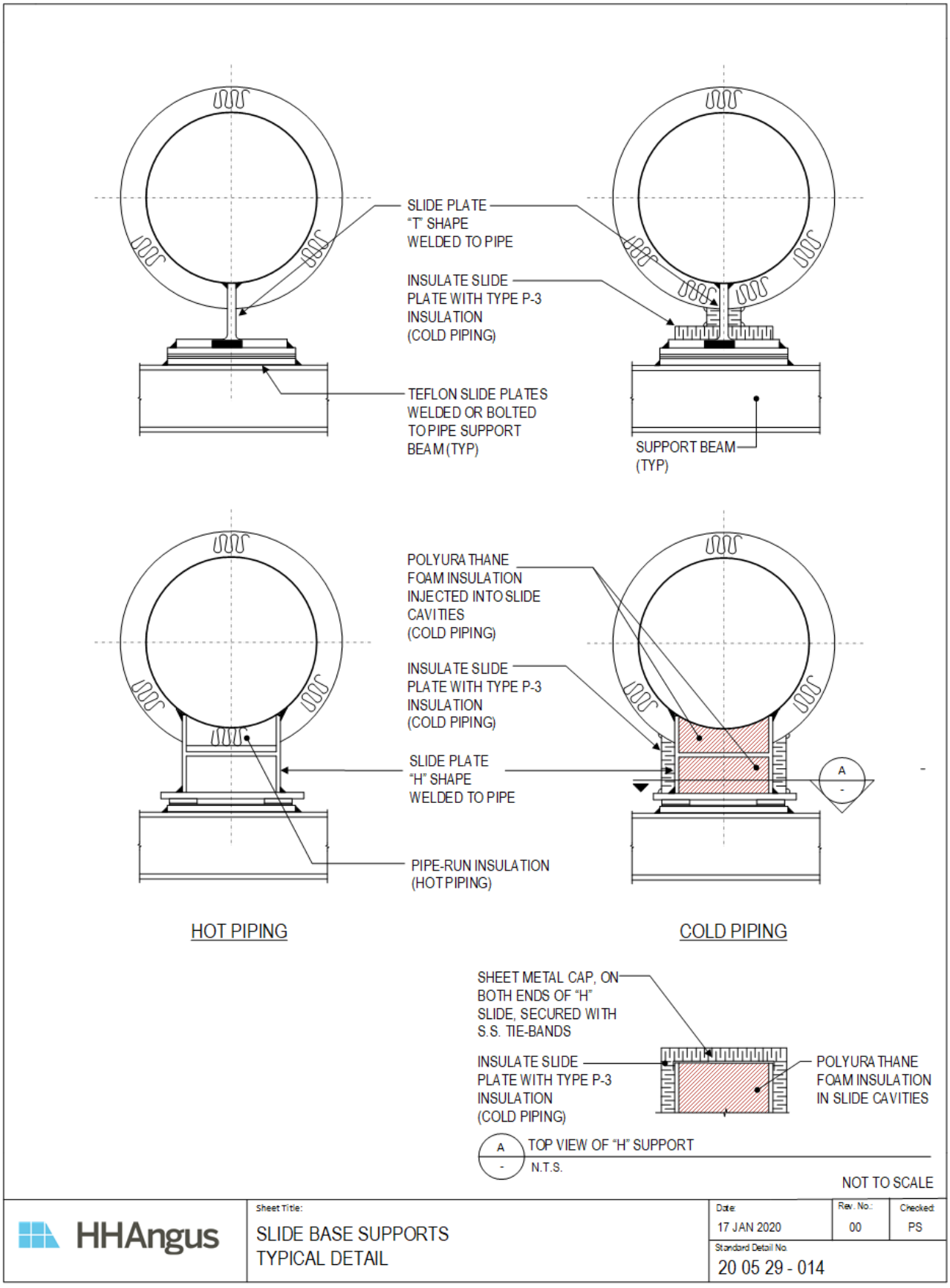
.1 Adjust hangers to equalize hanger loads, to support piping true to line and grade, and to minimize loads transferred through connections to equipment and outlets.

3.13 Standard Details

.1 The following standard details are appended to the end of this specification section.

.1 20 05 29-014

END OF SECTION


SLIDE PLATE "T" SHAPE WELDED TO PIPE
INSULATE SLIDE PLATE WITH TYPE P-3 INSULATION (COLD PIPING)
TEFLON SLIDE PLATES WELDED OR BOLTED TO PIPE SUPPORT BEAM (TYP)
SUPPORT BEAM (TYP)
POLYURATHANE FOAM INSULATION INJECTED INTO SLIDE CAVITIES (COLD PIPING)
INSULATE SLIDE PLATE WITH TYPE P-3 INSULATION (COLD PIPING)
SLIDE PLATE "H" SHAPE WELDED TO PIPE
PIPE-RUN INSULATION (HOT PIPING)
A
-
HOT PIPING
COLD PIPING
SHEET METAL CAP, ON BOTH ENDS OF "H" SLIDE, SECURED WITH S.S. TIE-BANDS
INSULATE SLIDE PLATE WITH TYPE P-3 INSULATION (COLD PIPING)
POLYURATHANE FOAM INSULATION IN SLIDE CAVITIES
A
-
TOP VIEW OF "H" SUPPORT
N.T.S.
NOT TO SCALE
HHAngus
Sheet Title:
SLIDE BASE SUPPORTS TYPICAL DETAIL
Date:
17 JAN 2020
Rev. No.:
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Checked:
PS
Standard Detail No.
20 05 29 - 014

VIBRATION ISOLATION
20 05 48

1 GENERAL

1.1 Scope

.1 Isolate condensing units CU-2 & CU-3.

.2 Provide restraints for equipment mounted on vibration isolation to limit movement during start-up and normal operation.

.3 Isolator and base type designations are taken from appropriate chapter of current ASHRAE Applications Handbook.

.4 Base type, isolator type and minimum static deflection are shown in equipment schedules and equipment selection sheets.

.5 Information shown in equipment schedules is to establish minimum standards, vibration isolation equipment to be selected to maintain noise levels in building below RC levels in following schedule.

AREA	NOISE CRITERIA (NC level)
Offices - private	32 to 34
-open plan	36 to 38
-business machine areas	40 to 42
-conference/boardrooms	30 to 32
Operating Rooms	25 to 27
Private Bedrooms	26 to 28
Hospital Wards	30 to 32
Public Areas	38 to 40

1.2 Related Sections

.1 Pipe movement control to Section 20 05 16 Flexible Connections, Expansion Joints, Anchors & Guides

.2 Piping constant load supports to Section 20 05 29 Hangers and Supports

1.3 Shop drawings

.1 Show vibration isolation for each piece of equipment hung from the structure or supported from the floor.

.2 Submit product data sheets for isolation components.

.3 Show fabrication details, location and size of anchor bolts and concrete requirements for inertia bases.

.4 Provide vibration isolation equipment by one manufacturer.

Standard of Acceptance
- Vibron / Kinetics
- BVA
- KorfundMason
- Tecoustics

2 PRODUCTS

2.1 Resilient isolator Type 1 (R1)

.1 Rubber waffle or ribbed pads:
- .1 30 durometer natural rubber, minimum of 13 mm (½ in) thick,
- .2 selected for maximum loading of 350 kPa (50 psi).

.2 Rubber-steel-rubber pads:
- .1 two layers of rubber waffle or ribbed pad, 13 mm (½ in) thick, as specified above,
- .2 bonded to 6 mm (¼ in) steel plate with holes sleeved and fitted with isolation washers.

.3 Neoprene jacketed pre-compressed moulded fibreglass.

2.2 Resilient isolator Type 2 (R2)

.1 Elastomer rubber:
- .1 threaded insert,
- .2 hold down bolts.

.2 Neoprene, 50 mm (2 in) free height:
- .1 natural frequency not to exceed 15 Hz at full load,
- .2 capable of sustaining load of 110 kg (250 lb) with maximum deflection of 5 mm (3/16 in).

2.3 Elastomeric mounts (E1)

.1 Construction:
- .1 colour coded neoprene in shear with
- .2 maximum durometer of 60,
- .3 threaded insert,
- .4 two bolt down holes,
- .5 ribbed top and bottom surfaces.

2.4 General requirements for spring mounts

.1 Isolator springs:
- .1 designed so that ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height,
- .2 selected for 50% travel beyond rated load,

.3 cadmium plated,

.4 colour coded.

.2 Mounts:

.1 zinc or cadmium plated hardware,

.2 rubber isolation washers,

.3 housings coated with rust resistant paint,

.4 levelling devices, and

.5 6 mm (¼ in) thick ribbed rubber sound pad bonded to load plate.

.3 Clearance between metal parts: 6 mm (¼ in) minimum.

2.5 Spring isolator Type 1 (S1)

.1 Open spring isolators:

.1 extra stiff springs with ratio of lateral to axial stiffness of 1.0.

2.6 Spring isolator Type 2 (S2)

.1 Controlled spring isolators with

.1 heavy rigid steel base frames,

.2 built-in vertical limit stops,

.3 removable spacers, and

.4 extra stiff springs with ratio of lateral to axial stiffness of 1.0.

2.7 Spring isolator snubber Type 3 (S3)

.1 Open spring isolators:

.1 horizontal arrangement

.2 heavy rigid steel equipment base mount, and structure mount

.3 open spring, with 25 mm (1 in) deflection range.

.4 isolator bushings.

2.8 General requirements for isolation hangers

.1 General

.1 swivel arrangement to permit hanger box or rod to move through 20 arc without metal to metal contact.

2.9 Hanger Type 1 (H1)

.1 Spring hanger:

.1 welded steel housing with one coat anti-rust paint,

.2 color coded spring,

.3 retaining cups,

.4 elastomeric washers.

2.10 Hanger Type 2 (H2)

.1 Rubber isolation hanger:

.1 welded steel housing with one coat anti-rust paint,

.2 25 mm (1 in) colour coded neoprene in shear with maximum durometer of 60,

.3 threaded insert.

2.11 Hanger Type 3 (H3)

.1 Horizontal thrust restraint:

.1 spring and elastomeric element

.2 housed in box frame with rods and angle brackets to connect unit between isolated equipment and fixed object, and

.3 fitted with means to adjust maximum start-stop movement to 9 mm (⅜ in).

2.12 Acoustic barriers for anchors and guides

.1 Manufactured from 25 mm (1 in) thick neoprene isolation with duck reinforcing material.

2.13 Equipment base Type A

.1 Direct isolation:

.1 used where equipment is unitary and rigid

.2 motor slide rails welded to unit.

2.14 Equipment base Type B

.1 Prefabricated steel base:

.1 welded from structural sections and

.2 reinforced for drive with;

(a) isolation elements attached to base brackets and
(b) adjustable motor slide rails.

.3 minimum vertical section of base selected on basis of motor size from following;

Motor Size Horsepower	Motor Size kW	Vertical Side mm (in)
up to 3	up to 2.2	75 (3)
7.5	5.5	100 (4)
20	15	150 (6)
50	37	200 (8)
over 50	37	250 (10)

2.15 Equipment base Type C

.1 Concrete filled inertia base:

.1 Type B base and,

.2 full depth perimeter structural section or formed plate channel frame with;

(a) welded in place reinforcing rods running in both directions and
(b) 1 mm (20 ga) metal pans,
(c) base section filled with concrete, vibrated into place.

.3 spring mount units carried by gusseted brackets welded to frame and

.4 'T' shaped bases to support pump elbows.

2.16 Base Type D

.1 Roof curb isolation rails:

.1 manufactured with structural steel or aluminum upper and lower members, with

(a) continuous flexible reinforced water and air tight seal fastened to upper and lower members,

.2 protected by removable metal weather shield.

.3 supported from lower members by stable steel springs, with

.4 maximum deflection 50 mm (2 in) and

.5 closed cell neoprene gaskets.

.6 constructed with neoprene cushioned restraints to resist wind load in any direction.]

3 EXECUTION

3.1 General

.1 Install vibration isolation equipment in accordance with manufacturer's instructions and locate isolation for equipment to provide stable support under saddles, frames and projections of equipment.

3.2 Equipment vibration isolation

.1 Provide additional steel in bases and rails to obtain rigidity and uniform load distribution.

.2 Pumps, fans and motor driven equipment to be mounted on vibration isolation as shown.

.3 Packaged boilers, and water chillers, located in mechanical areas on framed slabs:

.1 supported on Type S1 spring isolators,

.2 located as so that piping systems and equipment is isolated from building structure.

.4 Packaged cooling towers, located in mechanical areas on framed slabs:

.1 supported on Type S2 spring isolators,

.2 located as so that piping systems and equipment is isolated from building structure.

.5 Packaged boilers, water chillers, and cooling towers, located in mechanical areas where floor slab is directly in contact with ground:

.1 supported on Type R1 rubber-steel-rubber pads.

.6 Reciprocating air compressors in any location within building to be supported on

.1 individual Type ‘C’ inertia bases with

.2 Type 3 spring isolators.

.7 Suspended fans to be supported on

.1 Type A or B base with

.2 Type H3 hangers.

.8 Provide Type S3 horizontal thrust restraints for high pressure horizontal discharge fans developing over 1.5 kPa (6 in wg), arranged symmetrically on either side of unit and attached at centre line of thrust.]

.9 Block and shim bases level at correct operating height.

.1 Bases to clear housekeeping pads by:

(a) 25 mm (1 in) minimum for concrete and
(b) 50 mm (2 in) minimum for steel.

.10 Where isolation is bolted to floor, housekeeping slab or overhead structure:

.1 provide vibration isolation rubber washers.

.11 Where pumps are mounted on vibration isolators

.1 provide flanged or grooved coupling steel removable spool pieces on inlet and discharge connections to allow future installation of flexible connectors,

.2 locate spool pieces between system isolating valve and pump with flange to flange lengths as follows;

Pipe size (inches)	Spool Length (inches)	Pipe Size (mm)	Spool Length (mm)
2	18	50	450
2½ & 3	24¼	65 & 75	616
4 & 5	24⅝	100 & 125	625
6 to 12	25	150 to 300	635

.12 Where ducts attach to resiliently mounted equipment, flexible connections will be provided by ductwork installer.

3.3 Service connection vibration isolation

.1 Make pipe, duct and electrical connections to isolated equipment so as to maintain isolation system flexibility.

3.4 Piping vibration isolation

.1 Piping connected to isolated equipment:

.1 supported with;

(a) spring mounts or spring hangers with static deflection of twice deflection of isolated equipment at first point of support and
(b) 25 mm (1 in) minimum static deflection at remaining supports.

.2 installed with distance between support points selected as for regular pipe hangers and using spring type for

(a) first three supports for piping up to NPS 4.
(b) first four supports for piping NPS 5 to NPS 8.
(c) first six supports for piping NPS 10 and over.

.3 Isolated, with acoustic barrier material, at anchors and guides within pipe shafts, duct shafts, equipment and fan rooms, and up to first anchor outside these rooms or areas.

.2 Where piping crosses building expansion joint

.1 provide spring hangers at first two support locations of piping at either side of joint line.

3.5 Start-up and set-up

.1 After installation of connections to resiliently mounted equipment;

.1 remove shims and blocking and adjust mountings to level equipment,

.2 adjust connections, hangers, snubbers, and restraints ,

.3 ensure that there is no physical contact between isolated equipment and building structure.

.2 On completion of installation and start-up of equipment;

.1 make arrangements for manufacturer/supplier of Vibration Isolation equipment to visit site, check performance of systems, inspect installation, and submit written recommendations,

.2 make corrections to installation in accordance with manufacturer/suppliers recommendations,

.3 provide notice 24 hours in advance of this site visit.

3.6 Testing

.1 Engage and pay for an experienced sound and vibration professional to take measurements of sound and vibration generated by HVAC systems.

.2 Co-operate with manufacturer/supplier of Sound Attenuation equipment in this measurement and testing.

.3 Sound measurements to extend over full audio frequency range and to be taken in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and main electrical rooms.

.4 Submit outline of tests to be performed, details of instrumentation to be used and floor plans showing test locations prior to commencing work.

.5 Provide notice one week in advance of commencement of tests.

.6 Submit complete report of tests addressing noise and vibration levels measured in occupied areas and adequacy of Sound Attenuation and Vibration Isolation equipment.]

END OF SECTION

IDENTIFICATION FOR MECHANICAL SERVICES
20 05 53

1 GENERAL

1.1 Scope

.1 Provide identification nameplates, labeling for piping, ductwork, equipment, and valves, and specialty signage.

1.2 Applicable Codes and Standards

.1 Installation codes and standards:

.1 ANSI Z535.1 Standards for Safety Signs and Labels

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

1.3 Submittals

.1 Shop drawings:

.1 Submit product data sheets for materials specified herein.

2 PRODUCTS

2.1 General

.1 Manufactured identification systems:

.1 resistant to general chemical, and ultraviolet stabilized for outdoor use,

.2 minimum operating temperature: -25°C (-12°F),

.3 maximum operating temperature: 121°C (250°F).

.4 language: English

Standard of Acceptance

- Brady - identification tapes, bands, and markers.
- Seton - Setmark Pipe Markers.
- Smillie McAdams Summerlin.
- Craftmark Identification Systems.
- Primark

2.2 Engraved Equipment Identification Nameplates

.1 Laminated nameplates:

.1 laminated two-layer coloured plastic plates, with engraved lettering,

.2 minimum size: 90 mm x 40 mm x 2.5 mm (3 in x 1½ in x ⅛ in),

.3 letter height:

(a) ID and name: 20 mm (3/4 in.) minimum

(b) power source: 10 mm (⅜ in) minimum,

.4 provided with Class 125 barcode and tag file,

.5 nameplate colours:

(a) nameplate and letter colours are dependent on type of electrical power supply to equipment.

Power Source	Background Colour	Letter Colour
Normal or None	White	Black
Life-Safety/ Emergency	Red	White
Stand-by (non-life safety)	Orange	White
UPS	Blue	White

2.3 Piping Identification – Piping Systems other than Medical Gas Systems

.1 General:

.1 conform to ASME A13.1 and as shown in Schedule A at the end of this Section for marking colours and global harmonization system (GHS) hazard identification symbols.

.2 text height:

Pipe/Tube NPS	Marker Length mm (in)	Text Height mm (in)
≤ 1-1/4	200 (8)	13 (0.5)
1.5 to 2	200 (8)	19 (0.75)
2.5 to 6	300 (12)	32 (1.25)
8 to 10	600 (24)	65 (2.5)
>10	800 (32)	90 (3.5)

Flexible coil-wrap manufactured markers:

.3 PVC plastic coated markers with integral printing, or plastic cover with field applied self-adhesive markers,

.4 reversing text with integral arrow markers,

.5 application method:

(a) NPS ½ to NPS 6: full wrap of pipe

(b) NPS 8 and over: partial pipe wrap with perforations for securing with nylon tie-wraps, tie-wraps included.

.2 Self-adhesive polyester pipe name marking tape:

.1 reversing text with integral flow direction arrow markers,

.2 tape height: 65 mm (2.5 in) minimum.]

.3 Self-adhesive vinyl flow direction marking bands:

.1 colour band tape with flow direction arrows,

.2 colours: as specified for pipe name markers.

.3 tape width: 50 mm (2 in)

.4 tape length: wrapped around pipe or covering with ends overlapping one pipe diameter but not less than 25mm (1 in).

.5 flow arrow: 20 mm (¾ in) minimum high

2.4 Valve and Steam Trap Identification

.1 Engraved plastic laminate tags:

.1 text for valves:

(a) piping system fluid service, area location description, following by a series number

(b) where a valve is shown on drawings to be normally closed, include “Normally Closed”

.2 text for steam traps: abbreviation for steam pressure (e.g. “S70”) as shown, followed by a series number,

.3 tag background colour and test colour: same as for pipe markers in accordance with Schedule A at the end of this section.

.4 brass or stainless steel chain.

2.5 Miscellaneous Identification

.1 Self-adhesive polyester marking labels with global harmonized system (GHS) hazard pictograms.

.1 red border on white field,

.2 symbol height: 100 mm (4 in) minimum.

2.6 Signage

.1 Rigid plastic signs, UV stabilized and suitable for indoor and outdoor installation, for surface mounting.

.2 Graphic symbols:

.1 graphic image in accordance with WHIMS and ISO 7010,

.2 sign dimensions:

(a) indoors: 300 x 300 mm (12 in. x 12 in.)

(b) outdoors: 450 x 450 mm (18 in. x 18 in.)

.3 Colours:

.1 Field and text colours in accordance with ANSI Z535.1

Information Type	Background Colour	Letter Colour	Primary Notification Text
General information	Blue	White	NOTICE
General Safety, Exiting	Green	White	---
Caution	Yellow	Black	CAUTION
Warning	Orange	Black	WARNING
Danger	Red	White	DANGER
Biological	Fluorescent Orange	Black	BIOHAZARD

3 EXECUTION

3.1 Equipment Identification

.1 Where required:

.1 provided for equipment identified with number designations shown in equipment schedules, drawings, specifications, and/or equipment selection sheets.

.2 marked with equipment ID, service name, and power source using wording and numbering used in contract documents.

.3 for clarity, equipment identification nameplates are in addition to manufacturers plates.

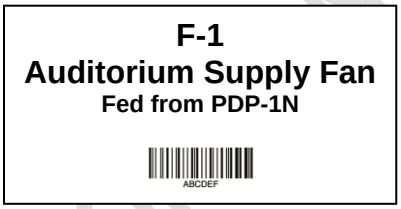
.2 Locate nameplates to be easily read, and fasten securely with mechanical fasteners. For pressure vessels, secure nameplates to equipment with high-tensile epoxy adhesive.

.3 Do not paint over equipment manufacturer or field installed nameplates.

.4 Provide metal standoffs on insulated equipment.

.5 Examples:

.1 at equipment (fan, pump, etc.), illustrated for Normal Power:



.2 at motor starter, adjustable frequency drive, and separate local disconnect, illustrated for Emergency Power:

3.2 Piping Identification - Except Non-Medical Gas Systems

.1 Provide manufactured pipe markers of the following types based on area of the building:.

.1 flexible coil-wrap:

(a) outdoor piping,

(b) indoor insulated piping with any type of jacket.

.2 Install self-adhesive markers on cleaned and prepared surfaces free of dirt and oil.

.2 Install pipe markers in the following locations:

.1 maximum every 15 m (50 ft) along length of pipe, except for natural gas and fuel oil,

.2 maximum every 6 m (20 ft) along length of pipe for natural gas and fuel oil,

.3 within 1 m (3 ft) of each side of barriers, floors and walls,

.4 within 1 m (3 ft) of and behind access doors ,

.5 within 1 m (3 ft) of piping termination point.

.3 Marker colours and hazard identification:

.1 Provide pipe markers with the colour coding and hazard identification symbols in accordance with Schedule A at the end of this section.

.2 Use the existing piping marker colour coding system for building additions and alterations.

3.3 Valve Identification

.1 Provide valves with a numbered tag showing valve type and size, attached to valve stem or wheel handle with chain.

.1 Valve identification is not required at the following valves:

(a) inside fire hose cabinets,

(b) radiation heating units, unit heaters, or fixture stops,

(c) plumbing fixture service stops,

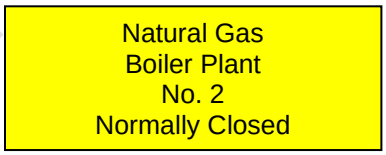
(d) within 4 m (12 ft) and in sight of equipment, fixtures, or apparatus that the valve controls provided there is no branch piping between the valve and equipment served,

(e) existing valves that are not provided under this project.

.2 Identification information – manual valves:

.1 each valve tag to indicate fluid service, sequential valve number (unique for each service) including supply or return, location identifier, and normal operating position

.2 examples (colour coding shown for illustration):



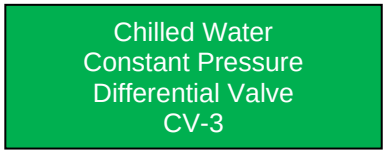
.3 Identification information – automatic control valves:

.1 provide valve tags for all automatic control valves except as follows:

(a) within sight of equipment that the valve controls.

.2 each valve tag to indicate fluid service, control function, control valve identification number,

.3 examples (colour coding shown for illustration):



.4 Provide a tag schedule for each system, designating valve numbers, fluid service, function, valve size, and location of each tagged item and normal operating position of each valve. Submit copies in original file format (Excel, Word) on two (2) removable mass storage devices.

3.4 Schedules

.1 The following Schedules form part of this specification section.

.1 Schedule A: Piping Marker Colours and Hazard Labels

.2 Schedule B: Ductwork and Equipment Hazard Labels

Schedule A – Piping Marker Colours and Hazard Labels

Fluid Service Category	Piping Services	Background Colour	Lettering Colour	GHS Hazard Symbol
Water	Potable (city) water, Non-potable water, Treated City Water, Sanitary, Storm Drainage, Chilled water, Condenser water, Cooling water, Heating water, Glycol heating or cooling water, Brine water, Boiler feedwater, Steam condensate	Green	White	None

END OF SECTION

COMMON REQUIREMENTS FOR MECHANICAL INSULATION
20 07 11

1 GENERAL

1.1 Scope

.1 Common requirements for insulation of mechanical services provided under Division 20 to 25 of the Work. The requirements of this specification section apply to separate specification sections for insulation of ductwork, equipment and piping.

1.2 Related Sections

.1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:

.1 20 05 29 Common Hanger and Support Requirements for Piping

.2 20 07 19 Piping Insulation

1.3 Definitions and Abbreviations

.1 The following definitions apply to this section.

.1 ***Ambient:*** as applied to temperatures means the interior or outdoor air temperature at time of installation.

.2 ***Coating***: light-consistency compound for indoor applications used in conjunction with reinforcing membrane, to provide either a breathable or vapour barrier finish to insulation.

.3 ***Cold services***: means cold ductwork, equipment and/or equipment.

(a) ***Cold ductwork***: mechanical ductwork with a service temperature greater than 1°C and up to and including 16°C (34°F to 61°F).
(b) ***Cold equipment***: mechanical equipment with a service temperature of 16°C (61°F) or less,
(c) ***Cold piping***: mechanical piping with a service temperature of 16°C (61°F) or less,

.4 ***Concealed services***: mechanical services that are located: in the space above opaque suspended ceilings; within trenches not located in service rooms; within pipe and/or duct shafts; or in non-accessible chases and wall cavities.

.5 ***Conditioned air***: air supplied from air handling units that heats, cools, dehumidifies, or humidifies the air.

.6 ***Conditioned space***: an enclosed space or room that is heating, cooled, dehumidified and/or humidified.

.7 ***Dual temperature services:*** means dual temperature ductwork, piping and/or equipment that operates, at different times, at both hot and cold temperatures.

(a) ***Dual temperature ductwork***: mechanical ductwork that operates at temperatures greater than 1°C and up to and including 38°C (34°F to 100°F), at different times or at different locations in the duct system and includes cooling systems with terminal reheat.
(b) ***Dual temperature equipment***: means mechanical equipment that operate, at different times, at cold equipment temperatures and at hot equipment temperatures.
(c) ***Dual temperature piping***: mechanical piping that operate, at different times, at cold piping temperatures and at hot piping temperatures.

.8 ***Ductwork*****:** includes ducts, fans, air handling equipment casings, and plenums.

.9 ***Exposed services***: mechanical services that are located in areas that are not "concealed" as defined above for concealed services. For greater certainty, the following locations are exposed services:

(a) services in tunnels,
(b) services in space beneath raised floors.
(c) trenches located in service rooms.

.10 ***Finish covering***: final protective layer for insulation that provides an aesthetic finish but that may also provide weather-protective, moisture and/or vapour protection.

.11 ***Hot services***: means hot ductwork, equipment and/or equipment.

(a) ***Hot ductwork***: mechanical ductwork with a service temperature greater than 28°C and up to and including 65°C (80 to 150°F) and does not have any mechanical cooling.
(b) ***Hot equipment***: mechanical equipment with a service temperature 38°C (100°F) and greater.
(c) ***Hot piping***: mechanical piping at service temperatures as shown in Table 1 of specification section 20 07 19.

.12 ***Mastic***: heavy-consistency waterproof compound for outdoor applications, used in conjunction with reinforcing membrane that remains adhesive and generally pliable with age, to provide either a breathable or vapour barrier finish for outdoor insulation.

.13 ***Mechanical services***: equipment, piping, ductwork and related accessories provided under Division 20 to 25 of the Work.

.14 ***Outdoor (services)***: mechanical services located outside of the building envelope including services located beneath overhangs, located in unconditioned soffits, or exposed to any outdoor condition including temperature, sun exposure, or precipitation.

.15 ***Pure water***: water that has been treated with filtration equipment, including but not limited to reverse osmosis, deionization, ultra-filtration, ultra-violet, distillation or any combination of such or similar equipment, to achieve water quality significantly free of impurities.

.16 ***Service temperature***: the highest (for hot mechanical services) or the lowest (for cold mechanical services) gas or vapour design operating temperature, or the liquid supply operating temperature.

.17 ***Surface temperature***: for the purpose of this specification, has the same meaning as service temperature.

.18 ***Unconditioned (space)***: rooms or spaces that are not conditioned spaces, and includes ceiling spaces which are not part of a ceiling return air plenum system.

.19 ***Wet area:*** spaces subject to high humidity or where mechanical services may be exposed to direct contact with water, including not limited to: pools, shower rooms, tub rooms, medical device reprocessing, dishwashers, sterilizers, cart-washing, vehicle washing, and emergency showers.

1.4 Applicable Codes and Standards

.1 Installation codes and standards:

.1	NFPA 90-A	Installation of Air-Conditioning and Ventilating Systems
.2	ASHRAE/IES 90.1	Energy Standard for Buildings Except Low-Rise Residential Buildings
.3	NFPA 255	Test of Surface Burning Characteristics of Building Materials

.2 Product standards:

.1	CAN/ULC-S102	Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
.2	CAN/ULC-S102.2	Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies
.3	CAN/ULC-S114	Standard Method of Test for Determination of Non-Combustibility in Building Materials
.4	ASTM B209	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

.5	ASTM B240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
.6	ASTM C177	Standard Test Method for Steady-State Het Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus
.7	ASTM C411	Standard Test Method for Hot Surface Performance of High Temperature Thermal Insulation
.8	ASTM C449	Standard Specification for Mineral Fibre Hydraulic-Setting Thermal Insulation and Finishing Materials
.9	ASTM C518	Standard Test Method for Steady State Thermal Transmission Properties by Means of Heat Flo Meter Apparatus
.10	ASTM C533	Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
.11	ASTM C534	Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
.12	ASTM C547	Standard Specification for Mineral Fiber Pipe Insulation
.13	ASTM C552	Standard Specification for Cellular Glass Thermal Insulation
.14	ASTM C553	Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
.15	ASTM C591	Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
.16	ASTM C612	Standard Specification for Mineral Fiber Block and Board Thermal Insulation
.17	ASTM C795	Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
.18	ASTM C1126 (Gr.1)	Standard Specification for Faced and Unfaced Rigid Cellular Phenolic Thermal Insulation
.19	ASTM C1290	Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts
.20	ASTM C1393	Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks
.21	ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
.22	CGSB 51-GP-52MA	Vapour Barrier, Jacket and Facing Material for Pipe, Duct, and Equipment Thermal Insulation.
.23	CGSB 51.53-95	Poly(Vinyl Chloride) Jacket Sheeting, for Insulated Pipes Vessels and Round Ducts.

1.5 Qualified Tradespersons

.1 Work to be performed by a recognized specialist firm with an established reputation in this field.

Standard of Acceptance

- Fattal's Thermocanvas
- Alpha-Maritex 3451-RW
- Clairmont Diplag 60
- Glass-Cell FR
- Newtex - Zetex Rewettable

1.6 Quality

.1 Manufacturers and products are listed in this section to establish quality and manufacturing standards. Products from other manufacturers with explicitly similar characteristics may be acceptable but must be submitted as an alternative product submission.

2 PRODUCTS

2.1 General Requirements

.1 Adhesives, coatings, finish coverings, lagging, sealers, and tapes:

.1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84.

.2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84.

.3 exception: vapor barrier mastics on mechanical services located outside of the building.

2.2 Adhesives, Fasteners, and Tape

.1 Contact bond cement:

.1 for quick setting for metal surfaces.

.2 Volatile Organic Content: maximum 80 g/L.

Standard of Acceptance
° Bakor - fig. 220-05
° Foster – fig. Drion 85-75

.2 Adhesive for flexible closed cell foam insulation:

.1 Volatile Organic Content: maximum 80 g/L.

Standard of Acceptance
° Armacell - Armaflex 520 BLV
° Armacell - Armaflex. Low VOC Spray Contact Adhesive

.3 Lap seal adhesive:

.1 for joints and lap sealing of vapour barriers.

.2 Volatile Organic Content: maximum 250 g/L.

Standard of Acceptance
° Bakor - fig. 220-05
° Childers - fig. CHIL-STIX FRN CP-82

.4 Fibrous insulation adhesive:

.1 Volatile Organic Content: maximum 250 g/L

Standard of Acceptance
° Childers - fig. CHIL-STIX FRN CP-82
° Foster - fig. 85-70

.5 Vapour barrier tape:

.1 colour matched and foil faced

.2 listed to UL 181A.

Standard of Acceptance
° Johns Manville - fig. Zeston Z-Tape

- ° MacTac Canada Ltd – fig. Vinyl Scrim or Foil Scrim Kraft
- ° Compac Corp.
- ° Fattal Canvas Inc. - fig. Insultape

.6 Weld pins, studs, clips and washers:

.1 Galvanized steel or copper plated steel, stainless steel or aluminium to match ductwork material.

.2 Attachment method:

(a) welded for outdoor ducts,
(b) welded for indoor ducts,
(c) self-adhesive base may be used for vertical surfaces of rectangular ducts.

Standard of Acceptance
- ° Midwest - fig. Fasteners
- ° Jordahl - fig. Studwelding

.7 Staples:

.1 Monel, flare type, minimum size 12 mm (½ in).

.8 Tie wire:

.1 1.6 mm (16 ga) stainless steel with twisted ends.

.9 Caulking for sheetmetal jackets (outdoor use only)

.1 fast-drying, aluminum colour finish, flexible butyl elastomer based vapour barrier sealant.

Standard of Acceptance.
- ° Foster - fig. 95-44

2.3 Coatings and Reinforcing Membranes

.1 Reinforcing membrane:

.1 synthetic fibre:

(a) Leno weave,
(b) indoor and outdoor use.

Standard of Acceptance
- ° Foster - fig. Mast-A-Fab

.2 glass-fibre fabric:

(a) indoor use.

Standard of Acceptance
- ° Childers - fig. Chil-Glas #5/#10

.3 glass-fibre fabric for use with elastomeric closed cell foam:

(a) indoor use.

Standard of Acceptance
- ° Childers - fig. Chil-Glass #10

.2 Breather coating - Indoors:

.1 for breather coatings and lagging adhesive,

.2 Volatile Organic Content: maximum 50 g/L

.3 white in colour,

Standard of Acceptance
- Childers- fig. CP-50A HV2
- Foster - fig. 30-36

.3 Breather mastic - Outdoors:

.1 for breather coatings and lagging adhesive,

.2 abrasion resistive, flexible,

.3 UV stabile,

.4 grey in colour.

Standard of Acceptance
- Childers - fig. Vi-Cryl CP-10/11
- Foster - fig. 35-00 / 45-00
- Bakor - fig. 120-10

.4 Vapor barrier coatings - Indoors:

.1 Volatile Organic Content: maximum 50 g/L.

.2 for vapor barrier coatings and lagging adhesive except for elastomeric closed cell foam,

(a) permeance rating 0.02 perms maximum,
(b) white in colour

Standard of Acceptance
- Childers - fig. Chil Perm CP-34/35
- Foster - fig. 30-80, 30-90

.5 Vapor barrier mastic - Outdoors:

.1 for vapor barrier coatings and lagging adhesive,

.2 asphalt cutback,

.3 permeance rating 0.02 perms maximum,

.4 grey in colour.

.5 for outdoor use only.

Standard of Acceptance
- Childers - fig. Chil-Pruf CP-22
- Foster - fig. 60-25/60-26

.6 Vapour barrier coatings – elastomeric foam insulation:

.1 for indoor and outdoor use,

.2 water bases sealer/finishing coat, water and UV resistant.

.3 white in colour.

Standard of Acceptance
- Armacell - fig. ArmaFlex WB Finish

2.4 Insulation and Finishing Cement

.1 Mineral fibre, hydraulic-setting insulation cement, to ASTM C449

.2 Temperature rating: 650°C (1200°F)

Standard of Acceptance

° Johns Manville - fig. CalCoat-127
° Ramco Insulation - fig. Ramcote 1200 (PKI Quick Cote)

2.5 Field Applied Coverings

.1 Fabric finish jacket:

.1 plain weave cotton fabric at 220 g/m2 (6 oz/sq yd), treated with fire retardant lagging adhesive, or

.2 re-wetable fiberglass lagging fabric with water activated self-adhesive.

.3 suitable for field painting.

Standard of Acceptance
° Fattal - fig. Thermocanvas
° Clairmont - fig. Diplag 60
° Newtex - fig. Zetex Rewettable

.2 PVC jackets:

.1 PVC sheeting, or pre-cut and rolled sheeting to suit OD of pipe and insulation, with UV inhibitor for white colour product,

(a) minimum thickness:
- indoors: 0.5 mm (20 mil-in.),
- outdoors: 0.8 mm (30 mil-in.),

(b) maximum operating temperature: 66°C (150°F) at the material,
(c) listed to CAN/ULC-S102/S102.2 or ASTM E84,

.2 PVC fitting jacket with integral insulation inserts:

(a) minimum 0.5 mm (20 mil-in) thickness,
(b) pre-molded fitting covers, one or two piece,
(c) maximum operating temperature: 66°C (150°F) at the material,
(d) self-sealing longitudinal joints or field applied sealer adhesive,
(e) listed to CAN/ULC-S102/S102.2 or ASTM E84,

.3 colour: match existing

.4 foam-glass or glass-fibre insulation molded insert, including for elbows, tees, valves, end-caps, and mechanical pipe couplings,

.5 multiple layers where required for thicker pipe insulation thicknesses.

.6 pressure sensitive, colour matching vinyl tape.

Standard of Acceptance
° Johns Manville - fig. Zeston 2000
° Proto PVC - fig. LoSMOKE
° ACWIL Insulations
° Sure Fit Systems

.3 Metal finish jacket:

.1 straight pipe, duct or plenum:

(a) stucco embossed aluminum 3105 or 3003 to ASTM B-209, not less than 0.45 mm (0.016 in) thick sheet, with integral 3 mil polyfilm moisture barrier on the interior surface, lock-forming quality,
(b) stainless steel type 304 to ASTM A-240, not less than 0.25 mm (0.010 in) thick sheet, lock-forming quality;
- stucco embossed,
- 0.19 mm (3/16 in) corrugated.

.2 fittings:

(a) custom made swaged ring or lobster back covers on bends and die shaped fitting covers over pipe fittings, round duct fittings, valves, strainers, flanges, and grooved couplings.

.3 bands:

(a) 12 mm (½ in) wide stainless steel with mechanical fasteners.

Standard of Acceptance
° Alcan Canada Products - fig. Thermaclad Type 1
° Childers Products Inc. - fig. Fab Straps
°

.4 Protective finish for elastomeric cellular foam insulation

.1 indoors and outdoors:

Standard of Acceptance
° Armaflex WB Finish

2.6 Insulation

.1 Refer to specification sections for duct, equipment, and piping insulation.

3 EXECUTION

3.1 General Requirements

.1 Apply insulation after pressure and leakage testing is completed and accepted, and heat tracing (if any) is installed.

.2 Surfaces to be clean and dry before application of insulation.

.3 Store and use adhesives, mastics, and insulation cements at ambient temperatures and conditions recommended by the product manufacturers.

.4 Do not apply insulation on chrome plated surfaces of piping, valves, fittings, and equipment.

.5 Cut and bevel insulation around nameplates and pressure vessel certification stamps, seals or similar markings.

.6 Neatly finish insulation at supports, protrusions, and interruptions.

.7 Where insulation media is exposed, seal the insulation with reinforced vapor barrier or breather coating or mastic.

3.2 Installation of Insulation

.1 Refer to specification sections for duct, equipment, and piping insulation.

3.3 Sealing of Insulation – General Requirements

.1 The following requirements apply to all mechanical insulation unless otherwise specified in each mechanical service insulation specification section. Refer to separate specifications for specific sealing requirements for ductwork, equipment and piping insulation.

.2 Apply sealer coatings and mastic in accordance with the following:

.1 use breather coating/mastics for hot services:

.2 use vapour barrier coating/mastic for cold and dual temperature services:

.3 only use mastics on outdoor installations.

.4 apply mastics and coatings when ambient temperature is above 4°C (40°F), unless manufacturer's instructions permit colder ambient installation conditions.

.3 Maintain integrity of vapour barrier through sleeves, around fittings and at hangers and supports.

3.4 Insulation Finish Coverings

.1 Where required to be provided by other mechanical insulation specification sections, install protective finish coverings (jackets) in accordance with the following.

.2 Install protective finish coverings on insulation after breather and vapor barrier sealing is completed.

.3 For hot services that are exposed in wet areas, secure and seal coverings in accordance with the requirements for cold and dual temperature services.

.4 Cut finish covering materials to allow 50 mm to 100 mm (2 in to 4 in) overlaps onto adjacent sheets. On vertical services, arrange circumferential overlaps to be on the lower end of each cover section.

.5 PVC jackets:

.1 Adhesives and sealers to be compatible with PVC material.

.2 Hot services;

(a) secure sheeting with colour matched tape around circumference, at least two places per section of sheet, and by stapling longitudinal and circumferential edges,
(b) except in wet areas, do not seal major joint edges with vapour barrier tape,
(c) seal PVC fitting covers at throat and heel seams by stapling and secure over adjacent insulation covers by banding or taping ends to adjacent finish covering with colour matched tape.
(d) Install PVC covers in accordance with the requirements for cold and dual temperature services.

.3 Cold and dual temperature services:

(a) seal longitudinal edges with vapor barrier coating adhesive or colour matched vapour barrier tape for the full length and depth of the overlap,
(b) seal circumferential butt edges of PVC fitting covers with reinforced vapour barrier coating adhesive extending over adjacent pipe insulation section with an overlap of at least 50 mm (2 in),
(c) seal PVC fitting covers at throat and heel seams by solvent bonding and secured over insulation with reinforced vapor barrier coating overlapping adjacent service insulation a minimum of 50 mm (2 in),
(d) neatly finish exposed edges with vapour barrier sealant/mastic.

.6 Metal jackets:

.1 use stucco embossed metal jackets on round surfaces with diameter of 2.4 m (8 ft) and smaller; refer to applicable duct, equipment and piping specification sections for metal type.

.2 use corrugated stainless steel metal jackets on flat surfaces, and on round surfaces with diameters greater than 2.4 m (8 ft).

.3 apply metal jacketing over mechanical services, with a 60 mm (2-1/2 in) overlap,

.4 use lock-on systems or secure sheeting with bands 450 mm (18 in) apart.

.5 make-up curved surfaces with custom made swaged ring or lobster back covers.

.6 for indoor mechanical services;

(a) seal cover joints for cold and dual temperature services with clear or colour-matched calking.

.7 on outdoor mechanical services;

(a) seal cover joints for cold and dual temperature services with clear or colour-matched calking to permit expansion of metal jacket.

.7 Fabric jackets:

.1 Cotton lagging:

(a) apply cotton lagging with minimum two coatings of breather or vapor barrier coating adhesive as applicable to the piping system, and finish to provide a smooth surface free of wrinkles and sags.
(b) where cotton lagging with appropriate coating is used this satisfies the requirements of a sealer coating for cold and dual temperature services.

.2 Fiberglass lagging:

(a) apply re-wettable fiberglass lagging in accordance with manufacturer instructions, and finish to provide a smooth surface free of wrinkles and sags.
(b) for cold and dual temperature services, apply a finish coat of vapour barrier sealer.
(c) where re-wettable fiberglass lagging is used this satisfies the requirements of a breather coating for hot piping systems,

3.5 Mechanical Damage Protection - Indoors

.1 Protect visible pipe insulation extending up through a floor sleeve at the floor line with 1.2 mm (18 ga) stainless steel jacket approximately 100 mm (4 in) high, secured to floor slab. Conceal fastenings by use of a floor plate.

.2 For piping systems using finishes, this protection cover is in addition to the specified pipe finish cover.

3.6 Field Quality Control

.1 The Consultant reserves the right to have protective finish coverings removed on up to 1% of all cold service and dual temperature service surfaces, fittings, flanges, couplings, valves, and ductwork/pipeline accessories to review the installation of the insulation, at no additional cost.

.2 If insulation sealing is found to be incorrect at any one sampled location, remove the protective finish on all fittings, flanges, couplings, valves, and pipeline accessories for review, at no additional cost.

.3 Repair defective insulation sealing and replace protective coverings at no additional cost.

End of Section

PIPING INSULATION
20 07 19

1 GENERAL

1.1 Scope

.1 Provide insulation, coatings, finishing coverings and mechanical protection of piping, valves, fittings, and pipeline accessories.

.2 Conform to Specification section 20 07 11 for common requirements for mechanical insulation.

1.2 Related Sections

.1 Without limiting the scope of work or applicability of other Specification sections, the work under this section directly integrates with or refers to the following Specification sections:

.1 20 05 29 Common Hanger and Support Requirements for Piping

.2 20 07 11 Common Requirements for Mechanical Insulation

2 PRODUCTS

2.1 General Requirements

.1 Insulation, adhesives, coatings, finish coverings, lagging, sealers, and tapes:

.1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84.

.2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84.

.3 exception: vapor barrier mastics on mechanical services located outside of the building

2.2 Pipe Insulation

.1 Type P-1 (molded glass-fibre):

.1 factory molded rigid glass-fibre to ASTM C547,

.2 nominal pipe size: NPS 24 and smaller,

.3 service temperature, jacketed: -18°C (0°F) to 65°C (150°F),

.4 jacket: all-service-jacket (ASJ) of white kraft paper bonded to aluminum foil, reinforced with glass fibre yarn, and laminated to an interior kraft paper face,

.5 vapor transmission: maximum 0.02 perms to ASTM E96,

.6 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.7 reduced environmental impact feature of either: bio-based binders, 25% minimum recycled glass content, and/or paper-free ASJ jacket material,

.8 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.034	93	0.040

Standard of Acceptance

- Johns Manville - fig. Micro-Lok HP (25% recycled content)
- Owens Corning - fig. Fiberglas Evolution (paper-free ASJ)
- Knauf Fiberglass - fig. Earthwool 1000 Ecose (bio-based binders)

.2 Type P-2 (semi-rigid glass-fibre roll):

.1 glass fibre semi-rigid roll insulation for tanks and pipes, to ASTM C1393 or ASTM C177,

.2 glass-fibre oriented to maintain uniform thickness when installed on round surfaces,

.3 density: 40 kg/m^3 (2.5 lb/ft^3),

.4 nominal pipe size: NPS 14 and larger,

.5 service temperature with jacket: up to 65°C (150°F),

.6 jacket: all-service-jacket ("ASJ") of white kraft paper bonded to aluminum foil, reinforced with glass fibre yarn, and laminated to an interior kraft paper face,

.7 vapor transmission: maximum 0.02 perms to ASTM E96,

.8 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.9 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.035	93	0.046

Standard of Acceptance

- Johns Manville - fig. Micro-Flex Pipe and Tank Wrap
- Owens Corning - fig. Fiberglas Pipe and Tank
- Knauf Fibreglass - fig. KwikFlex Pipe and Tank

.3 Type P-3 (molded mineral fibre):

.1 factory molded mineral fibre to ASTM C547,

.2 density: 128 kg/m^3 (8.0 lb/ft^3),

.3 nominal pipe size: NPS 30 and smaller,

.4 service temperature: up to 650°C (1200°F),

.5 jacket: integral foil skrim-kraft (FSK) jacket of aluminium foil reinforced with glass fibre yarn, and laminated to kraft paper,

.6 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.7 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
38	0.036	149	0.049

Standard of Acceptance

- Rockwool - fig. ProRox PS 960

- Johns Manville - fig. MinWool-1200
- Industrial Fiber-Tek - fig. IFT 1200 Pipe

.4 Type P-4 (molded mineral fibre, high temperature):

.1 factory molded mineral fibre, high temperature, to ASTM C547,

.2 density: 145 kg/m^3 (9.1 lb/ft^3),

.3 nominal pipe size: NPS 6 and larger,

.4 service temperature: up to 760°C (1400°F),

.5 jacket: none,

.6 compressive strength: 53 kPa (8 psi) at 10% compression,

.7 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.8 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
38	0.039	149	0.049

Standard of Acceptance

- Rockwool - fig. ProRox PS 980

.5 Type P-5 (cellular glass):

.1 fabricated pipe and fitting shapes, cellular glass to ASTM C552,

.2 density: 120 kg/m3 (7.5 lb/cu ft),

.3 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),

.4 nominal pipe size: NPS 16 and smaller,

.5 service temperature: -268°C (-450°F) to 480°C (900°F),

.6 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),

.7 jacket: none,

.8 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.9 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
10	0.040	24	0.042

Standard of Acceptance

- Owens Corning - fig. Foamglas

.6 Type P-6 (elastomeric foam plastic):

.1 flexible elastomeric closed cell foam, tubular with self-sealing seams, to ASTM C534,

.2 nominal pipe size: NPS 2 and smaller,

.3 service temperature: -183°C (-297°F) to 82°C (183°F),

.4 jacket: none,

.5 manufacturer specific sealer/adhesive,

.6 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.7 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
24	0.035	32	0.037

Standard of Acceptance

- Armacell - fig. AP Armaflex SS Pipe Insulation
- KFlex USA - fig. Insul-Tube

.7 Type P-10 (ceramic wool)

.1 alkaline earth silicate fibres (AES), roll insulation for tanks and pipes, to ASTM C201,

.2 free of binders and lubricants,

.3 density: 96 kg/m3 (6 lb/cu ft),

.4 continuous service temperature: 1000°C (1830°F),

.5 jacket: none,

.6 non-combustible,

.7 no requirement for labelling under the Global Harmonized System for classification labels for chemicals,

.8 not to exceed a maximum thermal conductivity at the following mean insulation temperatures:

Mean Temperature °C	Conductivity W/(m·°C)	Mean Temperature °C	Conductivity W/(m·°C)
800	0.21	1000	0.29

Standard of Acceptance

- Morgan Thermal Ceramics - fig. Superwool Plus][]

2.3 Pipe Support Insulation Inserts

.1 General:

.1 molded or fabricated high-density molded insulation inserts for pipe supports.

.2 Type P-21 – factory insulated shields:

.1 factory assembled high-density insulation insert with insulation shield,

.2 nominal pipe size: NPS 1/2 to NPS 30,

.3 service temperature: -40 to +125°C (-40 to +275°F),

.4 insulation:

(a) rigid phenolic foam insulation, to ASTM C1126, Gr.2, Type III,

(b) thickness: to match thickness of adjacent pipe insulation,

(c) nominal density:

i) NPS 10 and under: 60 kg/m^3 (3.75 lb/ft^3),

ii) NPS 12 to 30: 80 kg//m^3 (5.0 lb/ft^3),

(d) minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),

(e) pipe circumference coverage: 360°,

(f) insulation length: to extend at least 38 mm (1-1/2 in.) past each end of the integrated shield.

(g) vapour barrier jacket: three-ply composite polyester film and aluminium foil with self-securing lap-seal, with zero perm rating,

(h) listed to CAN/ULC-S102/S102.2 or ASTM E84.

.5 insulation shield:

(a) Z275 (G90) coating-weight galvanized steel to ASTM A653, with formed ribs to centre clevis hanger or strut,

(b) edges flared or hemmed to prevent damage to insulation,

(c) adhered to bottom of insulation insert,

(d) width: covering 180° arc of insulation,

(e) length and thickness: as required to not exceed the compression strength of the insulation insert when supporting piping filled with water based on the maximum pipe support spans as defined in MSS SP-58.

.6 heavy-duty insulation shield (designation P-21HD):

(a) as specified above for insulation shield except/and as follows,

(b) shield thickness: 2.75 mm (12 ga),

(c) with structural steel plate welded to bottom of shield.

.7 sliding protection shield (designation P-21SL)

(a) as specified above for insulation shield except/and as follows,

(b) secondary shield located below the primary protection shield, with PTFE layer bonded to the upper surface of the secondary shield,

(c) designed to allow relative movement between the primary shield and secondary shield.

Standard of Acceptance

- Buckaroos Inc. - fig. CoolDry Insulated Saddles
- Buckaroos Inc. - fig. CoolDry Heavy Duty Insulated Saddles
- Buckaroos Inc. - fig. CoolDry Sliding Insulated Saddles

.3 Type P-22 - cellular glass:

.1 cellular glass to ASTM C552,

.2 nominal pipe size: NPS 1-1/2 to NPS 24,

.3 density: nominal 120 kg/m^3 (7.5 lb/ft^3),

.4 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),

.5 service temperature: -73ºC to+121ºC (-100ºF to 250ºF),

.6 listed to CAN/ULC-S102/S102.2 or ASTM E84.

Standard of Acceptance

° Owens Corning - fig. Foamglas

3 EXECUTION

3.1 General

.1 Where repairs are made to existing insulated piping due to connections of new piping work, the insulation thickness for the existing piping is permitted to match the existing insulation nominal thickness, provided the extent of new insulation does not exceed a length of 1000 mm (39 in).

3.2 Applicable Systems – Hot piping

.1 Insulate Hot piping systems including pipe, valves, fittings, and pipeline accessories in accordance with the Schedule A at the end of this Specification section.

.1 Table 1A for all piping except engine combustion gas exhaust piping,

.2 Table 1B for engine combustion gas exhaust piping.

.2 Insulate condensate piping in accordance with the same criteria as its associated steam system.

.3 Insulate piping for safety valves or safety relief valves that is located;

.1 less than 2.4 m (8 ft) above a floor or work surface, or

.2 within 1 m (39 in) horizontally of, and less than 2.4 m (8 ft) above, an elevated work surface.

3.3 Insulating Hot Piping

.1 Insulate straight pipe sections by staggering adjacent longitudinal seams 1/4 turn for each butt joint.

.2 Secure insulation for domestic hot water piping, domestic hot water recirculation piping, non-potable hot water piping and non-potable hot water recirculation piping in accordance with the requirements for insulating Cold and Dual Temperature piping.

.3 Secure insulation with integral ASJ or FSK jackets by stapling the lap flap on 75 mm (3 in) centers or by use of self-sealing lap adhesive strip.

.4 Secure insulation that does not have an integral ASJ or FSK jacket by use of stainless steel wire at not less than 300 mm (12 in) centers, or by a continuous wire helix on the same center spacing.

.5 For type P-2 and P-4 insulation, or where the required pipe insulation thickness is greater than 50 mm (2 in);

.1 provide two layers of approximately equal thickness such that the total thickness is as specified,

.2 install straight pipe sections by staggering adjacent section longitudinal seams 1/4 turn for each section, and stagger butt joints between the first layer and second layer by at least 1/4 of the insulation section length, and

.3 secure the first layer of insulation with stainless steel wire on 300 mm (12 in.) centers, and secure the second layer with band straps on 300 mm (12 in) centers.

.6 Secure butt joints with vapour barrier tape or insulation butt strips.

.7 For piping service temperatures greater than 121°C (250°F);

.1 apply insulation finishing cement at all exposed edges of insulation where the insulation is interrupted by valves, connections to other equipment, and piping supports and anchors.

3.4 Insulation of Fittings, Flanges, and Couplings – Hot, Cold and Dual Temperature Piping

.1 Insulate fittings including elbows and tees, other than flanges and grooved-couplings:

.1 NPS 1½ and smaller:

(a) miter cut insulation to create tight fit,

(b) where PVC covers are used, trim backside of insulation on elbows to suit cover but do not reduce total thickness less than that of adjacent pipe insulation.

.2 NPS 2 and larger:

(a) use matching preformed insulation inserts, or fabricate tightly-fitting mitered insulation segments made from the same material as pipe insulation,

(b) number of mitered segments to be sufficient to maintain thickness of insulation around throat of elbow or tee,

.2 Insulate flanges and grooved-joint couplings:

.1 insulate with preformed inserts or build-up insulation with same material as on adjacent pipe:

(a) butt pipe insulation to each side of flange or grooved-joint coupling,

(b) build up rigid insulation blocking on each side of flange or grooved-joint coupling, with a width dimension same as pipe insulation thickness,

(c) apply insulation layer over the top of the flange or coupling to a thickness equal to pipe insulation thickness.

.3 Where type P-5 or P-7 insulation is used;

.1 insulate as described above except use factory made insulation inserts, or fabricate inserts to suit the pipe fitting, flange or coupling.

.4 Where type P-6 insulation is used;

.1 insulation as described above except adhere insulation to fitting, flange, or coupling with 100% coverage of adhesive,

.2 do not adhere insulation across bolted connections - insulate on each side of connection and add additional insulation layer across connection and fix in place with bands and seal joints.

.5 Secure insulation with stainless steel wire (Hot piping), or vapour barrier tape (all piping), prior to application of coatings and finishes.

3.5 Insulation of Pipeline Accessories – Hot, Cold and Dual Temperature Piping

.1 Insulate pipeline accessories depending on service temperature:

.1 valves,

.2 strainers,

.3 pressure reducing valves,

.4 control valves,

.5 meters,

.6 steam separators.

.2 Insulate pipeline accessories for Hot piping systems with sevice temperatures greater than 93°C (200°F) as follows:

.1 insulated with type P-8 removable/reusable fitted insulation covers, designed to allow free movement of valve actuator,

.2 insulation is not required at this service temperature range for drain valves, blowoff/blowdown valves, and drip caps or plugs.

.3 Insulate pipeline accessories for Hot piping systems with service temperature greater than 60°C (140°F) and up to 93°C (200°F) or less, as follows:

.1 insulated with:

(a) type P-8 removable/reusable fitted insulation covers designed to allow free movement of valve actuator, or

(b) insulated with fitted pipe insulation segments, or oversized sections of insulation arranged to permit its removal and reinstallation, or

(c) tightly placed flexible insulation and covered with PVC fitting covers.]

.2 insulation is not required at this service temperature range for drain valves, drain caps/plubs, and for pipeline accessories NPS 1 and smaller.

.4 Insulation of pipeline accessories is not required for Hot piping with service temperatures less than 60°C (104°F).

.5 Insulate pipeline accessories for chilled water, liquid refrigerant, and dual temperature heating/cooling systems as follows:

.1 detachable insulated box type with embossed aluminum or stainless steel jacket, with vapor barrier tape applied to seams when installed, and lined with one layer of 25 mm (1 in) P6 elastomeric blanket with no voids at corners or joints,

.2 alternatively, for accessories NPS 8 and larger, install one layer of 25 mm (1 in) type P-6 elastomeric blanket insulation adhered to pipeline accessories with 100% adhesive coverage, and all joints sealed with manufacturers sealant, including the joint between P-6 insulation and adjacent piping insulation,

(a) at locations requiring access, extend insulation to create a collar around bolted connection, and install a compression fit piece of insulation to cover equipment.

.3 alternatively, for accessories NPS 4 and smaller, insulate with fitted pipe insulation or mitered blocks with all joints sealed with two coats of vapour barrier coating complete with reinforcing membrane.

.6 Insulate accessories for all other Cold and Dual Temperature Piping systems as follows:

.1 insulate with flexible blanket insulation, fitted pipe insulation or mitered block of same material and thickness of adjacent piping and seal all joints with two coats of vapour barrier coating complete with reinforcing membrane or vapour barrier tape.

.7 At locations requiring access including valve handles, valve actuators, drain valves, etc. cut-back insulation and seal exposed edges.

3.6 Insulation Protection at Pipe Supports

.1 Installation of pipe insulation saddle protection for Hot piping:

.1 pipe saddles provided under Specification section 20 05 29,

.2 insulate the interior void spaces of pipe saddles, using the same material as adjacent pipe insulation,

.3 butt insulation up to sides and end of pipe saddle, and leave bottom surface of saddle exposed for direct contact with pipe support.

.2 Installation of pipe insulation shield protection for hot and cold piping:

.1 pipe insulation shields are provided under Specification section 20 05 29 except where specified herein as a factory assembled insulation insert and shield.

.2 provide high-density insulation inserts at pipe hanger locations as specified herein and in accordance with Specification 20 05 29 subject to fluid service temperature and pipe size,

(a) insert length: at least 50 mm (2 in) longer than the shield length to allow application of vapour barrier sealant or tape, but not less than the following:

Pipe Size NPS	Insulation Insert Length mm (in)
1 ½ to 4	400 (16)
6	550 (22)
8 - 24	700 (28)

(b) arc width: one-half of the pipe diameter for type P-22and P-23 inserts,

.3 fabricate the high-density inserts so their thickness is the same as the adjacent installed pipe-run insulation, with finished surface thickness within +3 mm/-0 mm (+1/8 in / -0 in) of adjacent pipe insulation thickness,

.4 for cold water piping, apply insulation cover and vapour barrier sealant to fully cover and seal the high-density insert, and to overlap the adjacent pipe-run insulation by at least 50 mm (2 in) on all edges,

.5 install the insulation shield between the finished insulation and the support pipe; the pipe support is sized for the outside dimension of pipe and insulation.

3.7 Insulation at Floor and Wall Openings

.1 Extend pipe insulation at full required thickness through floor and wall openings for Hot, Cold and Dual Temperature piping. Vapour barrier jackets for Cold and Dual Temperature piping are to extend unbroken through the wall or floor penetration. Finish coverings for Hot piping with service temperatures not exceeding 93°C (200°F) may terminate on each side of the opening.

.2 Reduction in insulation thickness through floor or wall openings is not permitted except by prior approval of Consultant on specific exceptional case basis;

.1 exception: Hot piping with service temperature not exceeding 93°C (200°F) may be reduced by one-half the required thickness stated in Schedule A1 through wall and floor penetrations, but such thickness reduction shall not extend more than 25 mm (1 in.) on each side of the opening.

.3 For penetrations through fire rated separations, provide finishes in accordance with fire stopping manufacturer's listing requirements.

.4 For outdoor piping passing through exterior walls or roof, terminate mastic lagging at outside face of sleeve and provide storm flashing to protect insulation, caulked to lagging and to building structure.

3.8 Sealing of Insulation – Hot Piping

.1 Seal hot piping insulation in accordance with Specification section 20 07 11 and/except as specified herein.

.2 Indoor installation (except wet areas):

.1 except where a separate protective finishing jacket is used, apply vapour barrier tape to butt joints, overlapping by at least 50 mm (2 in) each side,

.2 do not tape lap joints except as required to secure the insulation,

.3 where a separate protective finishing jacket is provided, no additional sealing of the insulation is required.

.3 Indoor installations – wet areas:

.1 regardless of how insulation is secured, apply vapour barrier tape to:

(a) all longitudinal lap seams and butt edges,

(b) 100% coverage of insulation at pipe joints, fittings, couplings, etc.

.4 Outdoor installation:

.1 apply two coats of breather mastic complete with reinforcing membrane to all lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side, and to all insulation that does not have a factory installed jacket.

3.9 Sealing of Insulation – Cold and Dual Temperature Piping

.1 Seal Cold and Dual Temperature piping insulation in accordance with Specification section 20 07 11 and/except as specified herein.

.2 Indoor installation (except wet locations):

.1 except for chilled water and Dual Temperature piping, tightly seal insulation ASJ jacket longitudinal seams and butt joints;

(a) using factory or field fabricated lap seams and butt joint strips with adhesive, or

(b) by applying colour matched vapour barrier tape to all edges, overlapping joint by minimum 50 mm (2 in) each side,

(c) where factory lap seams are damaged, apply colour matched vapor barrier tape along the damaged edges,

.2 for chilled water and dual temperature piping insulation with ASJ jackets, tightly seal longitudinal seams and butt joints;

(a) with two coats of vapor barrier coating complete with reinforcing membrane,

(b) for pipe size NPS 6 and smaller, colour matched vapour barrier tape is permitted to be used depending on location of piping in accordance with the following table.

Insulation Joint Sealing – Pipes NPS 6 and Smaller		
Piping Location	Vapour Barrier Tape	Vapour Barrier Coating with Membrane
Mechanical Service Rooms	No	Required
Vertical Service Spaces (shafts)	No	Required
Tunnels and trenches	No	Required
Unconditioned spaces	No	Required
Conditioned Spaces	Permitted [Note 1]	Permitted
Ceiling spaces over Conditioned Spaces	Permitted [Note 1]	Permitted
IT rooms	No	Required

Notes:
[1] Pipe size NPS 6 and smaller only.

(a) overlap insulation edges and butt joint by minimum 50 mm (2 in) each side,

(b) seal the butt end of the insulation with vapour barrier coating, overlapping onto the piping, at every fourth length of piping, but not to exceed 4 m (13 ft) in pipe run length.

.3 cover mechanical fastener penetrations including staples with colour matched vapour barrier tape, overlapping the fasteners by a minimum of 50 mm (2 in) in all directions.

.4 seal insulation on pipe elbows, tees, flanges, joints, couplings, and other fittings;

(a) with two coats of vapor barrier coating complete with reinforcing membrane,

(b) for pipe sizes NPS 6 and smaller, colour matched vapour barrier tape may be used in locations as described in the above table for piping.

.3 Indoor installations – wet areas:

.1 in wet areas, tightly seal piping in accordance with the requirements for outdoor installation except use vapour barrier coatings.

.4 Outdoor installation:

.1 tightly seal insulation with two coats of vapour barrier mastic complete with reinforcing membrane;

(a) at all lap edges and butt joints,

(b) 100% coverage of insulation of pipe elbows, tees, flanges, joints, couplings, and other fittings,

(c) to cover mechanical fastener penetrations including staples,

(d) in all cases overlapping the joint, fitting or fastener by a minimum 50 mm (2 in) each side.

.5 In all locations;

.1 seal insulation that does not have a factory applied ASJ jacket with 100% coverage of two coats of vapor barrier coating/mastic complete with reinforcing membrane,

.2 seal high-density inserts for pipe supports with two coats of vapour barrier coating/mastic complete with reinforcing membrane, overlapping adjacent insulation a minimum of 50 mm (2 in).

3.10 Insulation Finish Covering

.1 Provide insulation finish coverings selected in accordance with Schedule C at the end of this Specification section and installed in accordance with Specification section 20 07 11 and/except as specified herein.

.2 Self-adhesive weather barrier (SAWB) coverings;

.1 apply SAWB in accordance with manufacturer's instructions,

.2 do not place an overlap within one-eighth pipe diameter on each side of a horizontal pipe top centerline,

.3 for vertical piping, overlap higher layers over lower layers with an overlap not less than 100 mm (4 in).

3.11 Standard Details

.1 Refer to Specification section 20 05 29 for illustration of coordination of insulation with pipe supports, unless otherwise shown on drawings.

3.12 Schedules

.1 The following appended schedules form part of this Specification section.

.1	Schedule A1	Hot piping Systems, Insulation Type and Thickness (excluding engine combustion gas exhaust piping)
.2	Schedule B	Cold and Dual Temperature Piping Systems, Insulation Type and Thickness
.3	Schedule C	Piping Insulation Protective Finishes.

Schedule A1
Hot Piping Insulation Type and Thickness
(excluding engine combustion gas exhaust piping)

System	Fluid Nominal Temp. °C (°F)	Insulation Type	Nominal Pipe Size (NPS)				
			< 1	1 to 1¼	1½ to 3	4 to <8	≥ 8
			Insulation Thickness, mm (in)				
Steam and Condensate > 860 kPa (125 psi)	177 to 315°C (351 to 600°F)	P-3	115 (4.5) [Note 3]	125 (5) [Note 3]	125 (5)	125 (5)	125 (5)
		P-4	---	---	---	---	125 (5) [Note 1, 2]
		P-7	200 (8) [Note 3]	200 (8) [Note 3]	200 (8)	175 (7)	175 (7)
		P-2 P-4	---	---	---	---	150 (6) [Note 1, 2]
		P-7	125 (5) [Note 3]	175 (7) [Note 3]	175 (7)	175 (7)	150 (6)
		P-2 P-4	---	---	---	---	100 (4) [Note 1, 2]
		P-7	125 (5) [Note 3]	100 (4) [Note 3]	125 (5)	125 (5)	125 (5)
Hot Water Heating Glycol Heating Pumped Condensate	61 to 93 (141 to 200)	P-1 P-3	40 (1½) [Note 3]	40 (1½) [Note 3]	50 (2)	50 (2)	50 (2)
		P-2 P-4	---	---	---	---	65 (2½) [Note 1, 2]
		P-7	65 (2½) [Note 3]	65 (2½) [Note 3]	65 (2½)	65 (2½)	65 (2½)

Notes:
[1] For NPS 14 and larger.
[2] Install in two layers of insulation to make up total thickness.
[3] For piping NPS 1-1/4 and smaller located in partitions within conditioned spaces, insulation thickness may be reduced by up to 25 mm, but final thickness shall not be less than 25 mm.
[4] For heat-traced fire protection piping only, including drum drip assemblies on dry systems.

Schedule B
Cold and Dual Temperature Piping Insulation Type and Thickness

System	Fluid Nominal Temp. °C (°F)	Insulation Type	Nominal Pipe Size (NPS)				
			< 1	1 to 1¼	1½ to 3	4 to <8	≥ 8
			Insulation Thickness, mm (in)				
Dual Temperature Heating/Cooling	4 to 93 (39 to 200)	P-1 P-3	40 (1½)	40 (1½)	50 (2)	50 (2)	50 (2)
		P-2	---	---	---	---	65 (2½) [Note 1, 2]
Refrigerant Suction	< 4 (< 39)	P-6	25 (1)	25 (1)	25 (1) [Note 3]	---	---
		P-6 (outer layer)	---	---	---	25 (1)	25 (1)

Notes:
[1] For NPS 14 and larger.
[2] Install in two layers of insulation to make up total thickness.
[3] Do not use on pipe size NPS 2-1/2 to 3.

Schedule C
Piping Insulation Finish Coverings

Location	Exposed/ Concealed	Piping System	Finish Covering
Outdoors	Any	Engine combustion gas exhaust piping	Stainless Steel
		MRI quench vent piping	Stainless Steel
		All other piping	Stainless Steel

END OF SECTION

TESTING ADJUSTING AND BALANCING
20 08 05

1 GENERAL

1.1 Scope

.1 Test, adjust, and balance (TAB) air handling systems and hydronic systems installed, modified or extended as part of this work.

.2 Rechecking of testing and balancing during alternate heating/cooling season.

1.2 Qualifications and performance standards

.1 Balancing to be performed under supervision of recognized expert with an established reputation in this field.

.1 TAB contractor to be a member of AABC or NEBB.

.2 Perform testing and balancing in accordance with:

.1 SMACNA Testing, Adjusting and Balancing guidelines,

.2 Associated Air Balancing Council standards for Total System Balance.

1.3 Preparatory work

.1 Review design drawings and specifications, shop drawings, interference drawings and other related documentation to become familiar with their intended performance.

.2 Carry out site visits during later stages of construction to ensure that arrangements for TAB are incorporated.

.3 Confirm proper placement of thermometer wells, test ports, pressure gauge cocks, balancing valves, balancing dampers and splitter dampers, and access doors.

.4 Submit TAB schedule, with descriptive data outlining procedures and sample forms showing method of data presentation, three months before start of TAB work on site.

.5 Provide details of specific procedures to be used for determining test parameters from test measurements and criteria proposed to establish compliance with specification requirements.

.6 List instruments to be used, method of instrument application (by sketch) and correction factors.

.7 Calibrate instruments in accordance with recognized standards, and submit calibration curves not more than three months before commencement of TAB.

.8 TAB measurements to commence when building is “closed in” and work is sufficiently advanced to include;

.1 Installation of ceilings, doors and windows.

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

.3 Normal operation of mechanical systems.

1.4 Systems, equipment and related controls requiring TAB

.1 Air handling systems.

.2 Hydronic systems including

.1 Heating and cooling equipment and piping systems.

.2 Domestic water equipment and cold, hot and recirculation hot water piping systems.

2 AIR MOVING SYSTEMS

2.1 Parameters

.1 Listed below is an outline of the information to be established in the TAB process:

.1 Air flow related;

(a) Air velocity
(b) Flow cross sectional area.
(c) Static pressure.
(d) Velocity pressure.

.2 Temperature related;

(a) Wet bulb.
(b) Dry bulb.

.3 Equipment related;

(a) rotational speed (rpm)
(b) Electrical power,
(c) Voltage.
(d) Current draw.

.2 Measurement are required at and around equipment to establish air side performance of;

.1 Fans.

.2 Coils.

.3 Filters.

.4 Dampers.(fresh, return and relief)

.5 Humidifiers.

.6 Terminal units

.3 Measurement are required to characterize system performance;

.1 at main ducts.

.2 at branch ducts.

.3 at sub-branch ducts.

.4 at each supply, exhaust and return air inlet and outlet.

.5 in each thermostatically controlled zone.

2.2 General criteria

.1 Balance systems so that fans operate at lowest possible speed and static pressure consistent with delivery of specified air quantity at most remote terminal point.

.2 Set-up supply fans with sufficient speed to deliver required air quantity when filters are loaded to manufacturers recommended maximum pressure drop. Temporarily block filters to achieve maximum pressure drop at design air flow.

.3 Air quantities at each exhaust system inlet and supply system outlet are to be measured and throw and pattern is to be adjusted at each supply outlet.

2.3 Fan performance assessment

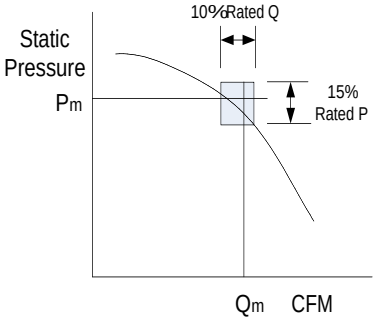
.1 Measure air quantity by taking anemometer traverses across a coil or at a filter bank or by pitot tube traverse in a straight section of duct at fan suction or discharge.

.2 Measure static pressure difference between fan inlet and discharge, motor amperage and fan speed in rpm. Determine motor input power from a curve showing power output as a function of motor amperage for the particular motor.

.3 Plot results of measurements on fan characteristic curve supplied by fan manufacturer and the air volume, static pressure and fan speed lines should form a triangle enclosed by a rectangle with a dimension of not more than 15% of the rated static pressure by a dimension of not more than 10% of the specified air quantity. Input power taken from the fan characteristic should be within 10% of the power determined from the motor amperage readings.

.4 If required precision is not obtained, readings to be repeated. If subsequent testing shows that the required precision is unobtainable then fan manufacturer is to submit written report explaining actual fan performance and provide new characteristic curve showing actual performance for fan “as installed”.

.5 Measure static pressure loss across cooling coils, heating coils and individual filter banks and tabulate readings with manufacturers published pressure loss figures for the actual measured air volume.



2.4 Variable volume system balancing procedure

.1 Obtain from Consultant the expected diversity value. Open sufficient boxes to 100%, and close a random selection of boxes, equally distributed throughout the system, to obtain the design fan flow rates.

.2 Set system to operate with 100% return air, set room thermostats at design indoor temperature, set fan discharge temperature at design point.

.3 Set thermostat in most remote zone to full cooling and adjust fan inlet guide vane, or AFD speed, static pressure control to supply specified air quantity at most remote zone volume damper, pneumavalve or terminal box.

.4 Reset most remote zone thermostat to design room temperature and set next most remote zone thermostat to full cooling and adjust branch splitter damper ahead of zone volume damper, pneumavalve or terminal box, to provide design air quantity at outlets.

.5 If zone air quantity is less than design, increase fan inlet guide vane, or AFD speed, static pressure control setting to achieve design air quantity and rebalance previously checked zones.

.6 Repeat as required for each zone.

2.5 Mixed constant volume and variable volume balancing procedure

.1 Same procedure as for all VAV system except as follows:

.1 Boxes which are constant volume are to be selected and set for 100% design airflow.

.2 Balance the constant volume boxes first, then the VAV boxes are per the procedure described above.

2.6 Induction primary air supply system balancing procedure

.1 Set system to operate with 100% return or supply air and measure plenum pressure at each induction unit on floor most remote from unit.

.2 Adjust fan inlet guide vane static pressure controller to provide design static pressure at most remote unit.

.3 Check and adjust individual unit dampers to obtain design static pressure at each air plenum of each induction unit supplied by fan on test.

.4 If nozzle plenum static pressure at an intermediate flow is less that for design air quantity, reset fan inlet guide vane static pressure controller to achieve value and re-balance more remote units.

2.7 Terminal box supply system balancing procedure

.1 Set system to operate with 100% return air, set room thermostats at indoor design temperature and set fan discharge temperature at design value.

.2 Set thermostat in most remote zone to full cooling and adjust fan inlet guide vane static pressure controller to maintain manufacturer's specified minimum static pressure at box inlet.

.3 Check air quantity delivered by box and adjust volume regulators to obtain design value.

.4 Reset room thermostat to full heating and check performance of regulator.

.5 Reset thermostat to design temperature and repeat procedure for remaining terminal boxes.

.6 If inlet static pressure at a subsequent box is less than manufacturer's specified minimum, reset inlet guide vane static pressure controller to suit.

.7 Open balancing dampers and adjust fan inlet static pressure controllers, or fan speed to obtain design air quantity at most remote outlet.

.8 Balance remaining outlets by adjusting dampers.

.9 If air quantity at some outlet other than the most remote outlet is less than design, re-adjust fan and rebalance previously adjusted outlets.

.10 Measure fan performance and adjust fan speeds and inlet guide vane controllers so that return air quantity is equal to supply air quantity less fixed exhaust air quantities, with a 10 percent allowance for pressurization.

2.8 Fresh air adjustment procedure

.1 After adjustment of supply, return and related exhaust fans, adjust minimum fresh air damper position to obtain design fresh air quantity.

.2 Damper position to be determined by measurement of outside return and mixed air temperatures and confirming calculations to be included in balance report.

.3 Where duct space permits, include airflow measurement of supply, and recirculation or outdoor air, to verify results.

2.9 Branch air quantity measurement procedure

.1 Branch air quantities to be determined using pitot tube traverses in accordance with the procedures outlined in "Testing, Balancing and Adjusting of Environmental Systems" by William G. Eads, P.E., issued by SMACNA.

.2 Measurements to be taken at each riser as it is connected to fan discharge or suction header and at each floor where branches are taken from the riser. Measurement to be repeated until sum of branch air quantities is within 10% of fan delivery.

3 HYDRONIC SYSTEMS

3.1 Parameters

.1 Listed below is an outline of the information to be established in the TAB process;

- .1 Flow.
- .2 Pressure.
- .3 Temperature.
- .4 Specific gravity.
- .5 Rotational speed (rpm).
- .6 Electrical
  - (a) power
  - (b) Voltage.
  - (c) Current draw.

.2 Measurement are required at and around equipment to establish fluid side performance of;

- .1 Heat exchangers (primary and secondary sides).
- .2 Coils.
- .3 Boilers.
- .4 Pumps.
- .5 PRVs.
- .6 Makeup (water) systems.
- .7 Domestic hot water heaters.
- .8 Humidifiers.

3.2 General criteria

.1 Use calibrated venturi tubes, orifices or other metered fittings and pressure gauges in conjunction with permanent and portable type flow meters to determine flow rates for system balance.

.2 Effect system balancing with automatic control valves open to heat transfer elements and bypasses closed.

.3 Base flow balance on (in order of preference):

.1 double regulating valves, or globe valves associated with flow measuring elements (flow meters),

.2 temporary non-invasive flow meters,

.3 differential pressure measurement across heat transfer elements, and checked against manufacturer's literature, or

.4 temperature difference across various heat transfer elements in the system where flow metering devices are not installed. This method may only be used at design heat transfer conditions.

.4 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing.

.5 Perform balancing by measurement of temperature differential in conjunction with air balancing.

.6 Adjust water distribution systems by means of double regulating valves, globe valves, balancing cocks, valves and fittings. Do not use shut-off valves for balancing unless indexed.

.1 Butterfly valves on discharge side of pumps may be used if they are one trade size smaller than system pipe size. Include Cv values and flow vs valve position curve with balancing report.

.7 Where available pump capacity is less than total flow requirements of individual system parts, full flow in any part may be simulated by temporary restriction of flow to other parts.

4 EQUIPMENT TESTING

4.1 Performance data

.1 Submit the following data as a minimum. If contractor's standard forms provide for additional data, also submit such additional data.

.1 Some equipment tests may need to be performed during the alternate season testing.

.2 Include nameplate data and as-tested results.

.2 Heat Transfer Equipment:

.1 manufacturer and type,

.2 inlet and outlet temperatures,

.3 pressure drop,

.4 flow rate.

5 REPORT PRESENTATION AND VERIFICATION

5.1 Required reports

.1 Provide the following reports:

.1 Air and water balancing report

.2 Alternate season test report.

5.2 Report format

.1 Reports to incorporate approved standard forms, with values expressed in SI and (Imperial) units.

.2 Include "as-built" system schematics showing flow quantities and measurement points. Use as-built drawings and ventilating line diagrams for references.

.3 Submit two hard copies of TAB reports, with index tabs, in "D" ring binders, for verification.

.4 Submit two soft copies of TAB reports in Adobe Acrobat V7 PDF format.

5.3 Accuracy

.1 Adjust systems until operating values within plus or minus 5% of design values are achieved.

.2 Measurements to be accurate to within plus or minus 2% of actual values.

5.4 Spot checks

.1 After review of the Draft Report by the Consultant and at the Consultants direction, retest up to 10% of all measurements in locations as directed by the Consultant, at no cost extra to the contract.

.2 If results indicate unusual testing inaccuracy, omissions, or incomplete balancing/adjustment, in the opinion of the Consultant, re-balance entire affected system(s) at no increase in Contract Price.

5.5 Balance position marking

.1 Mark the balance position of dampers and valves at the completion of the final testing:

.1 Ductwork: indicate with arrow using paint or permanent marker,

.2 Exposed ductwork in public areas: self adhesive label, placed adjacent to balancing damper, neatly filled in with % open or degree open value.

.3 Valves: self-adhesive label, placed on piping (insulated or not) adjacent to valve, neatly filled in with either % valve open, or number of valve turns to open.

.2 Additional requirements for Double Regulating Valves:

.1 Remove valve handle or other protective device, and set memory stop to limit valve open travel. Replace valve handle or protective cover.

5.6 Record keeping

.1 Keep records of trial and final balance and submit preliminary report as each system is completed.

.2 Make spot checks as requested and repeat balancing of system if actual spot check quantities do not agree with preliminary report figures.

5.7 Verification

.1 Reported measurements will be verified.

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

.3 Number and location of verification measurements to be at discretion of Engineer.

.4 Where discrepancies are encountered repeat TAB, and resubmit reports.

5.8 Completion

.1 Continue TAB until reports are approved.

.2 The Substantial Performance of the Mechanical Work will be considered reached when the initial Start-Up and Performance Testing report is accepted by the Consultant and in the opinion of the Consultant all systems have been satisfactorily installed, operated tested, balanced, and adjusted to meet the specified and intended performance.

.3 The substantial performance is not dependent upon alternate season testing.

.4 The total performance of the Mechanical Subcontract (Contract) will not be considered reached until the alternate season testing and balancing is completed and the final report submitted and accepted by the Consultant.

END OF SECTION

PROJECT CLOSE-OUT MECHANICAL
20 08 19

1 GENERAL

1.1 Scope

.1 Provide documentation deliverables at completion of the Work.

1.2 Occupancy Permit

.1 Submit the reviewed final Life Safety and Fire Protection Commissioning report two weeks prior to application for occupancy permit.

1.3 Substantial Performance

.1 Complete the Substantial Performance Checklist and submit with required documentation when applying for Substantial Performance of the Work.

.2 Where the work is sub-divided into separate scopes of Work, each requiring a separate Substantial Performance application, provide a separate checklist for each application.

.3 Prepare and submit to the Consultant a comprehensive deficiency list of items to be completed or corrected, as part of the application for a review by the Consultant to establish Substantial Performance of the Work, or for each designated portion of the Work in the case of phased Substantial Performance.

.1 Failure to include an item on the list does not alter the Contractor's responsibility to complete the Work.

.4 Within five working days of the Consultant's review report which indicates that Substantial Performance of the Work has been achieved, provide a detailed schedule for completion and/or correction of the Work of all items described in the Contractors' and the Consultants' deficiency list.

1.4 Total Performance

.1 Submit the following documentation with the application for Total Performance. Application for Total Performance cannot be submitted any earlier than the date of Alternate Season testing.

.1 Where documentation has already been submitted to the Owner, provide a copy of the transmittal.

SUBSTANTIAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ Contractor has compiled and submitted a detailed deficiency list, identifying work still to be completed, incomplete, or requires correction.
- ☐ Equipment start-up reports (Interim).
- ☐ Building department inspection reports.
- ☐ ESA field inspection reports.
- ☐ Vibration survey report (if specified).
- ☐ Controls / BMS operation report.
- ☐ Equipment, pipeline, and valve identification completed
- ☐ Clean-up completed.
- ☐ Spare parts and replacement parts turned over to Owner; transmittal attached.
- ☐ Warranty certificates
- ☐ Operating and Maintenance Manuals, draft, submitted.
- ☐ As-built drawings submitted
- ☐ Training completed and attendance logs submitted.
- ☐ Contractor has provided documentation to verify both air AHU-11 & AHU-12 had Blank openings and pressure test casings test performed. Leaking joints were re-caulked and retested to obtain air leakage rate not greater than 5% of rated air flow at pressure of 2.5 kPa (10 in wg).

Consultant Review		
Status:	☐ Reviewed	☐ Incomplete or deficient - resubmit
Signed:		
Date:		

TOTAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ All known deficiencies have been corrected, including latent deficiencies reported by the Owner.
- ☐ Air and water balancing - final versions including alternate season (summer and winter) testing completed and submitted.
- ☐ Final commissioning reports submitted and accepted by Owner.
- ☐ Operating and Maintenance manuals - finalized and submitted (if final version was issued at time of Substantial Performance indicate here)
- ☐ As-built drawings final version submitted (if final version was issued at time of Substantial Performance indicate here)

Consultant Review		
Status:	□ Reviewed	□ Incomplete or deficient - resubmit
Signed:		
Date:		

End of Section

HVAC PIPING SYSTEMS GENERAL REQUIREMENTS
23 05 01

1 GENERAL

1.1 Scope

.1 Provide heating and cooling piping systems in accordance with the referenced piping materials, standards, specifications and piping codes described herein.

.2 This specification applies to;

.1 water based piping systems, including glycol/water mixtures, for building hydronic heating and cooling systems,

.2 non-potable water systems for HVAC services, and

1.2 Related Sections

.1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:

.1 20 05 24 Welding and Brazing.

1.3 Applicable Codes and Standards

.1 Legislation:

.1 British Columbia Regulation 104/2004 Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation

.2 Installation standards and codes (as adopted and amended by the AHJ for pressure vessels):

.1 CSA B51 Boiler, pressure vessels, and pressure piping code

1.4 Qualified Tradesmen

.1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesmen holding applicable certificates of competency as applicable to the work.

1.5 Registration and Inspection

.1 Before commencing work, make arrangements and pay for registration and inspection by the AHJ responsible for boiler and pressure vessel safety for the following pressure piping systems:

.1 Steam, including condensate piping, at pressures greater than 100 kPa (15 psig), except piping NPS 3 and smaller.

.2 Service water piping for heating a building, at design temperatures greater than 121°C (250°F) or at design pressures greater than 1100 kPa (160 psig),

.2 At the start of the Work, obtain existing pressure piping system registration numbers, if available, from the Owner and/or the AHJ.

1.6 Design Criteria - Glycol system

.1 Piping design and installation code:

.1 To ASME B31.9 for piping system not subject to boiler and pressure vessel regulations.

.2 To ASME B31.1 for piping systems which are subject to boiler and pressure vessel regulations.

.2 System includes but is not limited to;

.1 Coils,

.3 System design criteria:

.1 Design temperatures and pressures:

System Type	Glycol Type	Glycol / Water %	Supply Temp. °C (°F)	Return Temp. °C (°F)	Design Temp. °C (°F)	Maximum Operating Pressure kPa (psig)	Design Pressure kPa (psig)
Glycol Heating – Air Handling Unit Coils	Propylene	50	60 (140)	48 (118)	93 (200)	900 (125)	1030 (150)

2 PRODUCTS

2.1 Dielectric Unions

.1 Construction:

.1 Bronze or brass body with non-metallic fitting or coating the FNPT tailpiece.

.2 FNPT x Copper sweat connection.

.3 Pressure rating; ASME Class 3000 at 121°C (250°F)

Standard of Acceptance

° Hart Industrial Unions - fig. D-3136 or Polymer Composite Coating

2.2 Dielectric Flanges

.1 Construction:

.1 ASME Class 150 or 300 carbon steel flange, Van-stone style with copper tube adapter tailpiece.

.2 Flange provided with a powder coated finish, and an EPDM insulator to isolate the copper tailpiece form contact with the flange.

.3 Minimum MCPR:

(a) Class 150: 1400 kPa (200 psi) at 121°C (250°F)

(b) Class 300: 28oo kPa (400 psi) at 121°C (250°F)

Standard of Acceptance

° CTS Flange Canada - fig. BF / WBG

3 EXECUTION

3.1 Pipe Installation General Requirements

.1 General layout of mains, risers, run-outs and connection details of piping systems are shown.

.2 Install concealed pipes close to building structure to keep furring spaces to minimum and minimize obstruction to other services in ceiling spaces.

.3 Run exposed piping parallel to walls and conserve headroom and space. Group piping wherever practical.

.4 Ream pipe after cutting to length and clean off scale and dirt inside and outside of pipe before threading or welding.

.5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and special fittings such as expansion joints.

.6 Cap ends during construction to prevent entry of foreign matter.

.7 Provide bends, expansion loops, hoses or joints to compensate for pipe expansion and contraction.

.8 Anchor, guide and laterally support vertical and horizontal piping to support filled weight and absorb thrust under operating conditions.

.1 For steam, gas and vapour piping, provide temporary intermediate supports when hydrostatically piping so that pipe support spans are not greater than that required for liquid piping service.

.9 Erect piping so that expansion forces, gravity forces and thrust from changes in direction do not stress connections to apparatus.

.10 Do not use galvanized materials in contact with glycols.

.11 Refer to piping system specifications for additional requirements.

3.2 Dissimilar Metals Galvanic Isolation

.1 Provide dielectric unions or flanges to separate copper and copper alloy tube and fitting materials from contact with carbon steel material. This includes equipment such as coils with copper header connections.

.2 Dielectric unions or flanges are not required when all of the following conditions are met:

.1 the hydronic water treatment program (existing or new) includes a cathodic and/or anodic filming chemistry for mixed metals,

.2 copper tubing is not used in the piping system, except for the final 1 m (40 in) length connection to terminal equipment and in which the tubing is isolated from the carbon steel piping by a bronze body or carbon steel body valve (no brass) , and

.3 terminal equipment which contains copper or copper alloy tubing is connected to carbon steel piping with a flexible connector having an internal non-metallic hose.

.3 For clarity, where copper tubing is installed in a part of a carbon steel piping system, dielectric unions or flanges are required.

3.3 Pressure and Leak Testing - Liquid Service Piping

.1 This test procedure applies to piping normally containing water, including HVAC and process water and glycol/water mixes, and steam-condensate piping.

.2 Pressure test liquid piping systems unless otherwise specified in other sections of Division 23.

.3 Initial pneumatic leak test:

.1 Conduct an initial pneumatic leak test to locate and repair major leaks.

(a) test pressure for ASME B31.1 systems: 175 kPa (25 psig),

(b) test pressure for ASME B31.9 systems: 70 kPa (10 psig).

.2 Remove compressed air source and maintain this pressure for the time necessary to inspect for leaks, but not less than 2 hours.

.3 Maintain pressure and examine each joint with commercial leak detector solution.

Standard of Acceptance

° Snoop

- Leak-tec

.4 Repair leaks where found prior to performing hydrostatic pressure tests.

.5 During pneumatic pressure tests, comply with the site safety requirements for notification and guarding during testing with compressed gasses.

.4 Final hydrostatic pressure test:

.1 Use the system design pressure for the entire installation, unless different design pressures are indicated for each floor.

.2 Pressure test condensate piping to the same test conditions as the steam system to which they are connected.

.3 Fill the system with water and gradually increase the system pressure to 150% of the design pressure and hold for 10 minutes, then reduce pressure to the design pressure.

.4 Inspect each pipe joint for leaks.

.5 As an alternative to inspection of each joint for leaks, conduct a 24 hour standing pressure test:

(a) raise the water pressure to 150% of the design pressure for 10 minutes, then reduce pressure to design pressure,

(b) record the test pressure one (1) hour after establishing the system hydrostatic test pressure at the design pressure. Record ambient air temperature at the same time.

(c) at the end of the 24 hour standing test period, record the test pressure and ambient air temperature. Make adjustments to the measured end-of-test pressure to account for change in fluid density due to change in ambient air temperature,

(d) acceptance criteria: maximum pressure loss over 24 hours not to exceed 1% of test pressure, corrected for ambient temperature,

(e) where acceptance criteria is not met, inspect pipe joints for leaks.

.6 Where leaks are found, repair leaks and retest piping as specified above.

3.4 Pressure Test Report

.1 Maintain a log of all pressure tests, including locating of where leaks have been repaired. Submit the log to the Consultant for review when requesting prior to substantial completion of the Work. Where a piping system is subject to AHJ inspection, provide evidence of such inspection by means of an AHJ inspection report or name of the AHJ inspector and the date they witnessed the pressure test.

3.5 Piping Material Selection Schedule

.1 Provide piping material in accordance with schedule Table 1 at the end of this specification section.

Table 1: Piping and Valve Material and Specification by System Type				
Piping System	Abbrev	Pipe Material	Pipe Specification	Valve Specification
Hydronic heating - closed loop (with glycol)	GHS/R	Carbon Steel	23 21 13.23	23 05 23.13
		Copper	23 21 13.33	23 05 23.13
		Copper Tube	23 21 13.33	23 05 23.13

END OF SECTION

GENERAL-DUTY VALVES FOR HVAC WATER PIPING
23 05 23.13

1 GENERAL

1.1 Scope

.1 Provide valves for general duty service in HVAC water piping systems, including shut-off valves, check valves, and manual balancing valves, for piping systems with a design pressure of 3500 kPa (507 psig) or less and a design temperature of 121°C (250°F) or less.

.2 This specification applies to hydronic heating and cooling water systems (with or without glycol additives) and other piping systems required to be carbon steel pipe, galvanized steel pipe, and/or coper tubing as specified in section 23 05 01, except as otherwise required for specific duty valve in other specification sections.

1.2 Related Sections

.1 Without limiting the scope of work or applicability of other specification sections, the work under this section integrates with or refers to the following specification sections:

.1 20 05 23 General Requirements for Valves

.2 23 05 01 HVAC Piping Systems General Requirements

1.3 Submittals

.1 Refer to section 20 05 23.

1.4 Applicable Codes and Standards

.1 Refer to section 20 05 23 and as specified herein.

.2 Where an HVAC liquid piping system is subject to registration as a pressure piping system as identified in specification section 23 05 01, all valves shall have Canadian Registration Numbers in accordance with CSA B51. In the following valve specifications, where the identified model does not have a current CRN, provide a valve of equal or greater performance which has a current CRN from the same manufacturer.

.3 For the purpose of this article, "current CRN" means a registration which does not expire for at least 12 months from the date of submittal of shop drawings.

2 PRODUCTS

2.1 Ball Valves – bronze/brass body

.1 NPS 2 and under:

.1 To MSS SP-110, 600 CWP/150 SWP, two-piece bronze or DZR brass body, full port, solid stainless steel or chrome plated bronze ball, PTFE seat and seals.

.2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.

.3 Required MCPR: 2300 kPa (335 psig) at 121°C (250°F).

.4 Solder ends:

Standard of Acceptance

- Kitz - fig. 59, 69AM-LL
- Apollo - fig. 77-200
- Nibco - fig. S-585-70
- Anvil - fig. 171S

.5 NPT threaded ends.

Standard of Acceptance

- Kitz - fig. 58, 68AM-LL
- Apollo - fig. 77-100
- Nibco - fig. T-585-70
- Anvil - fig. 171N

2.2 Ball Valves – carbon steel body

.1 NPS 2 and under:

.1 To MSS SP-110, 1500 CWP/150 SWP, carbon steel body, regular port, stainless steel or chrome plated carbon steel ball, PTFE seat and seals.

.2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.

.3 ISO 5211 mounting pad.

.4 Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

.5 Two-piece body style, NPT threaded ends:

Standard of Acceptance

- Apollo - fig. 89-100
- MAS - fig. CSCR-2
- Velan - fig. S-M1102-SSGA

.6 Three-piece body style, NPT threaded ends:

Standard of Acceptance

- Apollo - fig. 83A-140
- Nibco - fig. TM-590-CS-R-66-FS-LL
- MAS - fig. CSS-F-3N
- Velan - fig. S-K1802-SSGA

.7 Three-piece body style, socket weld ends:

Standard of Acceptance

- Apollo - fig. 83A-240
- Nibco - fig. KM-590-CS-R-66-FS-LL
- MAS - fig. CSS-F-3N-SW
- Velan - fig. W-K1802-SSGA

.2 NPS ½ to NPS 4:

.1 To MSS SP-72, ASME Class rated, carbon steel two-piece split body, full port, stainless steel or chrome plated carbon steel ball, PTFE seat and seals, ASME Class 150 flanged ends.

.2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.

.3 ISO 5211 mounting pad.

.4 Class 150:

(a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 150SCTDZM-N
- Apollo - fig. 88A-200
- Nibco - fig. F-515-CS-F-66-FS
- Velan - fig. SB-150

.5 Class 300:

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 300SCTDZM-N
- Apollo - fig. 88A-900
- Nibco - fig. F-535-CS-F-66-FS
- Velan - fig. SB-300

2.3 Inline Silent Check Valves

.1 NPS 2 and under, bronze, threaded:

.1 To MSS SP-80, Class 125, bronze body, spring-controlled inline style (non flapper), body guided disc, resilient EPDM or PTFE seat or disc; bronze, Inconel or stainless steel spring; with NPT threaded ends.

.2 Required MCPR: 1200 kPa (174 psig) at 121°C (250°F).

Standard of Acceptance

- Kitz - fig. 36
- Nibco - fig. T-480-Y
- Apollo - fig. CVBB 61-500
- Valmatic - fig. 1400THR

.2 NPS 2 ½ to NPS 12, wafer style:

.1 To MSS SP-125, Class 125 or 150, cast or ductile iron body, stainless steel trim and spring-controlled inline globe-style (non flapper), body guided disc, resilient BUNA-N seat, wafer body style for installation between flat-faced flanges.

.2 Valve design provides both a metal-to-metal and metal-to-resilient seat for zero leakage sealing.

.3 Required MCPR: 1200 kPa (174 psig) at 65°C (150°F).

Standard of Acceptance

- Dezurik - fig. APCO 300 Series
- Valmatic - fig. 1400A series
- Mueller - fig. 101MAT
- Nibco - fig. W-910

.3 NPS 2½ to NPS 24, flanged ends:

.1 To MSS SP-125, Class 125 or 150, cast or ductile iron body, stainless steel trim and spring-controlled inline globe-style (non flapper), body guided disc, resilient BUNA-N seat, with Class 125/150 flanges.

.2 Valve design provides both a metal-to-metal and metal-to-resilient seat for zero leakage sealing.

.3 Required MCPR:

- NPS 2-12: 1200 kPa (174 psig) at 65°C (150°F).
- NPS 14-24: 860 kPa (125 psi) at 65°C (150°F).

Standard of Acceptance

- Dezurik - fig. APCO 600 Series
- Valmatic - fig. 1800 series
- Mueller - fig. 107MAT
- Nibco - fig. F-960

.4 NPS 2½ to NPS 24, carbon steel, flanged:

.1 To MSS SP-126, Class 150 and 300, ASTM A216 WCB carbon steel body, stainless steel trim and spring-controlled inline globe-style (non flapper), body guided disc, stainless steel seat, with Class 150 / 300 flanges.

.2 Valve design provides both a metal-to-metal and metal-to-resilient seat for zero leakage sealing.

.3 Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

Standard of Acceptance

- Dezurik - fig. APCO 600 Series
- Durabla - fig. GLC
- Mueller - fig. 109MDT

3 EXECUTION

3.1 General

.1 Refer to section 20 05 23 and as required herein.

3.2 Valve Selection Based on Pressure Rating

.1 Unless otherwise specified herein or shown, select valves that have a Minimum Component Pressure Rating (MCPR) which exceed the applicable piping system Design Pressure and Design Temperature specified in section 23 05 01.

.2 Where drawings indicate either: (a) a pressure rating; or (b) a pressure rating and Class rating, by floor level then select valves as follows:

.1 For all valves, select a valve with a MCPR rating equal to or greater than the pressure rating indicated on the drawings for each floor level.

.2 For clarity, even if a valve has an ASME Class rating, do not select a valve based on its Class to match any Class rating shown on the drawings.

3.3 Check Valves

.1 Provide an inline silent check valve on the pump discharge under any of the following conditions:

.1 multi-parallel pump installation,

.2 where the pump discharge piping rises to more than 5 m (15 ft) above the pump discharge, and

.3 at other locations as shown on drawings.

.2 Provide an inline silent check valve where a check-valve is shown on drawings other than at a pump discharge.

.3 Provide swing check or silent check valves at other locations.

End of Section

HYDRONIC PIPING – CARBON STEEL
23 21 13.23

1 GENERAL

1.1 Scope

.1 Provide carbon steel pipe and fittings for HVAC liquid piping systems. Refer to section 23 05 01 for piping system applicability.

.2 This specification applies to liquid piping systems with design pressures not exceeding 2750 kPa (400 psig) at temperatures not exceeding 121°C (250°F, except as otherwise specified.

1.2 Related Sections

.1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:

.1	20 05 24	Welding and Brazing
.2	23 05 01	HVAC Piping Systems General Requirements

1.3 Applicable Codes and Standards

.1 Legislation:

.1 Refer to section 23 05 01.

.2 Installation standards and codes:

.1 Refer to section 23 05 01.

.3 Product standards:

.1	ANSI A21.11	Rubber Gasket joints for Ductile-Iron Pressure Pipe and Fittings
.2	ANSI B1.20.1	Pipe Threads, General Purpose (inch)
.3	ASME B16.1	Cast Iron Pipe Flanges And Flanged Fittings
.4	ASME B16.3	Malleable Iron Threaded Fittings.
.5	ASME B16.5	Pipe Flanges and Flanged Fittings
.6	ASME B16.9	Factory Made Wrought Steel Buttwelding Fittings
.7	ASME B16.11	Forged Steel Fittings, Socket-Welding and Threaded
.8	ASME B16.20	Metallic Gaskets for Pipe Flanges: Ring Joint Spiral Wound and Jacketed.
.9	ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flanges.
.10	ASME B18.2.1	Square and Hex Bolts and Screws,
.11	ASME B18.2.2	Square and Hex Nuts
.12	ASME B16.39	Malleable Iron Threaded Pipe Unions: Classes 150, 250 and 300.
.13	ASTM A47	Standard Specificatin for Ferritic Malleable Iron Castings.
.14	ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
.15	ASTM A105	Standard Specification for Carbon Steel Forgings for Piping Applications

.16	ASTM A106	Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
.17	ASTM A194	Standard Specification for Carbon and Alloy Steel Nuts and Bolts for High-Pressure or High-Temperature Service, or Both.
.18	ASTM A536	Standard Specification for Ductile Iron Castings.

2 PRODUCTS

2.1 Pipe

.1 Carbon steel:

.1 NPS 2 and under:

(a) ASTM A106 Gr B, schedule 40 seamless, or
(b) ASTM A53 Gr B, schedule 40 Electric Resistance Weld (ERW).

.2 NPS 2-1/2 to 10:

(a) ASTM A53 Gr B, schedule 40 Electric Resistance Weld (ERW).

.3 NPS 12 to NPS 18:

(a) ASTM A53 Gr B, schedule Standard (0.375 in. wall thickness) ERW.

.4 NPS 20 to NPS 24:

(a) ASTM A53 Gr B, schedule 30 ERW.

2.2 Pipe Joints and Fittings

.1 Threaded fittings:

.1 End connections: NPT thread to ANSI B1.20.1.

.2 Fittings: Class 150 and Class 300, malleable iron to ASME B16.3..

.3 Unions: Class 150 and Class 300, malleable iron body with ground joint and bronze face to ASME B16.39.

.4 Threaded joint compound: pulverized lead paste or Teflon pipe tape sealant.

Standard of Acceptance

- Masters Pro-Dope
- Masters Orange or White Tape.

.2 Welding fittings:

.1 Butt weld fittings:

(a) Forged to ASME B16.9,
(b) wall thickness to match pipe,
(c) long radius elbows.

.2 Welding outlet fittings:

(a) forged to ASTM A105,
(b) dimensions and pressure ratings to MSS SP-97, Standard Class for buttwelding branch connection and Class 3000 for threaded or socket welded branch connection,
(c) NPT ends to ASME B1.20.1.

.3 Socket welded fittings:

(a) forged to ASTM A105,
(b) dimensions and pressure ratings to ASME B16.11, Class 3000.

.4 Half couplings:

(a) forged carbon steel to ASTM A105,
(b) dimensions and pressure rating to ASME B16.11, Class 3000 socket weld or threaded ends,
(c) NPT ends to ASME B1.20.1.

.3 Flanges:

.1 Flat-faced cast iron to ANSI B16.1, Class 125.

.2 Raised-face forged carbon steel to ASME B16.5, Class 150 and Class 300, weld neck with wall thickness to match pipe, or slip on type.

.3 Studs, bolts and nuts to ANSI B18.2.1, ANSI 18.2.2 and ASTM A194, “high strength” type.

.4 Gaskets to ANSI B16.21, ANSI B16.20 or ANSI A21.11.

Standard of Acceptance

- Chesterton - fig. 100, 195 and 450
- Beldam

3 EXECUTION

3.1 Piping Installation

.1 Refer to section 23 05 01 for piping design criteria and general requirements for piping installation.

.2 Slope main piping horizontal or up in direction of flow nominally at a slope of 1:500 (0.2%);

.1 branch piping to have greater slope,

.2 slope piping up in direction of terminal heating and cooling devices,

.3 where supply and return piping are grouped together and flow is in opposite directions, arrange piping horizontal.

.3 Use eccentric reducers at pipe size changes arranged flat-on-top to assist venting.

.4 Cap ends during construction to prevent entry of foreign matter.

3.2 Class Rated Fittings and Flanges

.1 Select ASME Class rated fittings and flanges in accordance with the following table for design pressure limits at coincident design temperature limits unless otherwise shown on drawings.

Class	Maximum Design Pressure	Maximum Coincident Design Temperature
125 Note [1]	900 kPa (130 psi)	≤ 65°C (150°F)
125 Note [1]	700 kPa (100 psi)	≤ 121°C (250°F)
150	1720 (250 psi)	≤ 38°C (100°F)
150	1400 kPa (200 psi)	≤ 121°C (250°F)
300	3700 kPa (535 psi)	≤ 38°C (100°F)

Class	Maximum Design Pressure	Maximum Coincident Design Temperature
300	3100 kPa (450 psi)	≤ 121°C (250°F)

Notes:

[1] For flanges only.

3.3 Pipe Joints and Fittings

.1 Make pipe joints as follows.

.1 Piping NPS 2-1/2 and under:

(a) NPT threaded joint to ANSI B1.20.1 and made with Teflon tape or pipe dope, or
(b) socket weld joints.

.2 Piping NPS 2-1/2 and larger:

(a) welded,
(b) flanged.

.3 For clarity, pipe size of NPS 2-1/2 may be either type of joint specified.

.2 For flange joints, select gasket materials in accordance with the following table so that gasket pressure and temperature both exceed the piping system design pressure and design temperature.

Gasket Temperature Limit	**Gasket Pressure Limit**	**Gasket Material**	**Gasket Thickness**	**Chesterton Figure**
80°C (180°F)	1720 kPa (250 psig)	Red rubber	1.6 m (1/6 in)	100
200°C (390°F)	2400 kPa (350 psig)	Synthetic fiber with nitrile binder	1.6 m (1/6 in)	450
400°C (750°F)	3700 kPa (535 psig)	Synthetic fiber with nitrile binder	1.6 m (1/6 in)	195

3.4 Equipment connections

.1 Make pipe connections to equipment as follows:

.1 NPS 2 and smaller: threaded fittings.

.2 NPS 2 ½ and larger:

(a) flanged connections,

.2 Where connection is made to equipment with a threaded fitting, provide a union between the isolation valve and the equipment connection.

3.5 Welding

.1 Comply with section 20 05 24 and as specified herein.

3.6 Branch Connections

.1 Make branch connections to mains in accordance with Table 2a and 2b.

.1 These tables are valid for design pressures up to 2070 kPa (300 psig), without adding reinforcement material where branch pipe is directly welded to the main. For welded branch connections at higher design pressures, use buttweld, socket weld, or integrally reinforced outlet fittings only.

.2 In these tables, the following abbreviations apply.

Abbreviations:

TH	Threaded fitting to ASME B16.3
SW	Socket weld fittings to ASME B16.11
HC	Half coupling to ASME B16.11
BW	Buttweld fitting to ASME B16.9
OF	Reinforced Outlet Fittings to MSS SP-97
DP	Direct welding of Branch Pipe to Main without added reinforcement.

Table 2a – Allowable Branch to Main Connections (NPS 1 to NPS 10)

Branch NPS	Mains Pipe, NPS									
	1	1-1/4	1-1/2	2	2-1/2	3	4	6	8	10
3/ 4	TH SW	TH SW	TH SW	TH SW	BW SW	BW, OF SW HC DP	BW, OF SW HC DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
1	TH SW	TH SW	TH SW	TH SW	BW SW	BW, OF SW DP	BW, OF SW HC DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
1-1/4	---	TH SW	TH SW	TH SW	BW SW	BW, OF SW DP	BW, OF SW DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
1-1/2	---	---	TH SW	TH SW	BW SW	BW, OF SW DP	BW, OF SW DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
2	---	---	---	TH SW	BW SW	BW, OF SW	BW OF SW DP	BW, OF DP	BW, OF HC DP	BW, OF HC DP
2-1/2	---	---	---	---	BW SW	BW, OF SW	BW, OF SW	BW, OF DP	BW, OF DP	BW, OF DP
3	---	---	---	---	---	BW	BW, OF SW	BW, OF DP	BW, OF DP	BW, OF DP
4	---	---	---	---	---	---	BW	BW, OF	BW, OF DP	BW, OF DP
6	---	---	---	---	---	---	---	BW	BW, OF	BW, OF DP
8	---	---	---	---	---	---	---	---	BW	BW, OF
10	---	---	---	---	---	---	---	---	---	BW

Table 2b – Allowable Branch to Main Connections (NPS 12 to NPS 30)								
Branch NPS	Mains Pipe, NPS							
	12	14	16	18	20	22	24	30
¾ to 2	OF HC DP	OF HC DP	OF HC	OF HC	OF HC	OF HC	OF HC	OF HC
2-1/2	OF DP	OF DP	OF	OF	OF	OF	OF	OF
3	OF DP	OF DP	OF	OF	OF	OF	OF	OF
4	BW OF DP	OF DP	OF	OF	OF	OF	OF	OF
6	BW OF DP	BW OF DP	BW OF	OF	OF	OF	OF	OF
8	BW OF DP	BW OF DP	BW OF	BW OF	BW OF	OF	OF	OF
10	BW OF DP	BW OF DP	BW OF	BW OF	BW OF	BW OF	BW OF	OF
12	BW	BW OF DP	BW OF	BW OF	BW OF	BW OF	BW OF	OF
14	---	BW	BW OF	BW OF	BW OF	BW OF	BW OF	BW OF
16	---	---	BW	BW OF	BW OF	BW OF	BW OF	BW OF
18	---	---	---	BW	BW OF	BW OF	BW OF	BW OF
20	---	---	---	---	BW	BW OF	BW OF	BW OF
22	---	---	---	---	---	BW	BW OF	BW OF
24	---	---	---	---	---	---	BW	BW OF
30	---	---	---	---	---	---	---	BW

.2 Use of Class 3000 half-couplings as a branch connector (“HC”), and direct welding of branch piping to main piping (”DP”), is permitted in accordance with the following requirements:

.1 half-coupling or branch pipe sits-on mains pipe, and does not insert into the main pipe,

.2 the opening size in the main pipe to closely follow the inside diameter of the half-coupling or branch pipe,

.3 half-coupling or branch pipe attachment end is shaped and beveled to closely following the surface of the main pipe, suitable for a pull-penetration weld,

.4 the half-coupling or direct branch pipe is attached with a groove weld and covered with a smooth finishing fillet weld in accordance with the requirements of the applicable piping code.

.3 Where integrally reinforced outlet fittings, half-couplings or direct welding of branch pipe is used, hole saw or drill and ream mains pipe to maintain full inside diameter of branch line prior to welding.

.4 Where multiple branch pipes are to connect to the main pipe in close proximity to each other, provide a minimum separation between the centerlines of adjacent branch pipes equal to or greater than the sum of the OD dimensions of the adjacent branch pipes.

.5 If threaded fittings have been installed where the specification requires welded fittings, either cut-out and replace the fitting, or fully seal-weld the exposed threads.

.6 Where saddle type branch welding fittings are used on mains, hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding.

3.7 Pressure Testing

.1 Conduct pressure and leak tests in accordance with section 23 05 01.

3.8 Flushing and Cleaning

.1 After pressure testing, clean piping in accordance with Section 23 25 05.

.2 For piping changes to existing systems, which consist of NPS 2 and smaller branch piping to terminal heating or cooling equipment, the following abbreviated cleaning and flushing procedure may be used:

.1 After cutting of threads and de-burring, and before installation of piping, manually clean the interior of the pipe with wire-brush on an extended rod, while washing the inside of the pipe with a solution of non-foaming, phosphate free detergent, 3% by weight, followed by a hose rinse flushed to drain until water runs clear.

.2 After installation of piping, check strainers are clean, and open isolation valves to use service water for pressure testing and final flush.

.3 After pressure testing, isolate new piping from existing piping, fully open control valves (where installed) and flush service water to drain. Use compressed air at not more than 70 kPa (10 psig) to assist in flushing the water.

.4 Refill system with service water and circulate for two hours. Inspect strainers, and repeat drain, fill and recirculate routine until strainers are free of debris.

END OF SECTION

HYDRONIC PIPING - COPPER
23 21 13.33

1 GENERAL

1.1 Scope

.1 Provide copper tube and fittings for HVAC liquid piping systems for aboveground and underground installations for the following applications:

.1 (as an alternative to steel piping) final connections not exceeding 1 m (39 in) in length to terminal heating units which have copper tube coils, copper tube heating elements, and copper tube radiant panels,

.2 tubing located in slabs or under slab-on-grade floors to connect to terminal heating or cooling units,

.3 drain and vent piping for equipment and piping systems (except cooling tower drainage piping).

.4 non-potable make-up water piping for HVAC services, or

.5 where otherwise shown.

.2 This specification applies to liquid piping systems with design pressures not exceeding 2000 kPa (290 psig) at temperatures not exceeding 121°C (250°F, except as otherwise specified. Refer to section 23 05 01 for piping system applicability.

.3 The use of copper tube is limited to nominal tube sizes NPS 3 and under.

1.2 Related Sections

.1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:

.1 20 05 24 Welding and Brazing

.2 23 05 01 Heating and Cooling Piping Systems General Requirements

1.3 Applicable codes and standards

.1 Legislation:

.1 Refer to section 23 05 01.

.2 Installation standards and codes:

.1 Refer to section 23 05 01.

.3 Product standards:

.1	ASME B16.15	Cast Bronze Threaded Fittings, Classes 125 and 250
.2	ASME B16.18	Cast Copper Alloy Solder Joint Pressure Fittings
.3	ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
.4	ASME B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
.5	ASME B16.24	Cast Copper Alloy Pipe Flanges and Flanged Fittings; Class 150, 300, 400, 600, 900, 1500, & 2500.
.6	ASME B16.50	Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings

.7	ASTM A307	Standard Specification for Carbon Steel Bolts and Studs 60,000PSI Tensile Strength
.8	ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
.9	ASTM B32	Specification for Solder Metal
.10	ASTM B88	Standard Specification for Seamless Copper Water Tube
.11	ASTM B828	Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
.12	AWS A5.8	Specification for Filler Metals for Brazing and Braze Welding
.13	AWS A5.31	Specification for Fluxes for Brazing and Braze Welding
.14	AWS C3.4	Specification for Torch Brazing

2 PRODUCTS

2.1 Tube

.1 Aboveground:

.1 NPS ½ to 2: to ASTM B88, type "L" hard-drawn copper tube.

.2 NPS 2-1/2 to NPS 3: to ASTM B88, type "K" hard-drawn copper tube.

.2 Underground or in-slab:

.1 NPS ½ to NPS 3: to ASTM B88, type “K” hard-drawn or annealed copper tube.

.3 Copper tube to be listed to the applicable standard and bear the green marking (type “K”) or blue marking (type “L”) stripe for type K tubing, and bear the markings of the testing agency accredited by Standards Council of Canada.

2.2 Tube Joints and Fittings

.1 Fittings:

.1 Cast bronze fittings to ASME B16.18.

.2 Wrought copper and bronze fittings to ASME B16.22.

.3 Brazed joints only: Wrought copper and copper alloy to ASME B16.50.

.4 Threaded fittings including unions to ASME B16.15, Class 250.

.2 Flanges:

.1 Brass or bronze to ANSI B16.24.

.2 Gaskets to ANSI B16.21.

Standard of Acceptance

- Chesterton - fig. 100, 195 and 450
- Beldam

.3 Solder:

.1 95:5 tin/antimony solder to ASTM B32.

.4 Braze filler:

.1 Silver brazing alloy: classification BCuP-5 to AWS A5.8.

3 EXECUTION

3.1 Tubing Installation

.1 Refer to section 23 05 01 for piping design criteria and general requirements for piping installation.

.2 Maximum tube size: NPS 3.

.3 Slope main piping horizontal or up in direction of flow nominally at a slope of 1:1000 (C in in 10 ft).

.1 branch piping to have greater slope,

.2 slope piping up in direction of terminal heating and cooling devices.

.3 where supply and return piping are grouped together and flow is in opposite directions, arrange piping horizontal.

.4 Use eccentric reducers at tube size changes arranged flat on bottom to assist venting.

.5 Where tubing is installed to run inside of concrete slabs, support tubing to maintain tube centerline at the center of the floor slab unless otherwise shown. Where tubing is supported by ferrous metals or where it might come into contact with reinforceing steel bar, provide two layers of Denso Tape around the tubing at the point of contact.

.6 Use copper tubing for equipment drains (pressure and non-pressure)

.7 Provide di-electric unions or flanges in accordance with section 23 05 01.

3.2 Tube Joints and Fittings

.1 Prepare and install tube and fittings;

.1 in accordance with ASTM B828 for solder joints,

.2 in accordance with AWS C3.4 and specification section 20 05

.2 Use of direct butt weld style soldered or brazed joints, including pulled-Tee's, are not permitted.

.3 Before assembling solder or brazed joints, remove working parts of valves.

.4 Make tube joint for above-ground piping as follows:

.1 NPS 2 and smaller: soldered or brazed joints with socket type fittings.

.2 NPS 2-1/2 to NPS 3: brazed joints with socket type fittings.

.5 Make tube joints for underground and/or in-slab piping as follows:

.1 All sizes: brazed joints with sweat fittings.

.2 Arrange tubing to minimize the number of joints. Use annealed tubing wherever possible, with field-bends made with tube bending dies which provide uniform support of tubing during bending operations.

3.3 Equipment Connections

.1 Equipment connections:

.1 NPS 2 and smaller: unions and threaded fittings,

.2 NPS 2 ½ to NPS 3: flanged connections.

3.4 Pressure and Leak Testing

.1 Conduct pressure and leak tests in accordance with section 20 05 01.

3.5 Flushing and cleaning

.1 After pressure testing, clean piping in accordance with Section 23 25 05.

.2 For piping changes to existing systems, which consist of NPS 2 and smaller branch piping to terminal heating or cooling equipment, the following abbreviated cleaning and flushing procedure may be used:

.1 After cutting of threads and de-burring, and before installation of tubing, manually clean the interior of the tube with wire-brush on an extended rod, while washing the inside of the tubepipingsolution of non-foaming, phosphate free detergent, 3% by weight, followed by a hose rinse flushed to drain until water runs clear,

.2 After installation of piping, check strainers are clean, and open isolation valves to use service water for pressure testing and final flush.

.3 After pressure testing, isolate new piing form existing piping, fully open control valves (where installed) and flush service water to drain. Use compressed air at not more than 70 kPa (10 psig) to assist in flushing the water.

.4 Refill system with service water and circulate for two hours. Inspect strainers, and repeat drain, fill and recirculate routine until strainers are free of debris.

END OF SECTION

STEAM AND CONDENSATE PIPING – CARBON STEEL
23 22 13.23

1 GENERAL

1.1 Scope

.1 Provide pipe and fittings for steam, condensate and related systems. Refer to section 23 05 01 for piping system applicability.

.2 This specification applies to:

.1 saturated steam piping with design pressures of 1750 kPa (250 psig) or less,

.2 condensate piping with design pressures of 2750 kPa (400 psig) or less,

.3 boiler feedwater piping with design pressures of 2750 kPa (400 psig) or less, and

.4 boiler blowdown, blow-off, drain piping and chemical treatment piping.

1.2 Related Sections

.1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:

.1 20 05 24 Welding and Brazing

.2 23 05 01 HVAC Piping General Requirements

.3 23 25 05 HVAC Pipe Cleaning

1.3 Applicable Codes and Standards

.1 Legislation:

.1 Refer to section 23 05 01.

.2 Installation standards and codes:

.1 Refer to section 23 05 01.

.3 Product standards:

.1	ASME B1.20.1	Pipe Threads, General Purpose (inch)
.2	ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
.3	ASME B16.3	Malleable Iron Threaded Fittings.
.4	ASME B16.5	Pipe Flanges and Flanged Fittings
.5	ASME B16.9	Factory Made Wrought Steel Buttwelding Fittings
.6	ASME B16.11	Forged Steel Fittings, Socket-Welding and Threaded
.7	ASME B16.20	Metallic Gaskets for Pipe Flanges: Ring Joint Spiral Wound and Jacketed.
.8	ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flanges.
.9	ASME B16.39	Malleable Iron Threaded Pipe Unions: Classes 150, 250 and 300.
.10	ASTM A47	Standard Specification for Ferritic Malleable Iron Castings.
.11	ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

.12	ASTM A106	Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
.13	ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
.14	ASTM A194	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
.15	ASTM A536	Standard Specification for Ductile Iron Castings.

1.4 Submittals

.1 Submit shop drawings where headers and pipe assemblies with fittings, elbows and flanges are shop fabricated.

2 PRODUCTS

2.1 Pipe

.1 Carbon steel:

.1 NPS 2 and smaller:

(a) to ASTM A106 Gr B seamless (S), or

(b) to ASTM A53 Gr B seamless (S) or dual-labeled seamless/electric resistance welded (S/ERW),

.2 NPS 2-1/2 and larger:

(a) to ASTM A106 Gr B seamless (S),or

(b) to ASTM A52 Gr B seamless (S) or electric-resistance-welded (ERW).

.3 with pipe schedule in accordance with the following table.

Pipe Service	Joint Method	Pipe Size NPS	Maximum System Design Pressure	Schedule
Steam	Welding (butt weld, socket weld)	NPS ½ to NPS 10	1750 kPa (250 psig)	40
		NPS 12 to 18	1750 kPa (250 psig)	Standard (0.375 in. wall)
		NPS 20 to 24	1750 kPa (250 psig)	30
	Threaded	NPS ½ to NPS 2	1750 kPa (250 psig)	40
Condensate	Welding (butt weld, socket weld)	NPS ½ to NPS 12	2750 kPa (400 psig)	80
	Threaded	NPS ½ to NPS 2	2750 kPa (400 psig)	80

2.2 Pipe Joints and Fittings

.1 Threaded fittings:

.1 end connections: NPT thread to ANSI B1.20.1,

.2 fittings: Class 150 and Class 300, malleable iron to ASME B16.3,

.3 unions: Class 150 and Class 300, malleable iron body with ground joint and bronze face to ASME B16.39,

.4 threaded joint compound: pulverized lead paste or Teflon pipe tape sealant.

Standard of Acceptance

- Masters Pro-Dope
- Masters Orange or White Tape.

.2 Welding fittings:

.1 Butt weld fitting:

(a) forged to ANSI B16.9,

(b) wall thickness to match pipe,

(c) long radius elbows.

.2 Welding outlet fittings:

(a) forged to MSS SP-97, Standard Class for buttwelding branch connection, and Class 3000 for threaded or socket welded branch connection,

(b) NPT ends to ASME B1.20.1.

.3 Socket welded fittings:

(a) forged to ASTM A105,

(b) dimensions and pressure ratings to ASME B16.11, Class 3000.

.4 Half couplings:

(a) forged carbon steel to ASTM A105,

(b) dimensions and pressure rating to ASME B16.11, Class 3000 socket weld or threaded ends,

(c) NPT ends to ASME B1.20.1.

.3 Flanges:

.1 Flat-faced cast iron, Class 125 to ANSI B16.1;

.2 Raised-face forged steel, Class 150 and Class 300 to ANSI B16.5, weld neck with wall thickness to match pipe, or slip on type;

.3 Studs and bolts: to ASTM A193, Grade B7,

.4 Nuts: to ASTM A194 Grade 2H or 2HM,

.5 Gaskets to ANSI B16.21, ANSI B16.20 or ANSI A21.11 of red rubber sheet 1.6 mm ($^{1}/_{16}$ in) thick.

Standard of Acceptance

- Chesterton - fig. 195, 450
- Beldam

3 EXECUTION

3.1 Piping Installation

.1 Refer to section 23 05 01 for piping design criteria general requirements for piping installation.

.2 Steam piping:

.1 slope mains down in direction of flow 1:250 (½ in in 10 ft),

.2 install branches with greater slope,

.3 provide concentric reducers at pipe size changes in vertical runs,

.4 provide eccentric reducers at pipe size changes in horizontal runs, arranged flat-on-bottom,

.5 provide eccentric reducers arranged flat-on-bottom at valve inlet and flat-on-top at valve outlet, in horizontal runs at throttling or control valves where pipe connection size is greater than valve size. Pitch piping on both sides of valve to drain away from the valve.

.3 Condensate piping:

.1 slope return mains down in the direction of flow 1:160 (¾ in in 10 ft),

.2 install return branches with greater slope,

.3 provide concentric reducers at pipe size changes in vertical runs,

.4 provide eccentric reducers at pipe size changes in horizontal runs, arranged flat-on-bottom,

.4 Cap pipe ends during construction to prevent entry of foreign matter.

3.2 Class Rated Fittings and Flanges

.1 Select ASME Class rated fittings and flanges in accordance with the following table for design pressure limits at coincident design temperature limits unless otherwise shown on drawings.

Class	Steam	Condensate	
	Maximum Design Pressure Saturated Steam	Maximum Design Pressure	Maximum Coincident Design Temperature
125 Note [1]	550 kPa (80 psig)	700 kPa (100 psi)	≤ 121°C (250°F)
150 Note [2]	1030 kPa (150 psi)	1400 kPa (200 psi)	≤ 121°C (250°F)
300 Note [2]	2060 kPa (300 psi)	3100 kPa (450 psi)	≤ 216°C (420°F)
3000 Note [3]	2060 kPa (300 psi)	3100 kPa (450 psi)	≤ 216°C (420°F)

Notes:
[1] Flanges only.
[2] Flanges and fittings.
[3] Welding outlet fittings and socket weld fittings.

3.3 Pipe Joints and Fittings

.1 Make pipe joints as follows:

.1 NPS 2-1/2 and under:

(a) NPT threaded joint to ANSI B1.20.1 with Teflon tape or pipe thread dope; or

(b) socket weld joints.

.2 NPS 2-1/2 and larger:

(a) flanged or welded.

(b) provide flanges at all equipment connections.

.3 For clarity, pipe size of NPS 2-1/2 may be either type of joint specified.

.2 For flange joints, select gasket materials in accordance with the following table so that gasket pressure and temperature both exceed the piping system design pressure and design temperature.

Gasket Temperature Limit	Gasket Pressure Limit	Gasket Material	Gasket Thickness	Chesterton Figure
175°C (350°F)	2400 kPa (350 psi)	Synthetic fiber with nitrile binder	1.6 m (1/6 in)	450
400°C (750°F)	3700 kPa (535 psi)	Synthetic fiber with nitrile binder	1.6 m (1/6 in)	195

3.4 Equipment Connections

.1 Make pipe connections to equipment as follows:

.1 NPS 2 and smaller: unions and threaded fittings;

.2 NPS 2 ½ and larger: flanged connections.

.2 Where connection is made to equipment with a threaded fitting, provide a union between the isolation valve and the equipment connection.

3.5 Welding

.1 Comply with section 20 05 24 and as specified herein.

3.6 Branch Connections

.1 Make branch connections to mains in accordance with Table 2a and 2b :

.1 These tables are valid for design pressures up to 2070 kPa (300 psig), without adding reinforcement material where branch pipe is directly welded to the main. For welded branch connections at higher design pressures, use buttweld, socket weld, or integrally reinforced outlet fittings only.

.2 In these tables, the following abbreviations apply.

Abbreviations:

TH Threaded fitting to ASME B16.3
SW Socket weld fittings to ASME B16.11
HC Half coupling to ASME B16.11
BW Buttweld fitting to ASME B16.9
OF Reinforced Outlet Fittings to MSS SP-97
DP Direct welding of Branch Pipe to Main without added reinforcement.

Table 2a – Allowable Branch to Main Connections (NPS 1 to NPS 10)

Branch	Mains Pipe, NPS									
NPS	1	1-1/4	1-1/2	2	2-1/2	3	4	6	8	10

Table 2a – Allowable Branch to Main Connections (NPS 1 to NPS 10)										
3/ 4	TH SW	TH SW	TH SW	TH SW	BW SW	BW, OF SW HC DP	BW, OF SW HC DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
1	TH SW	TH SW	TH SW	TH SW	BW SW	BW, OF SW DP	BW, OF SW HC DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
1-1/4	---	TH SW	TH SW	TH SW	BW SW	BW, OF SW DP	BW, OF SW DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
1-1/2	---	---	TH SW	TH SW	BW SW	BW, OF SW DP	BW, OF SW DP	BW, OF HC DP	BW, OF HC DP	BW, OF HC DP
2	---	---	---	TH SW	BW SW	BW, OF SW	BW OF SW DP	BW, OF DP	BW, OF HC DP	BW, OF HC DP
2-1/2	---	---	---	---	BW SW	BW, OF SW	BW, OF SW	BW, OF DP	BW, OF DP	BW, OF DP
3	---	---	---	---	---	BW	BW, OF SW	BW, OF DP	BW, OF DP	BW, OF DP
4	---	---	---	---	---	---	BW	BW, OF	BW, OF DP	BW, OF DP
6	---	---	---	---	---	---	---	BW	BW, OF	BW, OF DP
8	---	---	---	---	---	---	---	---	BW	BW, OF
10	---	---	---	---	---	---	---	---	---	BW

Table 2b – Allowable Branch to Main Connections (NPS 12 to NPS 30)								
Branch NPS	Mains Pipe, NPS							
	12	14	16	18	20	22	24	30
¾ to 2	OF HC DP	OF HC DP	OF HC	OF HC	OF HC	OF HC	OF HC	OF HC
2-1/2	OF DP	OF DP	OF	OF	OF	OF	OF	OF
3	OF DP	OF DP	OF	OF	OF	OF	OF	OF

Table 2b – Allowable Branch to Main Connections (NPS 12 to NPS 30)

Branch NPS	Mains Pipe, NPS							
	12	14	16	18	20	22	24	30
4	BW OF DP	OF DP	OF	OF	OF	OF	OF	OF
6	BW OF DP	BW OF DP	BW OF	OF	OF	OF	OF	OF
8	BW OF DP	BW OF DP	BW OF	BW OF	BW OF	OF	OF	OF
10	BW OF DP	BW OF DP	BW OF	BW OF	BW OF	BW OF	BW OF	OF
12	BW	BW OF DP	BW OF	BW OF	BW OF	BW OF	BW OF	OF
14	---	BW	BW OF	BW OF	BW OF	BW OF	BW OF	BW OF
16	---	---	BW	BW OF	BW OF	BW OF	BW OF	BW OF
18	---	---	---	BW	BW OF	BW OF	BW OF	BW OF
20	---	---	---	---	BW	BW OF	BW OF	BW OF
22	---	---	---	---	---	BW	BW OF	BW OF
24	---	---	---	---	---	---	BW	BW OF
30	---	---	---	---	---	---	---	BW

.2 Use of Class 3000 half-couplings as a branch connector (“HC”), and direct welding of branch piping to main piping (”DP”), is permitted in accordance with the following requirements:

.1 half-coupling or branch pipe sits-on mains pipe, and does not insert into the main pipe;

.2 the opening size in the main pipe to closely follow the inside diameter of the half-coupling or branch pipe;

.3 half-coupling or branch pipe attachment end is shaped and beveled to closely following the surface of the main pipe, suitable for a pull-penetration weld;

.4 the half-coupling or direct branch pipe is attached with a groove weld and covered with a smooth finishing fillet weld in accordance with the requirements of the applicable piping code.

.3 Where integrally reinforced outlet fittings, half-couplings or direct welding of branch pipe is used, hole saw or drill and ream mains pipe to maintain full inside diameter of branch line prior to welding.

.4 Where multiple branch pipes are to connect to the main pipe in close proximity to each other, provide a minimum separation between the centerlines of adjacent branch pipes equal to or greater than the sum of the OD dimensions of the adjacent branch pipes.

.5 If threaded fittings have been installed where the specification requires welded fittings, either cut-out and replace the fitting, or fully seal-weld the exposed threads.

.6 Where saddle type branch welding fittings are used on mains, hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding.

3.7 Drip Trap Assemblies

.1 Provide drip trap assemblies in accordance with section 23 22 13.23.

.2 Pipe condensate discharge from drip trap assemblies to drain by gravity to the nearest flash tank or condensate receiver taking condensate from equipment or drip assemblies connected to steam supplies at same pressure.

3.8 Pressure Testing

.1 Conduct pressure and leak tests in accordance with section 23 05 01.

3.9 Flushing and Cleaning

.1 After pressure testing, clean piping in accordance with Section 23 25 05.

.2 For piping changes to existing systems, which consist of NPS 2 and smaller branch piping to terminal heating equipment or process equipment, the following abbreviated cleaning and flushing procedure may be used:

.1 After cutting of threads and de-burring, and before installation of piping, manually clean the interior of the pipe with wire-brush on an extended rod, while washing the inside of the pipe with a solution of non-foaming, phosphate free detergent, 3% by weight, followed by a hose rinse flushed to drain until water runs clear,

.2 After installation of piping, check strainers are clean, and fill steam piping and condensate piping with water mixed with corrosion inhibiter compatible with steam plant chemical treatment.

.3 After pressure testing, drain steam and condensate piping to drain.

.4 Open new piping isolation valves to place system under steam pressure. After one day of piping in-service, inspect strainers; if readily visible dirt and slag are present, then repeat cleaning until strainers are free of debris.

END OF SECTION

DUCT ACCESSORIES
23 33 05

1 GENERAL

1.1 Scope

.1 Provide duct accessories as shown.

.2 Access doors for kitchen grease ducts to conform to Specification section 23 31 13.23.

1.2 Applicable Codes and Standards

.1 Product standards:

.1 LEED v4 New Construction, Low-Emitting Materials credit

.2 ULC-S110 Standard Methods of Test for Air Ducts

1.3 Submittals

.1 Submit product data sheets for:

.1 sealants,

.2 tapes,

.3 duct access doors and hardware,

.4 instrument test ports.

2 PRODUCTS

2.1 Duct Sealant

.1 Water-based polymer emulsion type, flame resistant duct sealing compound.

.2 Operating temperature range: -29°C to 93°C (-20°F to 200°F).

.3 Operating pressure: tested to operate at 2.5 kPa (10 in.w.c.) duct static air pressure,

.4 Meets requirements for SMACNA Class A, B and C duct sealing requirements.

.5 Listed to ULC-S102 with flame-spread rating of 25 or less and smoke-development classification of 50 or less.

.6 LEED requirements:

.1 meets requirements for LEED BD+C v4 credit for low emitting material – Paints and Coatings.

.2 manufacturer to supply documentation demonstrating compliance.

Standard of Acceptance

- Bakor - fig. Duck-Seal
- RCD - fig. #6 Mastic
- Childers - fig. CP-146
- McGill Air Seal - fig. United Duct Sealer (Water Based)
- Duro Dyne - fig, DWN (water based)

2.2 Tape

.1 Polyvinyl treated open weave glass fibre tape, 50mm (2") wide.

2.3 Access Doors for Plenums

.1 Shop fabricated doors:

.1 double-wall construction, fully encapsulating 25 mm (1 in.) thick glass-fibre insulation,

.2 same material as duct, with both inner and outer panels of same thickness as associated plenum wall but not less than 0.6 mm (26ga.) thick,

.3 door frame: structural angles, galvanized steel minimum 2.0 mm (14 ga.) thickness, with continuous welded joints,

.4 gasket: automotive-style Neoprene gaskets bonded to door frame,

.5 door size: 500 mm wide x 1370 mm high (20 in. x 54 in.) except as otherwise shown,

.6 door swing:

(a) inwards for positive pressure plenums,

(b) outwards for negative pressure plenums.

.2 Door hardware:

.1 hinges: continuous piano hinge, zinc-plated steel or stainless-steel,

.2 handles: two (2) handles operable from both sides.

Standard of Acceptance

° Duro-Dyne - fig. SP-20 (door handles)

2.4 Instrument Test Ports

.1 Manufactured test ports:

.1 nominal size: Ø25 mm (1 in) minimum inside diameter, length to suit insulation thickness,

.2 extended body to accommodate 25 and 50 mm (1 and 2 in.) insulation thickness as applicable to the duct system,

.3 1.6 mm (16 ga.) thick steel body zinc plated after manufacture,

.4 chain-secured neoprene expansion plug with cam lock handle,

.5 Neoprene mounting gasket: flat for rectangular duct and moulded for round duct.

Standard of Acceptance

° Duro-Dyne - fig. TH1 or IP2

.2 Sealant for test port: high temperature silicone.

Standard of Acceptance

° Duro-Dyne - fig. Red High Temperature Silicon

3 EXECUTION

3.1 Sealant and Tape

.1 Apply sealant to ductwork joints and seams as detailed in other sections.

.2 Use of tape is limited to low-pressure systems requiring Class C

3.2 Access Doors for Process Exhaust Ducts

.1 Provide access doors in process exhaust ducts in the following locations:

.1 within the first 2.0 m (6.5 ft) of connection to terminal unit,

.2 at bottom of duct risers.

3.3 Access Doors for Plenums

.1 Provide access doors to plenums and casing in locations as shown.

.2 Weld door frames in place for plenums and casings.

3.4 Instrument Test Ports

.1 Install test ports for duct velocity traverse readings and for duct air temperature readings.

.2 Locate across duct or plenum at right angles to flow, at not more than 250 mm (10 in) intervals for traverses and at not more than 500 mm (20 in) for temperature measurements.

.3 Install test ports for velocity traverses in the following locations:

.1 at ducted inlets to roof and wall exhausters,

.2 at inlet to and outlet from other fan systems, and

.3 at main and branch ducts where branch serves more than one outlet. Ports in main to be upstream of branch in both diverging and converging flow.

.4 Install test ports for temperature measurement;

.1 at outside air intakes,

.2 at inlet and outlet of coils, and

.3 downstream of intersection of converging air streams of different temperatures.

END OF SECTION

DUCT CLEANING
23 33 47

1 GENERAL

1.1 Scope

.1 Professionally duct clean both air handling units when internal works are completed.

.2 Clean both air handling units where the wors were preformed and adjacent air handling unit areas.

.3 Provide schedule details to the General contractor at the time of tender so duct cleaning can be factored into the overall schedule. The duct cleaning to be performed after all dust producing construction is complete.

1.2 Proof of Cleaning

.1 Submit written verification that air handling units have been completely cleaned and verified on site. Provide a written report and a colour video of the system before and after cleaning

1.3 Qualifications

.1 Cleaning to be performed by agent specializing in this field of work, be a member in good standing with National Air Duct Cleaners Association (NADCA), and to comply with NADCA standards.

2 PRODUCTS

2.1 Self-propelling Full Contact Brushes for Unlined Ducts Only:

.1 Employ brushes specially made and shaped to fit the individual ducts or components in which they are used. Ensure continuous full contact and powerful scrubbing action of the interior surfaces of the ducts or components in which they are installed.

.2 Brush bristles to be of nylon, polypropylene or other non-metallic material.

.3 Brushes to be robotic or self-propelled, in either case having an integrally-mounted propulsion motor or drive. Motors or drives must be powerful enough to continue to propel the brush even when the brush bristles have been severely distorted

.4 Brushes to have the capability to clean ventilation ducts of 80 sq. mm. to 500 sq. mm.

2.2 Robotic Brush:

.1 A remote controlled self-propelled vehicle with robotic brush is to be used in all areas where a self-propelled brush is not suitable or cannot reach.

.2 To ensure continuous full contact and powerful scrubbing action of the interior surfaces of the ducts or components, the robot-manipulated brush is to be of the same material as all other brushes and to have a rotary action mounted on a shaft at right angles to the longitudinal axis of the duct.

.3 The rotary action brushes and mounting shaft to be adjustable in all dimensions to maintain contact with the interior surfaces of the duct.

.4 The robotic vehicle is to have a mounted camera device to monitor cleaning and record to video tape at all times.

2.3 Robotic Acoustic Lining Cleaner:

.1 Cleaning of acoustically-lined ductwork and components is to be carried out only with use of specially designed apparatus that has been demonstrated not to damage the lining, and is directly connected to the remote controlled, self-propelled video camera unit so that progress can be constantly monitored and maximum force can be used in vibrating the lining material without causing damage.

2.4 Robotic Acoustic Lining Sealing:

.1 Sealing of the acoustic lining shall be a specially designed self-propelled and robotic assembly which is equipped with a spraying mechanism that has been demonstrated not to damage the lining and is constantly video monitored to ensure that the application of the sealing material is properly directed and applied at the designed rate.

2.5 Robotic Video Camera - Cleaning:

.1 A remote vehicle is to have video camera device mounted to monitor cleaning process and record to video tape at all times the condition of the ventilation duct and components after cleaning as proof that cleaning has been completed as per the contract.

2.6 Robotic Video Camera - Inspection:

.1 The video camera used for the survey and visual inspections shall be a remote controlled, self-propelled unit capable of entering a duct as small as 175 x 175 mm square or 175 mm diameter round without any loss of maneuverability or control, and to continually provide video coverage of the duct or component of the system being checked.

.2 The camera shall be capable of being mounted on a probe of up to 3 meters in length and in this configuration shall be able to enter a duct as small as 100 mm x 100 mm diameter.

.3 For optimum clarity, the camera shall be of HD quality

.4 The video camera unit shall have full remote control, allowing it to stop at any time, turn left or right, back up and to focus on any object or feature within the duct.

.5 The video camera unit shall be equipped with sufficient light to illuminate the entire viewing area of the camera without causing "hot spots" or shadowed edges or corners on the monitor.

2.7 Vacuum Unit:

.1 Vacuum unit shall consist of fan, HEPA filter section, hose and vacuum head. All vacuum units shall be equipped with integral HEPA filters. Filters must be maintained in top condition.

.2 Vacuum cleaning units shall be used only to supplement direct contact brushing.

.3 Vacuum units shall be powerful enough and multiple units shall be used, to entrain all removed dirt and particulate matter in the airstream until captured by the vacuum units.

.4 No cleaning operations shall take place until vacuum units are in place and operating.

.5 Coils, walls, humidifiers, elements and heat exchangers are to be brushed and vacuumed and where necessary low pressure washed in place. Fan blades will be wiped and vacuumed.

.6 A HEPA filter system in the negative air pressure unit must be installed before any cleaning can take place.

.7 Any altered components such as dampers will be reset to their original positions after cleaning.

3 EXECUTION

.1 The section being cleaned must be isolated from other areas and put under vacuum pressure through a HEPA filter system.

.2 The cleaning must encompass all surfaces that air passes over in the AHU.

.3 Where brushing and vacuuming is not appropriate or sufficient to clean a component, dismantle and remove to the outside and clean with a pressure washer.

.4 The system's state of cleanliness shall be determined through the use of the following three methods:

.5 Visual inspection: Through the use of robotic video camera and by direct inspection of various sections and components of the system;

.6 Submit a preliminary inspection report outlining the general condition of the inspected ductwork describing both its physical state and its degree of cleanliness

3.2 Cleaning of Components:

.1 All components of the system are to be thoroughly cleaned, coils, humidifier, supply fan, heat wheel, control components including sensors and especially corners and pockets where dirt or dust may accumulate.

.2 Clean all fittings, components and other features within the system on the same section-by-section basis so that dirt from a section being cleaned will never pass through a section that has already been cleaned.

.3 Pass brushes through sections or components as many times as necessary to achieve the degree of cleanliness required.

.4 Where brushing and vacuuming is not appropriate or not sufficient to clean a component of the system, dismantle and remove the component to the outside where it shall be pressure-washed to the required state of cleanliness.

3.3 Manual Cleaning:

.1 Cleaning operations performed by hand are acceptable only for purposes of cleaning individual components of the system such as fan blades, dampers, controls, turning vanes, etc. Manual brushing and vacuuming shall not be acceptable for purposes of cleaning the entire system.

.2 Compressed air or manual or hand cleaning is not to be used for cleaning of air handling units except in isolated instances and when areas are too small to use robotic equipment or only if specifically instructed by the Engineer in writing.

3.4 Cleaning Standards:

.1 The ventilation system being cleaned shall be cleaned to like-new condition throughout unless specifically noted otherwise in this specification.

.2 Air handling units and components shall be cleaned to the following standards:

.1 Supply side air handling units and components: Particulate: Scale rating of 1; and microbial growth: Scale rating of 1.

.2 Exhaust and return side ductwork and components: Particulate: Scale rating of 2 or less; and microbial growth: Scale rating of 2 or less.

3.5 Inspection After Cleaning:

.1 This inspection shall only take place after all systems and components have been cleaned.

.2 Follow the same video survey plan used for the preliminary survey.

.3 Perform video survey of same sections, features and points as were previously recorded for purposes of comparison.

.4 Perform visual inspections throughout as well as Microbial Growth Evaluation wherever this method was used in preliminary examination.

.5 Incorporate all data, observations and recommendations in to the final report as described elsewhere in this specification.

4 REPORTS:

.1 Submit two (2) copies of separate reports both before and after the cleaning procedure has been undertaken. Both reports shall include the following:

.1 Name of facility and address

.2 Name and address of cleaning contractor

.3 Description of the ventilation system with drawings or clear neat sketches showing the various systems

.4 Identification scheme for all points in system that were examined and notes describing method of examination or testing used

.5 Description and location of problem areas encountered and special or unusual situations or conditions and any comments or recommendations

.6 Comments complete with photos illustrating each sampling location and other observed features of the system

.7 DVD format videos showing all areas tested for particulate analysis or microbial growth evaluation, all areas of special interest and general representative sections of the duct and components for each ventilation system cleaned.

.8 Report verification by a TAB Agent and Certification that NADCA standards have been met

.2 Submit two (2) USB sticks with all pre and final videos and pdfs of all reports and tests with each report.

.3 Reports shall be bound in binders, complete with index and title page.

END OF SECTION

REFRIGERATION PIPING - HVAC
23 61 07

1 GENERAL

1.1 Scope

.1 Provide field installed refrigeration piping for split-type air conditioning systems as shown.

.2 This specification does not apply to process refrigeration systems.

1.2 Definitions

.1 The following definitions apply to this section.

.1 ***Split-type air conditioning systems:*** a system comprised of a manufactured packaged evaporator section, and a separate packaged condensing section, where the compressor(s) are located in either section, and in which only the installation of field-installed refrigerant piping is required to complete the refrigeration circuit.

1.3 Applicable codes and standards

.1 Installation codes and standards:

.1	ASME B31.5	Refrigeration Piping and Heat Transfer Components
.2	CSA B51	Boilers, Pressure Vessels, and Pressure Piping
.3	CSA B52	Mechanical Refrigeration Code

.2 Product standards:

.1	ASTM B88	Standard Specification for Seamless Copper Water Tube
.2	ASTM B280	Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
.3	ASME B16.18	Cast Copper Alloy Solder Joint Pressure Fittings
.4	ASME B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
.5	ASME B16.50	Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
.6	AWS A5.8	Brazing Filler Metal.
.7	ASTM B32	Specification for Solder Metal
.8	ASTM B813	Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
.9	ASTM B828	Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings

1.4 Qualified Tradesperson

.1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency for pressure piping and refrigeration.

1.5 Registration and Inspection

.1 Before commencing work, make arrangements and pay for registration and inspection by the AHJ responsible for boiler and pressure vessel safety for the following pressure piping systems:

.1 refrigeration piping systems with a capacity greater than 18 kW (5 tons).

.2 At the start of the Work, obtain existing pressure piping system registration numbers, if available, from the Owner and/or the AHJ.

1.6 Design Criteria

.1 Design pressure for field piping system is in accordance with split-system manufacturer ratings. In the absence of manufacturer data, the following minimum design pressures apply.

Minimum Design Pressures			
Refrigerant Type	Low Side @ 27°C (80°F) kPa (psig)	High Side (air cooled) @ 52°C (125°F) kPa (psig)	High Side (water cooled) @ 40°C (105°F)
R-410A	1630 (236)	3100 (450)	2330 (338)

2 PRODUCTS

2.1 Refrigerant Pipe and Fittings

.1 Pipe:

.1 Type L hard drawn copper tube to ASTM B88.

.2 Type L annealed copper tube to ASTM B88.

.3 ACR copper to ASTM B280, except limited to a maximum 35 mm (1⅜ in) O.D..

.4 Factory cleaned and sealed.

.2 Fittings:

.1 long radius type for elbows and return bends,

.2 flared type with soft annealed copper tubing

.3 wrought copper or forged brass solder type with hard drawn tubing,

2.2 Valves

.1 Isolation valves with access fittings:

.1 Full port, quarter turn valve, packless, brass body and copper tube sweat connections, Class 500 up to 3.5 Mpa (500 psi),

.2 stem for socket wrench and removable seal cap

.3 refrigerant access fitting,

.4 ULC listed, CRN registered

.5 moisture proof seal type for applications where refrigerant temperature is below freezing.

Standard of Acceptance

° Sporlan – series EBVT

.2 Relief valves:

.1 reseating type with forged brass body.

2.3 Refrigerant

.1 Type:

.1 In accordance with split-system equipment requirements.

.2 Refrigerant to be delivered in original manufacturer's containers.

3 EXECUTION

3.1 Installation

.1 Use copper tubing types as follows:

.1 all locations except ceiling spaces used as return air plenum: Hard Drawn type L or ACR.

.2 In return air ceiling plenums: soft annealed type L or ACR, using minimum possible joints and with all joints located in an accessible location for inspection and testing.

.3 Final 1000 mm (3 ft) length at equipment connections: soft annealed type L or ACR.

.4 Maximum ACR tube size: 35 mm (1⅜ in) O.D.

.2 Grade horizontal pipe carrying gases 1:240 down in direction of flow.

.3 Support tubing at intervals of not more than 2.4 m (8 ft) and anchor within 1 m (3 ft) of each elbow. Keep elbows and fittings to a minimum.

.4 In multiple tubing installations, center tubes on 150mm (6 in) centers.

.5 Install rubber grommets between tubing and clamps to prevent line chafing.

.6 Where a vertical suction riser exceeds 1500 mm (5 ft), make riser connection into top of next horizontal run with a minimum 150mm (6 in) high swing arm.

.7 Where the compressor is located at an elevation higher than the evaporator, provide double risers on suction piping to aid oil return.

.8 Install tubing to prevent refrigerant or oil from flowing back into compressor or evaporator.

.9 Connect branch suction lines to and from top of suction main using wye-fittings.

.10 Install isolation valves with integral access fitting at both ends of suction and gas lines for purging and charging.

.11 Provide permanent guards to protect piping and fittings from damage. Provide metal pipe sleeves where tubing passes through wall or floor. Seal annular space around tubing with firestopping.

3.2 Joints

.1 Braze joints with BCuP-5 “Sil-Fos 15” silver brazing filler.

.1 When required by the split-system equipment manufacturer, use solder joints at split-system equipment connections using “Sil-Fos Clean 'n Brite™ 6” silver based solder

.2 Swab each length of refrigeration piping with cloth soaked in refrigerant oil and remove dirt, filings, and visible moisture.

.3 Keep piping ends sealed except when fabricating joints.

.4 Bleed dry nitrogen into piping when brazing connections.

3.3 Pressure and Leak Testing

.1 Pressure test field installed piping before evacuating system. Isolate refrigerant piping and components which form part of packaged split-system equipment.

.1 Test pressure: the lesser of the Design Pressure or the pressure relief valve settings of the applicable portions of the packaged split-system equipment.

.2 Test duration: 2 hrs minimum.

.2 Use refrigerant gas as tracer with dry nitrogen to develop pressure, and test for leaks with halide detector.

.3 Where leaks are found, isolate defective area, discharge gas, repair leaks, and retest.

.4 Upon completion of testing, leave field-made joints visible for inspection by the Authority Having Jurisdiction, before concealing or insulating piping.

3.4 Dehydration

.1 Keep service valves on packaged split-system equipment closed during dehydration.

.2 Evacuate field-installed tubing using two stage vacuum pump with gas ballast on second stage capable of pulling vacuum of 50 microns (0.05 mm hg).

.1 Fill pump with fresh dehydrated oil before starting work.

.2 Connect high vacuum hose or seamless copper tubing jumper lines to both high and low pressure sides.

.3 Locate manual isolating valve between pump and vacuum gauge and take readings with system isolated from pump.

.3 Maintain ambient temperature of 13°C (55°F) or higher throughout refrigeration system for at least 12 hours before and during dehydration.

.4 Evacuate equipment received with dry air, wrong refrigerant, or lost holding charge and if compressor is being evacuated energize crankcase heaters during process.

3.5 Charging

.1 After evacuation is complete, break vacuum with initial charge through high side charging valve with pressure gauge and new filter-drier installed in connection to charging valve.

.2 Calculate amount of refrigerant required and meter refrigerant into system. When calculated amount has been charged, close liquid charging valve, start system and monitor sight glass at receiver outlet.

.3 Low side charging to be permitted only for charging small amounts of refrigerant in gaseous state.

3.6 Close-Out

.1 For systems with greater than 23 kg (50 lb) of refrigerant, complete the declaration for field pressure testing and submit copies to the Owner and the Authority Having Jurisdiction.

END OF SECTION

CONDENSING UNITS
23 62 13

1 GENERAL

1.1 Scope

.1 Provide Microprocessor controlled, multiple-scroll compressor, air-cooled, condensing units of the scheduled capacities as shown and indicated on the Drawings, including but not limited to:

- .1 Condensing Unit package
- .2 Electrical power and control connections
- .3 Air Handling Unit DX Coil connections

1.2 Applicable standards

.1 Installation to comply with CSA B52, ARI, ASME, and ASHRAE codes and standards.

1.3 Quality Assurance

.1 Products shall be Designed, Tested, and installed in compliance with applicable sections of the following Standards and Codes:

- .1 ANSI/ASHRAE Standard 15 – Safety Code for Mechanical Refrigeration
- .2 CSA B52 – Mechanical Refrigeration Code
- .3 ASHRAE 90.1 - Energy efficiency compliance.
- .4 Conform to Intertek Testing Services, formerly ETL, for construction of condensing units and provide E.T.L./c E.T.L. Listing label.

.2 Factory Test:

.3 Warranty:

- .1 Manufacturer shall Warrant all equipment and material of its manufacture against defects in workmanship and material for a period of one year from date of initial start-up or eighteen (18) months from date of shipment, whichever occurs first.

2 PRODUCTS

2.1 General

.1 Factory testing:

- .1 Condensing Unit shall be pressure tested, evacuated and given a nitrogen holding charge and an initial oil charge, and shall be factory operational run tested to assure each control device operates properly.

.2 Delivery and storage:

- .1 ship equipment factory dehydrated and sealed with holding charge of dry nitrogen with tracer,
- .2 ship compressors with full charge of lubricating oil.

2.2 Condensing Units

.1 General

.1 Install and commission, as shown on the schedules and plans, factory assembled, charged, and tested air cooled scroll compressor condensing unit as specified herein.

.2 Condensing Unit shall be designed, selected, and constructed using the refrigerant shown on the equipment schedules.

.3 Condensing unit and system shall include:

(a) at a minimum the number of refrigerant circuits shown on the equipment schedule
(b) at a minimum the number of scroll compressors shown on the equipment schedule
(c) air-cooled condenser
(d) refrigerant
(e) lubrication system
(f) interconnecting wiring,
(g) safety and operating controls including capacity controller, control center, motor starting components, and special features as specified herein or required for safe, automatic operation.

Standard of Acceptance

- Aaon
- Daikin
- Quantech

.2 Cabinet:

.1 External structural members shall be constructed of heavy gauge, galvanized steel coated with baked on powder paint which, when subject to ASTM B117, 1000 hour, 5% salt spray test, yields minimum ASTM 1654 rating of “6”.

.2 Painted steel louvered panels to protect condenser coils and screen internal components from environmental damage and to restrict unauthorized access.

.3 Compressors

.1 Construction:

(a) Electric driven hermetic scroll-type including

- Compliant design for axial and radial sealing.
- Refrigerant flow through the compressor with 100% suction cooled motor.
- Large suction side free volume and oil sump to provide liquid handling capability.
- Compressor crankcase heaters to provide extra liquid migration protection.
- Annular discharge check valve and reverse vent assembly to provide low pressure drop, silent shutdown and reverse rotation protection.
- Initial Oil charge.
- Oil Level sightglass.
- Vibration isolator mounts for compressors.
- Brazed-type connections for fully hermetic refrigerant circuits.

.2 Capacity control:

(a) Capacity control shall be as indicated on the equipment schedule

.3 Starter

(a) Microprocessor controlled, factory installed Across-the-Line type compressor motor starters.

.4 Air cooled condensers

.1 Construction:

(a) heavy gauge aluminum or galvanized sheet steel casing and supports with galvanized nuts and bolts,
(b) equipped with heavy gauge die formed or structural steel legs and anchor plates.

.2 Coils:

(a) Copper seamless tubing with aluminum fins, design pressure of 4.5 MPa (650 psi) air pressure under water

.3 Fans:

(a) direct or V-belt drive propeller fans, dynamically and statically balanced with steel wire fan guards, spun bell mouth fan orifice, cowl to direct fan discharge vertically, and protected, totally enclosed air-over (TEAO) motors with weather protection covers,
(b) motor bearings and fan bearings fitted with extended lubrication lines accessible from casing exterior,
(c) divider plates to separate fan sections in multiple fan models.

.5 Hot Gas Bypass:

.1 Hot gas bypass to be provided that permits continuous, stable operation at capacities below the minimum step of unloading to as low as 5% capacity by introducing an artificial load.

.2 Installed on only one refrigerant circuit if multiple circuits are used.

.6 Condensing Unit Controls

.1 Automatic start, stop, operating, and protection sequences across the range of scheduled conditions and transients. Manual on/off building operator switch.

.2 Microprocessor Enclosure shall be rain and dust tight NEMA 3R cabinet with hinged, latched, and gasket sealed door.

.3 Microprocessor Control Center:

(a) Condensing Unit control is set for DX Coil Discharge Air Temperature Control
(b) Automatic control of compressor start/stop, anti-coincidence and anti-recycle timers, automatic pump-down shut-down, condenser fans, unit alarm contacts, and condensing unit operation from 0°F to 125°F (-18°C to 52°C) ambient. Automatic reset to normal operation after power failure.
(c) Software stored in non-volatile memory, with programmed set-points retained in battery-backed clock (RTC) memory for minimum 5 years.
(d) Display with descriptions in English, numeric data in English (or Metric) units. Sealed keypad or touchscreen with sections for Setpoints, Unit Options & clock, and On/Off Switch.
(e) Programmable Set-points (within Manufacturer limits): display language; suction pressure setting and control range, remote reset temperature range, set daily schedule/holiday for start/stop, manual override for servicing, low and high ambient cutouts, number of compressors, low suction pressure cutout, high discharge pressure cutout, anti-recycle timer (compressor start cycle time), and anticoincident timer (delay compressor starts).
(f) Display Data: Suction temperatures (optional), low ambient temperature cutout setting, outdoor air temperature, English or metric data, suction pressure cutout setting, each system suction pressure, discharge pressure (optional), discharge air reset signal from Building Automation System, anti-cycle timer status for each system, anti-coincident system start timer condition, compressor run status, no cooling load condition, day, date and time, daily start/stop times, holiday status, automatic or manual system, automatic lead/lag of compressors within a system, compressor starts/operating hours (each), status of hot gas valves, and fan operation, run permissive status, number of compressors running, liquid solenoid valve status, load & unload timer status.
(g) Discharge air temperature setpoint controlled via Building Automation System via a 4-20 mA or 0-10 VDC input.
(h) System safeties shall cause individual compressor systems to perform auto shut down; manual reset required after the third trip in 90 minutes. Includes: high discharge pressure, low suction pressure, high pressure switch, and motor protector.
(i) Compressor motor protector shall protect against damage due to high input current or thermal overload of windings.

(j) Unit safeties shall be automatic reset and cause compressors to shut down if low ambient, or under voltage.
(k) Alarm Contacts: Low ambient, low voltage, low battery, and high discharge pressure (per compressor circuit), and low suction pressure (per compressor circuit).
(l) High ambient control permits unit operation above 115°F (46°C) ambient.
(m) Motor Current Module capable of monitoring compressor motor current to provide extra protection against compressor reverse rotation, phase-loss and phase imbalance.

.4 Pressure & Temperature Transducers and Sensors

(a) Discharge Pressure Transducers permits unit to sense and display discharge pressure.
(b) Suction Pressure Transducers permits unit to sense and display suction pressure.
(c) Suction Temperature Sensors permits units to sense and display suction temperature.

.5 Control Power Transformer: Converts unit power voltage to 120V/1PH/60Hz Factory mounting includes primary- and secondary-wiring between the transformer and the control panel.

.6 External Controls

(a) Unit shall be equipped with low pressure and high-pressure safety for each refrigerant circuit.
(b) Unit manufacturer shall provide necessary relays for cooling stages as stated on equipment schedule.

.7 Manufacturer shall provide any controls not listed above, necessary for automatic condensing unit operation. Mechanical Contractor shall provide field control wiring necessary to interface sensors to the condensing unit control system.

.7 Electrical Power

.1 Power Panels:

(a) NEMA 3R cabinets with hinged, latched, and gasket sealed outer doors. Provide main power connection(s), control power connections, compressor and fan motor start contactors, current overloads, and factory wiring.
(b) Power supply shall enter unit at a single location, be of voltage and phase as per equipment schedule, and connect to individual terminal blocks per compressor.
(c) Exposed compressor, control and fan motor power wiring shall be routed through liquid tight conduit.

.2 Power Supply Connections:

(a) Single Point Power Supply: Single point Terminal Block for field connection and interconnecting wiring to the compressors.

2.3 Refrigerant Circuits

.1 Independent refrigerant circuits shall be furnished on each unit.

.2 All unit piping shall be copper, with brazed joints. The liquid line will include a field connection shutoff valve with charging port located on each condenser circuit. Suction line connections are provided on each refrigeration circuit.

.3 Filter drier and sight glass, expansion valve, liquid line solenoid valve, and refrigerant piping are to be installed on each refrigerant circuit.

2.4 Receivers

.1 Manufactured to ARI 495 for design pressure, materials, welding test and relief devices.

.2 Sized for system pump down with 80% of receiver internal storage volume as refrigerant liquid at 32°C (90°F) temperature.

2.5 Evaporators

.1 Air handling unit coils:

.1 Air handling coils to sections 23 82 16 – Coils and 23 73 13 – Modular Air Handling Units

2.6 Refrigerant pipe and fittings

.1 Pipe:

.1 Factory cleaned and sealed seamless ACR copper conforming to ASTM B88-81,

.2 Copper tube type "L" with brazed joints for relief valve discharge pipe on outdoor installations

.2 Fittings:

.1 long radius type for elbows and return bends,

.2 flared type with soft annealed copper tubing

.3 wrought copper or forged brass solder type with hard drawn tubing,

.4 made up with SIL-FOS-15 phosphor-copper-silver alloy for copper piping jointed by copper fittings,

.5 170 Mpa (2500 psi) solder for brass fittings, and

.6 95-5 solder for connections to equipment or accessories.

.3 Flexible connections:

.1 made up using coiled soft copper tubing for 10 mm (⅜ in) or less,

.2 Seamless flexible bronze hoses with bronze wire braid covering and factory sealed neoprene jacket units for larger sizes.

2.7 Valves

.1 General:

.1 Valves to be manufactured to ANSI-B31.5, and supplied with stem for socket wrench and removable seal cap where specified with flare or brazing connection.

.2 Service valves:

.1 backseated, packless, forged brass Class 500 up to 3.5 Mpa (500 psi), and cast bronze Class 375 up to 2.5 Mpa (375 psi),

.2 removable seal cap and gauge port for control capillary connections at compressors,

.3 moisture proof seal type for applications where refrigerant temperature is below freezing.

.3 Stop valves:

.1 diaphragm packless type with integral mounting bracket, forged brass bodies and bonnets, globe and angle non-directional type for 22 mm (⅞ in) nominal o.d. or less,

.2 heavy globe or angle body, positive sealing, self-aligning, heavy nylon disc for 28 mm (1⅛ in) nominal o.d. and larger.

.4 Relief valves:

.1 fusible plug or rupture disc type with forged brass body.

.5 Check valves:

.1 spring operated, guided piston type with forged brass body in flare connection sizes up to 22 mm (⅞ in) nominal o.d,

.2 guided piston type, spring operated with bolted bonnet or cover plate in sweat connections 28 mm (1⅛ in) nominal o.d. and larger.

.6 Solenoid valves:

.1 valve bodies with pressure ratings as for service valves, direct acting up to 9 mm (⅜ in) and pilot operated in larger sizes,

.2 field replaceable coils, serviceable without removing valve from line and rated according to temperature service,

.3 manual lift stem for pump down service.

Standard of Acceptance
- Alco
- Sporlan

.7 Expansion valves:

.1 thermostatic type with external equalizer, adjustable superheat setting, capacity and bulb charge to suit operating conditions.

Standard of Acceptance
- Alco
- Sporlan

.8 Back pressure valves:

.1 direct acting or external pilot type with adjustable pressure setting, convertible in field to external sensing.

Standard of Acceptance
- Alco
- Sporlan

.9 Crankcase pressure regulators:

.1 "Hold-back" type,

.2 suitable for gauge pressures between 0-275 kPa (0-40 psi), and

.3 selected with pressure drop at design refrigerant flow of 3.5 to 7 kPa (0.5 to 1.0 psi).

Standard of Acceptance
- Alco
- Sporlan

.10 Water regulating valves:

.1 self contained pressure activated modulating two-way straight-through or three way by-pass type.

Standard of Acceptance
- Penn Controls

2.8 Liquid line filter driers

.1 Rreplaceable cartridge type conforming to ARI 710,

.2 Sized for system nominal tonnage with type of refrigerant used.

Standard of Acceptance
- Alco - ADK Dri-Kleaner
- Sporlan - Catch-All

2.9 Suction line filter driers

.1 As described for liquid line driers,

.2 Sized to manufacturer's suction line ratings, with pressure drops and operating suction pressures related to type of refrigerant used.

2.10 Strainers

.1 Field serviceable without removing housing from line,

.2 Drawn brass shell with 0.177 mm (0.007 in) mesh monel screen in sizes up to 28 mm (1⅛ in) and 0.297 mm (0.012 in) mesh screen in larger sizes.

2.11 Sight glasses

.1 Combination liquid flow and moisture indicating type with chemical impregnated filter paper moisture detection element and fused glass viewing port,

.2 Line size up to 25 mm (1 in) and

.3 13 mm (½ in) installed in by-pass configuration where line size is greater than 28 mm (1⅛ in).

Standard of Acceptance
- Sporlan - See-All
- Alco - AMI Eye-Spy.

2.12 Oil Separators

.1 Fabricated with inlet, outlet and oil return connections,

.2 Separator drum un-heated and insulated.

2.13 Oil level control system

.1 Consisting of oil reservoir, differential check valve and individual oil level controls on each compressor.

.2 Reservoir:

.1 inlet and outlet service valves,

.2 high level and low level sight glasses, and

.3 vent connection.

Standard of Acceptance
- Sporlan - OR 1½

.3 Oil differential check valve in vent connection to compressor suction to maintain pressure in reservoir.

Standard of Acceptance
° Sporlan - OCV

.4 Oil level controls for each compressor with sight glass, float valve, equalizing connection and crankcase connection.

Standard of Acceptance
° Sporlan - OL

2.14 Liquid/suction line heat exchangers

.1 Fabricated from soldered tubes, tube-in-tube or shell and finned tube type.

2.15 Refrigerant

.1 Refrigerant to be as shown on the equipment schedule.

.2 Use only refrigerant for which equipment was designed.

.3 Refrigerant to be delivered in original manufacturer's containers.

3 EXECUTION

3.1 Installation

.1 Provide clearances around unit for service and maintenance.

.2 Drains from evaporators to be run to floor drains.

.3 Provide base under roof mounted air cooled condensers and air cooled condensing units consisting of two pressure treated structural timbers weatherproofed to CSA 080-M1983.

3.2 Refrigeration piping

.1 Swab each length of refrigeration piping with cloth soaked in refrigerant oil and remove dirt, filings, and visible moisture.

.2 Keep piping ends sealed except when fabricating joints.

.3 Grade horizontal pipe carrying gases 1:240 down in direction of flow.

.4 Tubing installed in trenches or conduit under floor to be level.

.5 Support lines at intervals of not more than 2.4 m (8 ft) and anchor within 1 m (3 ft) of each elbow. Keep elbows and fittings to minimum.

.6 When multiple runs are installed, spread pipes to 150 mm (6 in) minimum to allow for expansion and contraction.

.7 Use rubber grommets between tubing and clamps to prevent line chafing.

.8 Where vertical rise of more than 1.5 m (5 ft) occurs in suction line, connect riser into top of next horizontal section.

.9 Provide double risers in hot gas and suction piping for oil return.

.10 Connect branch suction lines to and from top of suction main using wye-fittings.

.11 Install piping and suction accumulator to prevent refrigerant or oil from flowing back into compressor or evaporator.

.12 Limit screwed and flanged joints to equipment connections not available in brazing format. Limit flared joints to 10 mm (⅜ in) nominal O.D. tubing.

.13 Bleed dry nitrogen into piping when sweating connections.

.14 Braze flexible pipe vibration isolators and stub connectors on sealed hermetic compressors using alloys which melt at 620°C (1148°F) or below.

.15 Install ball check isolating valves at receiver sight glass, charging valve for high and low side, filter drier, liquid line moisture and liquid indicator, solenoid valve, and thermostatic expansion valve.

.16 Install filter drier with three valve bypass.

.17 Provide two evacuation fittings, one in suction line at inlet side of suction line filter, and one in liquid line at outlet side of filter-drier. Connection in liquid line may be valved to serve as charging valve. After evacuation and charging, cap fittings. Connections should be at least 10 mm (⅜ in).

.18 Vent pressure relief in accordance with CSA B52.

.19 Install special accessories as follows;

.1 Oil separator with automatic oil return to crankcase, through filter, automatic stop valve with by-pass valve, external float valve.

.2 Capacity controls, evaporator pressure controls, crankcase pressure controller, hot gas by-pass to suction line with de-superheat control, hot gas by-pass to evaporator inlet.

.3 Purge valve at high point of condenser for units operating at sub-atmospheric suction pressures.

.20 Provide permanent guards to protect piping and fittings from damage. Provide metal pipe sleeves where tubing passes through wall or floor, and fill space around tubing with firestop and mastic insulating compound.

3.3 Pressure and leak testing

.1 Perform leak test before evacuating system.

.2 Comply with CSA B52.

.3 Use refrigerant gas as tracer with dry nitrogen to develop pressure.

.4 Compressors with refrigerant holding charge to remain isolated from system.

.5 Build to 35 kPa (5 psi) initial refrigerant pressure in high and low side and add dry nitrogen to field test pressure.

.6 Test for leaks with halide detector.

.7 Where leaks are found, isolate defective area, discharge gas, repair leaks, and retest.

3.4 Dehydration

.1 Evacuate using two stage vacuum pump with gas ballast on second stage capable of pulling vacuum of 50 microns (0.05 mm hg).

.2 Fill pump with fresh dehydrated oil before starting work.

.3 Maintain ambient temperature of 13°C (55°F) or higher throughout refrigeration system for at least 12 hours before and during dehydration.

.4 Connect high vacuum hose or seamless copper tubing jumper lines to both high and low pressure sides.

.5 Line size not less than 6 mm (¼ in) nominal o.d. for units of 70 l (2.5 cu ft) internal volume and 10 mm (⅜ in) or 12 mm (½ in) nominal o.d. for larger volumes.

.6 Install thermocouple vacuum gauge with micron (mm) scale to measure system pressure.

.7 Locate manual isolating valve between pump and vacuum gauge and take readings with system isolated from pump.

.8 When compressor/condensing unit has refrigerant holding charge intact, service valves to remain closed during evacuation.

.9 Evacuate equipment received with dry air, wrong refrigerant, or lost holding charge and if compressor is being evacuated energize crankcase heaters during process.

.10 Triple evacuate system as follows

- .1 Evacuate to 1500 microns (1.5 mm) and hold for [4] hours.
- .2 Break vacuum to gauge pressure of 14 kPa (2 psi) with refrigerant, charging through filter-drier.
- .3 Evacuate again to 1500 microns (1.5 mm) and hold for [4] hours.
- .4 Break vacuum with refrigerant as before.
- .5 Evacuate for third time and continue pumping for minimum [12] hours after reaching 500 microns (0.5 mm).
- .6 Isolate pump from system and make graphic time based record of vacuum reading and ambient temperature for following 12 hours.

3.5 Charging

.1 After evacuation is complete, break vacuum with initial charge through high side charging valve with pressure gauge and new filter-drier installed in connection to charging valve.

.2 Calculate amount of refrigerant required and meter refrigerant into system. When calculated amount has been charged, close liquid charging valve, start system and monitor sight glass at receiver outlet.

.3 When refrigerant container is to be changed during charging process, re-purge charging line after connection of new container.

.4 Low side charging to be permitted only for charging small amounts of refrigerant in gaseous state.

3.6 System start-up, check-out and adjustment

.1 Provide instruments, gauges, and testing equipment.

.2 Check compressor oil level and add oil to bring level to centre of crankcase sight glass. Use only refrigeration oil recommended by compressor manufacturer, from factory sealed, unopened containers.

.3 Lubricate motors or moving parts with proper oil or grease.

.4 Bring equipment into operation, trial run for at least 24 hr, and make up any loss of oil and refrigerant. During start-up, no compressor shall be left unattended and unwatched until system is properly charged and refrigerant and oil levels are stable.

.5 Adjust controls to obtain design conditions and verify equipment performs in accordance with manufacturer's ratings.

.6 Check compressor crankcase sight glass after reaching operating condition to be sure system does not contain excess oil.

.7 Test and record refrigerant temperatures and pressures cooling apparatus entering and leaving air temperatures, outdoor dry bulb and wet bulb, room dry bulb and wet bulb and condenser water temperatures and flow quantities.

.8 Test and record voltage and running amperes on each phase of each motor and compare to nameplate data. Also record starter heater rating for each motor.

.9 Ensure that insulation of refrigerant piping and accessories is completed.

END OF SECTION

AIR HANDLING UNITS
23 73 43

1 GENERAL

1.1 Scope

.1 Replace the existing hydronic heating coils in both air handling units with a new hydronic heating coil and dx cooling coil. Cut a hole in both air handling units to remove the existing heating coil, use the same hole to install the new coil blocks, seal and patch hole to be airtight.

1.2 Related Sections

.1 Specification sections within divisions 20 to 25 provide detail requirements for components and equipment, such as; fans, motors, vibration isolation, filters, dampers, belt drives, belt-guards, flexible connections, acoustic panels, acoustic lining, access doors, vibration isolation, and coils, spray sections, drip pans, blanking plates and coil supports.

.2 Where requirements defined here exceed the standard set out in the reference section, this section governs.

1.3 Submittals

.1 Submit shop drawings for;

.1 Shop fabricated air handling unit casings

.2 Air handling unit curbs and bases

2 PRODUCTS

2.1 Single Thickness Casings and Plenums

.1 Construction:

.1 fabricated from galvanized 1.2 mm (18 ga) panels,

.2 joined at sidewall and roof by 38 mm (1½ in) standing seams with mismatched seams parallel to air flow in adjacent panels.

.3 standing seams on outside, or on inside where acoustic insulation is applied.

.4 reinforced with supplementary reinforcing angles, spanning between vertical seams and securely riveted to panels to make structurally sound and vibration-free assembly able to withstand applied pressure differential.

2.2 Double Wall Casings and Plenums

.1 Construction:

.1 fabricated from double wall 100 mm (4 in) thick panels with,

.2 outer skin: 1.2 mm (18 ga) galvanized steel,

.3 inner skin: 1.0 mm (20 ga) galvanized steel,

.4 intermediate ribs and framing to make structurally sound and vibration-free assembly able to withstand applied pressure differential.

.5 assembled with tongue and groove or 'C' type panel joints.

.2 Insulation:

.1 48 kg/m^3 (3 lb/ft_3) density glass fibre.

2.3 Acoustic Panel Casings and Plenums

.1 Construction:

.1 fabricated from factory manufactured acoustic panels specified in Sound Attenuation Section, reinforced to make structurally sound and vibration-free assembly able to withstand applied pressure differential.

.2 openings or panel penetrations greater than 300 mm (12 in) (diameter or length and width) cut and framed at factory and

.3 openings or penetrations less than 300 mm (12 in) (pipe, conduit and instrument holes) cut in field.

2.4 Connections Between Sub-assemblies

.1 Angle or bent plate flanges with neoprene rubber gaskets;

.1 rivets or bolts on not more than 300 mm (12 in) centres.

2.5 Walk-in Access Doors

.1 Same material as casing, framed with reinforcing angle above and below opening.

.1 sizes as indicated, with Georgian wired glass ports, hinged to open against air pressure.

2.6 Removable Panels

.1 Same material as casing, framed with angle or bent plate.

.1 sizes as indicated, secured with hex head bolts and nuts welded to rear of frame.

2.7 Weather Proof Sheet Metal Casings

.1 As specified above for casings and plenums;

.1 roofs sloped 1:80 over width of unit, with joints caulked and weather caps over standing seams,

.2 designed for maximum wind velocity of 100 km/h (60 mph), snow load of 2.9 kN/m^2 (60 lb/sq ft).

.3 connections, openings, and penetrations caulked, flashed and counter-flashed, and

.4 gasketed access doors and removable panels.

2.8 Mixing Section

.1 Constructed to match adjacent casings with access door and frames and flanges for damper installation;

.1 expanded metal walking grate where dampers are shown in floor.

2.9 Filter Section

.1 Constructed to match adjacent casings with filter arrangement as shown.

.2 Access to filters through hinged access door.

2.10 Blanking Plates

.1 Fitted around coils, dampers, filters and other components.

3 EXECUTION

3.1 Unit Casings and Plenums

.1 Field assembled from components to form supply air system casings with exhaust, return and fresh air plenums and equipment as shown.

.2 Fitted with access doors constructed in accordance with Section 20 82 00 for access doors in casings and plenums.

.3 Equipment service lights in each chamber.

3.2 Jointing

.1 Flange and bolt casings to equipment with 6 mm (¼ in) stove bolts at approximately 75 mm (3 in) centres or as determined by holes in flanges of equipment.

.2 At floor line attach casing to curb with toe angles bolted on 300 mm (12 in) centres for full length of casing.

.3 Provide similar reinforcing angles and expansion shields where casing joins masonry wall or concrete roof deck.

3.3 Sealing and Testing

.1 Prior to assembly apply sealer to casing seams, where toe angles meet curbs at floor line and at joints between casing and walls and roof decks.

.2 Blank openings and pressure test casings. Re-caulk leaking joints and retest to obtain air leakage rate not greater than 5% of rated air flow at pressure of 2.5 kPa (10 in wg).

END OF SECTION

HYDRONIC AIR COILS
23 82 16.11

1 GENERAL

1.1 Scope

.1 Provide hydronic heat transfer coils and accessories for air handling equipment, as shown.

1.2 Applicable Codes and Standards

.1 Installation codes and standards:

.1	CSA B51	Boiler, Pressure Vessel, and Pressure Piping Code

.2 Product standards:

.1	AHRI 410	Forced-Circulation Air-Handling and Air-Conditioning Coils
.2	ASHRAE 62.1	Ventilation for Acceptable Indoor Air Quality
.3	ASME B1.20.1	Pipe Threads, General Purpose, Inch
.4	ASME B16.5	Pipe Flanges and Flanged Fittings
.5	ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
.6	ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

1.3 Design Criteria

.1 Coils to have a Canadian Registration Number (“CRN”) in accordance with CSA B51.

1.4 Submittals

.1 Submit shop drawings for;

.1 drip pans and coil supports.

.2 Submit manufacturers product sheets with performance data for;

.1 coils,

.3 Coil data to include:

.1 coil size: face area, tube length, tube face, number of rows, circuiting arrangement,

.2 construction: tube material and size, fin material and spacing, header material and connection sizes, casing and tube support material,

.3 heat transfer fluid performance: working pressure, fluid flow rate, entering and leaving fluid temperatures, tube fluid velocity, and fluid pressure drop,

.4 air side performance: air flow rate, entering air dry-bulb and wet-bulb temperatures, leaving air dry-bulb and wet-bulb temperatures, and air side pressure drop.

.5 AHRI certified performance.

2 PRODUCTS

2.1 General

.1 Companies, and/or trade names listed below are acceptable for various coil types.

Standard of Acceptance

- Scott Springfield
- Daikin

.2 Coil connections: (unless otherwise specified):

.1 NPS 2 and smaller: threaded to ASME B1.20.1.

.2 NPS 2-1/2 and larger: raised face flange to ASME B16.5.

(a) Class 150 flanges for piping system design pressures of 1380 kPa (200 psig) or less,

(b) Class 300 flanges for piping system design pressures greater than 1380 kPa (200 psig) and not exceeding 2700 kPa (390 psi).

.3 Coil design for cleaning accessibility:

.1 Notwithstanding any other requirement shown, coils are to be selected to also meet the following performance condition:

(a) have an airside pressure drop not greater than 185 Pa (0.74 in.w.c.) at an air velocity of 2.5 m/s (500 fpm) under dry-coil conditions.

.2 The above requirement does not apply where the drawings or equipment specification provides for a minimum access space of 450 mm (18 in.) on both sides of the coil and is provided with access doors.

2.2 Water and Glycol Coils in Heating Service

.1 General:

.1 Coil performance certified to AHRI 410.

.2 Coils factory leak tested with air under water between 120 and 150% of design pressure.

.3 Coil design criteria to be in accordance with the following table except as otherwise shown on equipment schedules or drawings:

Parameter	Value SI	Value IP
Minimum design pressure	1340 kPa	(200 psig)
Airside face velocity, maximum	2.5 m/s	(488 FPM)
Airside pressure drop, maximum	52 Pa	(0.21 in.w.c)
Fluid tube velocity, maximum	0.9 m/s	(2.9 fps)
Fluid side pressure drop - glycol	[see schedule] [41 kPa]	[13.7 ft]
Maximum coil section fin height	762 mm	(30 in)

.2 Tubes and fins:

.1 tubes: copper, minimum 0.5 mm (0.020 in) wall thickness

.2 fins:

(a) air entering temperature ≤ 4°C (40°F): aluminum with electrostatic epoxy coatin

.3 fin density: not greater than 640 fins/m (16 fins/in),

.4 fin thickness: as selected by manufacturer

.5 tube length: maximum 3 m (10 ft).

.6 turbulators: required where water velocity in tube is less than 1.2 m/s (3.85 fps) at design conditions,

.3 Headers:

.1 steel headers with brazed tube joints,

.2 vent connection on inlet header and drain connection on outlet header,

.4 Casings and tube supports:

.1 1.6 mm (16 ga) 304 Type 304/304L stainless steel,

.2 casings designed for bolting to other sections,

.3 tubes supported at intermediate points along tubing to prevent tube sagging with water in tube, without relying on fins for support.

2.3 Coil Support Racks

.1 Coils installed in air handling units to be supported on coil racks:

.1 welded angle racks arranged and stiffened to allow withdrawal of individual coils through the side of the air handling unit,

.2 materials:

(a) cooling (condensing) coils: Type 304/304L stainless steel,

(b) other coils: hot dipped galvanized steel to ASTM A123

2.4 Condensate Drain Pans

.1 Construction:

.1 drain pans to conform to ASHRAE 62.1.

.2 1 mm (18 ga) thick, Type 304/304L stainless steel with continuous welded joints, with welds mechanical polished or post-weld pickled to remove all welding heat tint,

.3 drain pan shaped to provide a 1% slope from all points on the pan, to the drain outlet connection,

.4 drain outlet connection located at the lowest point in the drain pan, either:

(a) at the bottom of the pan, or

(b) on the side of the pan provided that the invert of the drain connection is lower than the lowest point in the drain pan,

.5 drain connection:

(a) ASTM A312 pipe or ASTM A269 tube, with NPS 1-1/4 threaded adaptor to ASME B1.20.1.

(b) size: minimum NPS 1-1/4.

.2 Drain pan dimensions for cooing coils and heat reclaim devices:

.1 run continuously under the complete length of each coil section and coil bank, and not less than the interior width of the air handling unit or duct,

.2 extend at least 75 mm (3 in) from the upstream face of the coil or heat reclaim device, with a drain outlet fitting,

(a) for clarity, only one upstream drain pan is required,

(b) if the air handling unit section immediately upstream of the coil or heat reclaim device is provided with a drain pan for the unit and a drain connection, then a separate drain pan on the upstream side of the coil or heat reclaim devices is not required.

.3 extend from the downstream face of the coil or heat reclaim device, a distance equal to one-half the height of the coil or heat reclaim device,

(a) for clarity, for stacked coils in a coil bank, the downstream pan length under each coil in each level need only be at least half the height of each individual coil, not the total height of the entire coil bank.

.3 Drain pan dimensions for moisture eliminators:

.1 extend at least 25 mm (1 in) from the upstream face of the eliminator,

.2 extend at least 100 mm (4 in) from the downstream face of the eliminator,

2.5 Blanking Plates

.1 Fabricated from 0.8 mm (22 ga) of same material as coil support rack.

2.6 Moisture Eliminators for Coils in Condensing and Cooling Service

.1 Construction:

.1 factory fabricated,

.2 capped 3-bend, 2-hook style spaced on 30 mm (1 in) centers in sections not more than 315 mm x 610 mm (3 ft x 2 ft),

.3 materials: 0.6 mm (24 ga) Type 304/304L stainless steel

.4 supporting frame:

(a) of same material as eliminator sections,

(b) clips to permit removal of individual sections.

3 EXECUTION

3.1 Coil Installation

.1 Install coils in accordance with manufacturer's instructions.

.2 Install coils with positive slope to coil header drain connection.

.3 Fit each vent and drain outlet with hose end packless valve with pipe cap.

3.2 Coil Support Racks

.1 Mount coils in coil support racks, arranged to permit removal of the coil or each coil section sideways through the side of the air handling unit, casing or ductwork.

3.3 Condensate Drain Pans

.1 Provide drain pans for the following equipment;

.1 coils and heat recovery devices in condensing and cooling service,

.2 Provide drain pans under each

.1 cooling coil,

.2 under each moisture eliminator.

.3 Where multiple coils are installed vertically in a coil bank, provide a drain pan under each individual coil section.

.4 In stacked coil arrangements, provide drainage piping from each drain pan and pipe into the drain pan immediately below with an NPS 1½ stainless steel drain tube.

.5 Provide a P-trap drain in the lowest coil drain pan in each coil bank and pipe to a floor or hub drain with NPS 1-1/2 copper DWV tubing.

3.4 Blanking Plates and Casing Connections

.1 Install blanking plates at entering or leaving air side of each coil, to close bypass openings between coils, coil supporting frames and casings of air handling equipment.

.2 Provide gaskets for, or apply sealer or caulking to, connections between coils, blanking plates, coil supporting frames, and casings.

.3 Flange and bolt casings to single coils, coils support frames and spray sections with 6 mm (¼ in) stove bolts at approximately 75 mm (3 in) centers or as determined by holes in flanges of equipment.

END OF SECTION

REFRIGERANT AIR COILS
23 82 16.13

1 GENERAL

1.1 Scope

.1 Provide refrigerant heat transfer coils and accessories for air handling equipment, as shown.

1.2 Applicable Codes and Standards

.1 Installation codes and standards:

.1	CSA B51	Boiler, Pressure Vessel, and Pressure Piping Code

.2 Product standards:

.1	AHRI 410	Forced-Circulation Air-Handling and Air-Conditioning Coils
.2	ASHRAE 62.1	Ventilation for Acceptable Indoor Air Quality
.3	ASME B1.20.1	Pipe Threads, General Purpose, Inch
.4	ASME B16.5	Pipe Flanges and Flanged Fittings
.5	ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
.6	ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
.7	CSA B242	Groove and Shoulder Type Mechanical Pipe Couplings

1.3 Design Criteria

.1 Coils to have a Canadian Registration Number (“CRN”) in accordance with CSA B51.

1.4 Submittals

.1 Submit shop drawings for;

- .1 drip pans and coil supports.

.2 Submit manufacturers product sheets with performance data for;

- .1 coils,

.3 Coil data to include:

- .1 coil size: face area, tube length, tube face, number of rows, circuiting arrangement,
- .2 construction: tube material and size, fin material and spacing, header material and connection sizes, casing and tube support material,
- .3 heat transfer fluid performance: working pressure, fluid flow rate, entering and leaving fluid temperatures, tube fluid velocity, and fluid pressure drop,
- .4 air side performance: air flow rate, entering air dry-bulb and wet-bulb temperatures, leaving air dry-bulb and wet-bulb temperatures, and air side pressure drop.
- .5 AHRI certified performance.

2 PRODUCTS

2.1 General

.1 Companies, and/or trade names listed below are acceptable for various coil types.

Standard of Acceptance

- Scott Springfield
- Heatcraft
- Daikin

.2 Coil connections: (unless otherwise specified):

.1 NPS 2 and smaller: threaded to ASME B1.20.1.

.2 NPS 2-1/2 and larger: raised face flange to ASME B16.5, , or groove coupling joint to CSA B242.

(a) Class 150 flanges for piping system design pressures of 1380 kPa (200 psig) or less,

(b) Class 300 flanges for piping system design pressures greater than 1380 kPa (200 psig) and not exceeding 2700 kPa (390 psi).

(c) groove coupling joints are permitted for piping system design pressures of 2000 kPa (290 psig) or less.

.3 Coil design for cleaning accessibility:

.1 Notwithstanding any other requirement shown, coils are to be selected to also meet the following performance condition:

(a) have an airside pressure drop not greater than 185 Pa (0.74 in.w.c.) at an air velocity of 2.5 m/s (500 fpm) under dry-coil conditions.

.2 The above requirement does not apply where the drawings or equipment specification provides for a minimum access space of 450 mm (18 in.) on both sides of the coil and is provided with access doors.

2.2 Direct Expansion Refrigerant Coils

.1 General:

.1 coil performance certified to AHRI 410.

.2 coils factory pressure tested in accordance with the requirements of CSA B52.

.3 coil design criteria to be in accordance with the following table except as otherwise shown on equipment schedules or drawings:

Parameter	Value SI	Value IP
Minimum design pressure	1340 kPa	(200 psig)
Airside face velocity, maximum	2.48 m/s	(488.1 FPM)
Airside pressure drop, maximum - wet coil [Note 1]	159 Pa	(0.64 in.w.c)
Maximum coil section fin height	838 mm	(33 in)

Notes:
[1] Under wet coil conditions,

.2 Tubes and fins:

.1 tubes: copper, minimum 0.5 mm (0.020 in) wall thickness

.2 fins: pre-coated aluminum

.3 circuits: multi-circuit type with liquid distributors,

.4 joints: silver-alloy brazed,

.5 tubes evacuated, charged with nitrogen and sealed before shipment to site.

.6 fin coating:

(a) aluminum fins pre-coated with electrodeposited epoxy prior to assembly on coil tubes,

(b) coating material to pass a 5000 hr salt spray resistance test to ASTM B117,

(c) compatible for bonding to aluminium, copper, galvanized steel, stainless steel,

(d) coating thermal performance reduction: less than 1% reduction compared to untreated coil,

Standard of Acceptance

° Luvata - Electrofin E-coat

.3 Headers:

.1 factory piped coil collector tubing, of same material as coil tubes, for both liquid and gas lines.

.4 Casings and coil supports:

.1 1.6 mm (16 ga) thick galvanized sheet steel

.2 designed for bolting to other sections,

.3 tubes supported at intermediate points along tubing to prevent tube sagging with water in tube, without relying on fins for support.

2.3 Coil Support Racks

.1 Coils installed in air handling units to be supported on coil racks:

.1 welded angle racks arranged and stiffened to allow withdrawal of individual coils through the side of the air handling unit,

.2 materials:

(a) cooling (condensing) coils: Type 304/304L stainless steel,

(b) other coils: hot dipped galvanized steel to ASTM A123

2.4 Condensate Drain Pans

.1 Construction:

.1 drain pans to conform to ASHRAE 62.1.

.2 1 mm (18 ga) thick, Type 304/304L stainless steel with continuous welded joints, with welds mechanical polished or post-weld pickled to remove all welding heat tint,

.3 drain pan shaped to provide a 1% slope from all points on the pan, to the drain outlet connection,

.4 drain outlet connection located at the lowest point in the drain pan, either:

(a) at the bottom of the pan, or

(b) on the side of the pan provided that the invert of the drain connection is lower than the lowest point in the drain pan,

.5 drain connection:

(a) ASTM A312 pipe or ASTM A269 tube, with NPS 1-1/4 threaded adaptor to ASME B1.20.1.

(b) size: minimum NPS 1-1/4.

.2 Drain pan dimensions for cooing coils and heat reclaim devices:

.1 run continuously under the complete length of each coil section and coil bank, and not less than the interior width of the air handling unit or duct,

.2 extend at least 75 mm (3 in) from the upstream face of the coil or heat reclaim device, with a drain outlet fitting,

(a) for clarity, only one upstream drain pan is required,

(b) if the air handling unit section immediately upstream of the coil or heat reclaim device is provided with a drain pan for the unit and a drain connection, then a separate drain pan on the upstream side of the coil or heat reclaim devices is not required.

.3 extend from the downstream face of the coil or heat reclaim device, a distance equal to one-half the height of the coil or heat reclaim device,

(a) for clarity, for stacked coils in a coil bank, the downstream pan length under each coil in each level need only be at least half the height of each individual coil, not the total height of the entire coil bank.

.3 Drain pan dimensions for moisture eliminators:

.1 extend at least 25 mm (1 in) from the upstream face of the eliminator,

.2 extend at least 100 mm (4 in) from the downstream face of the eliminator,

2.5 Blanking Plates

.1 Fabricated from 0.8 mm (22 ga) of same material as coil support rack.

2.6 Moisture Eliminators for Coils in Condensing and Cooling Service

.1 Construction:

.1 factory fabricated,

.2 capped 3-bend, 2-hook style spaced on 30 mm (1 in) centers in sections not more than 315 mm x 610 mm (3 ft x 2 ft),

.3 materials: 0.6 mm (24 ga) Type 304/304L stainless steel

.4 supporting frame:

(a) of same material as eliminator sections,

(b) clips to permit removal of individual sections.

3 EXECUTION

3.1 Coils

.1 Install coils in accordance with manufacturer's instructions.

.2 Install coils with positive slope to coil header drain connection.

3.2 Coil Support Racks

.1 Mount coils (except reheat coils) in coil support racks, arranged to permit removal of the coil or each coil section sideways through the side of the air handling unit, casing or ductwork.

3.3 Condensate Drain Pans

.1 Provide drain pans for the following equipment;

.1 coils and heat recovery devices in condensing and cooling service,

.2 Provide drain pans under each

.1 cooling coil,

.3 .

.4 In stacked coil arrangements, provide drainage piping from each drain pan and pipe into the drain pan immediately below with an NPS 1½ stainless steel drain tube.

.5 Provide a P-trap drain in the lowest coil drain pan in each coil bank and pipe to a floor or hub drain with NPS 1-1/2 copper DWV tubing.

3.4 Blanking Plates and Casing Connections

.1 Install blanking plates at entering or leaving air side of each coil, to close bypass openings between coils, coil supporting frames and casings of air handling equipment.

.2 Provide gaskets for, or apply sealer or caulking to, connections between coils, blanking plates, coil supporting frames, and casings.

.3 Flange and bolt casings to single coils, coils support frames and spray sections with 6 mm (¼ in) stove bolts at approximately 75 mm (3 in) centers or as determined by holes in flanges of equipment.

END OF SECTION

BUILDING AUTOMATION COMMON WORK RESULTS
25 05 01

1 GENERAL

1.1 Scope

.1 The BAS is to integrate with:

.1 The condensing unit, refrigeration circuit control valves with the existing system.

1.2 Dependent Sections

.1 The BAS Work is further defined in the following specification sections:

25 05 06	Work on Existing Building Automation
25 90 01	Building Automation Control Sequences

1.3 Related Sections

.1 Without limiting the scope of work or applicability of other specification sections, the BAS system is further described in the following the work under this section directly integrates with or refers to the following specification sections:

.1 20 05 12 Wiring Requirements for Mechanical Services

.2 20 05 49 Seismic Restraint

1.4 Equipment Supplied for Installation under Other Sections

.1 Supply the following equipment for installation under other Sections of Division 20;

.1 automatic control valves and pressure independent control valves,

.2 temperature wells for controllers and sensors provided under this Section, for installation in piping systems,

1.5 Equipment Provided under Other Divisions

.1 The following equipment is provided under other Sections of Division 20;

.1 Dx cooling coil with automatic control valves,

1.6 Definitions and Abbreviations

.1 The following definitions, abbreviations, and acronyms apply to this Division of the Work:

.1 AI Analog Input: continuously variable value, usually a sensor, referenced to a controller

.2 AO Analog Output: continuously variable value, usually a control signal to an actuator device, referenced to a controller.

.3 ASC Application Specific Controller

.4 DI Digital Input: a two-state (On-Off) value, usually associated with a switch or state, referenced to a controller.

.5 DO Digital Output: a two-state (On-Off) value, usually associated with starting or stopping equipment or generating an alarm, referenced to a controller.

.6 FC Fail Close (valve or damper action on failure of the controller)

.7 FO Fail Open (valve or damper action on failure of the controller)

.8 FAS Fire Alarm System

.9 GUI Graphic User Interface: an LED, LCD or monitor display

.10 I/O Input/Output

.11 LAN Local Area Network

.12 NC Normally Closed: position of device in a de-energized state.

.13 NO Normally Open: position of device in a de-energized state.

.14 NSC Network Supervisory Controller

.15 OEM Original Equipment Manufacturer

.16 OWS Operator workstation: a PC based server or computer

.17 Tier 1 Building level network providing communication between NSCs and workstations.

.18 Tier 2 Field level network providing communications between ASCs and NSCs

.19 WAN Wide Area Network

1.7 Applicable Codes and Standards

.1 Product standards:

.1 ANSI/ASHRAE 135 BACnet – A Data Communication Protocol for Building Automation and Control Networks

.2 ANSI/CEA 709.1 Control Network Protocol Specification (Lonworks)

.2 Interfacing Standard:

.1 Input/output devices to use ASCII (American Standard for Communication and Information Interchange) code and standard EI (Electronic Industry Association) interfaces.

(a) CSA T530 Commercial Building Standard for Telecommunications Pathways and Spaces

(b) IEEE 802.3 Ethernet

1.8 Qualified Tradesperson

.1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

.2 BAS to be provided by an organization that:

.1 specializes in design, installation, commissioning and service of BAS systems,

.2 has completed five (5) projects of similar size and complexity within the preceding five (5) years,

.3 employs licensed journeymen experienced in this type of work,

.4 is either:

(a) a controls manufacturing company listed under the following Standard of Acceptance to directly perform the Work, or

(b) provided by an authourized controls distributor-contractor of the listed manufacturer, to perform the Work.

Standard of Acceptance
° Delta Controls Inc

1.9 Design Services

.1 Provide engineering services for the design of the BAS including product selection, wiring details, and all installation details to meet the prescribed and performance requirements described in the

specifications sections of Division 25. Issued design documents are to be sealed by a professional engineer licensed in the province of the Work.

.2 Prior to preparation of shop drawings for the BAS, provide a design assist to review Consultant's sequence of operation and provide feedback on any recommendation that may improve the installation or ease of operation, while remaining within the hardware scope as originally designed and specified herein.

1.10 Licences and Ownership

.1 Ownership of, and licences for, hardware and software supplied or used for this project or for ongoing system operation, maintenance and modification to be registered, without restrictions, in Owner's name.

.2 This is applicable to System Software, Workstation Application Editors, and Controller Software.

.3 Licensing to permit an unlimited number of users to access system without additional fees.

.4 At the time of substantial performance of the Work, upgrade the BAS software to the most current release version at that time, at no additional cost to the Owner.

.5 Project-developed software and resulting documentation to be treated as part of system and subject to these same requirements for ownership and licensing. This material includes;

.1 project graphic images,

.2 CAD generated record drawings,

.3 project database,

.4 project-specific application programming code and documentation.

1.11 Seismic Qualification

.1 Seismically qualify (certify) control panels for the BAS to remain operational after being subjected to the design seismic forces assuming a building height factor (NBCC) A_x = 3.0 with equipment rigidly mounted, by the shaker table method in accordance with Specification section 20 05 49.]

1.12 Submittals

.1 Submit one (1) completely engineered and coordinated shop drawing package. Partial or incomplete submission of data and/or drawings will be returned without review.

.2 Submit shop drawings for designed elements;

.1 list of materials of equipment to be used indicating manufacturer, model number, and other relevant technical data,

.2 BAS riser diagram showing system controllers, operator workstations, network devices, and network wiring,

.3 control panel internal wiring diagrams, .

.4 single-line schematics and system flow diagrams showing location of control devices,

.5 wiring diagrams identifying interface hard-wire terminations to controlled equipment OEM control panels,

.6 points list for each system controller, including: Point Type, System Name, Object Name, Expanded ID, Display Units, Controller Type, Address, Cable Destination, Panel, Reference Drawing, and Cable Number,

(a) points to be named by function, and list to include software points such as programmable set-points, range limits, time delays, and so forth,

.7 detailed analysis of each Sequence of Operation from Consultant's design documents, ready for development of actual programming code,

.8 written Sequence of Operations to cover normal operation and operation under various alarm conditions applicable to that system.

.3 Submit shop drawing schedules for;

.1 control dampers: spreadsheet type, to include separate line for each damper and columns for damper attributes.

.2 control valve: spreadsheet type, to include separate line for each valve and separate columns for valve attributes.

.4 Submit catalogue cut-sheets for;

.1 manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for equipment and hardware items as follows;

(a) controllers (NSC's and ASC's),

(b) instrumentation, including

i) accuracy data, range and scale information,

ii) one sheet for each device marked with applicable options. Where several devices of same type are to be used, submit one sheet for each device, individually marked.

(c) actuators,

(d) valves and dampers,

(e) relays/switches,

(f) control panel enclosures,

(g) power supplies,

(h) batteries,

(i) GUI operator interfaces,

(j) wiring and wiring accessories.

.5 Submit supporting documentation:

.1 representative examples of graphics for GUI to include;

(a) BAS network schematics,

(b) typical terminal unit floor plan graphic that shows conditions on occupied floor,

(c) typical equipment room floor plan graphic,

(d) typical graphics for each system and terminal unit at least one sample graphic for each type of equipment,

(e) one sample graphic for chilled water system,

(f) one sample graphic for hot water system,

(g) description of techniques used for dynamic display of information on graphics and method of how building operator drills down to secondary information and affects control of equipment.

.2 Protocol Implementation Conformance (PIC) statement for BACnet devices,

.3 where interfaces occur with control or wiring diagrams of other sections, obtain reproducible copies of those diagrams and revise to show terminal numbers at interface and include diagrams as part of interconnection schematic shop drawings.

1.13 Quality Control

.1 Continuity of staff and subcontractors:

.1 Controls contractor's project manager is to be nominated at time of shop drawing submission and is to remain involved with the project, from shop drawing preparation through to project acceptance, unless a request for change of personnel is submitted to and approved by Owner.

.2 Subcontractors listed in preliminary design submission are to execute the Work defined as sublet in preliminary design document, unless request for change is submitted to and approved by Owner.

.3 Requests for changes in staff, subcontractors, or extent of work subcontracted are to be submitted for approval by Owner and such approval is not to be unreasonably withheld.

.2 Identification of non-conforming materials and equipment:

.1 Submit documentation at time of bid, identifying nature and extent of non-conformance and variances from specifications or referenced standards.

.2 Failure to submit this documentation at time of bid will be interpreted as confirmation that materials, workmanship, hardware and software will be in strict accordance with specifications and standards.

.3 All products that are connected to a piping system that is subject to registration under applicable boiler and pressure vessel legislation are to have current Canadian Registration Numbers in accordance with CSA B51.

1.14 Warranty

.1 At completion of Work, submit written guarantee undertaking to remedy defects in work for period of two (2) years from date of acceptance, which includes:

.1 rectification of control system failures attributable to defects in workmanship, materials, hardware, and software,

.2 service technician to arrive on site within 24 hours of warranty service request, to install and de-bug software patches, to replace defective parts, materials or equipment, and to provide incidental supplies, and labour for remedial work,

.3 technician to remain in attendance until system is returned to operating condition.

.2 Submit similar guarantee for any part of the Work accepted by Owner, before completion of whole work.

2 PRODUCTS

2.1 General

.1 Provide equipment which functions and meets detailed performance criteria when operating in following minimum ambient condition ranges unless otherwise specified in other specification sections of Division 25:

.1 temperature: 0°C to 40°C (32°F to 104°F)

.2 relative humidity 10% to 90% non-condensing

.3 electrical power service of single phase, 120 VAC +/- 10%, 60 Hz nominal.

.2 Components installed within motor control devices to be designed to operate with transient electrical fields occurring within these devices.

2.2 Equipment Standard

.1 Products and software: manufacturer/developer/supplier's catalogued current stock.

.2 This installation is not to be used as test site for newly developed product or software, without explicit written approval by Owner.

.3 Equipment and systems installed to meet;

.1 performance specifications when subjected to VHF, UHF, FM, AM or background RFI as generated by commercial or private, portable or fixed transmitters that meet regulatory codes,

.2 Federal Communication Commission (FCC) Rules and Regulations, Part 15, Subpart J for computing devices.

2.3 BAS General Functional Requirements

.1 Control mechanical and electrical equipment as specified in control sequences.

.2 Scalable system architecture to be modular, permitting stepped expansion of application software, system peripherals, and field hardware.

.3 Control system:

.1 high-speed, peer-to-peer network of microprocessor based Direct Digital Control (DDC) controllers with web-based operator interface,

.2 each mechanical system, building floor plan, and control device to be displayed through point-and-click graphics,

.3 Web server with network interface card to gather data from this system and generate web pages that can be accessed through conventional web browser on any PC connected to network,

.4 operators to access this system through web browser on connected PC's, wireless tablet PCs and smart phones to perform normal operator functions,

.5 scalable, modular, automatic process and optimized workflows, with automatic data acquisition and energy performance analytics,

.4 Each controller;

.1 operates with local closed loop programming, independent from server, able to continue functional control if peer-to-peer communication is interrupted;

.2 performs resident control routines;

(a) receiving information from field mounted sensors and switches and

(b) transmitting instructions to actuators to perform control sequences.

.3 manages local hardware and software alarms;

(a) to collect historical data,

(b) to facilitate operator input and output,

(c) to communicate with Central BAS web server and GUI.

.5 Central BAS Web server;

.1 performs global application programs and data consolidation;

(a) communicating with controllers,

(b) obtaining data from field devices for central monitoring of building systems, and

(c) transmitting instructions to controllers.

.2 has software routines for;

(a) BAS Server operation,

(b) database creation and data storage,

(c) web based GUI with graphics generation and display,

(d) report formulation, printing, and presentation,

(e) alarm detection, management and reporting,

(f) event initiated programming.

2.4 Network Integration Functional Requirements

.1 Open protocol:

.1 Provide an integrated, open protocol building automation system using BACnet to ANSI/ASHRAE Standard 135, with native integration with:

(a) Lonworks,

(b) Modbus,

(c) OPC (OLE for process control).

(d) ONVIF,

(e) DALI.

.2 Integral systems integration functionality:

.1 provide hardware and software to allow bi-directional digital communications between BAS and facility control subsystems including:

(a) HVAC,

(b) fire safety including fire alarm systems,

(c) security systems,

(d) power control and monitoring systems,

(e) lighting control systems,

(f) 3rd party integration with other facility systems.

.3 OEM Controller integration:

.1 provide hardware and software to allow bi-directional digital communications between BAS and 3rd party manufacturers' equipment control panels including but not limited to;

(a) boilers,

(b) chillers,

(c) variable frequency drives,

(d) packaged HVAC equipment,

(e) power monitoring equipment,

(f) medical gas equipment.

.2 integrate real-time data from these systems.

2.5 BMS Network Architecture

.1 Refer to specification section 25 05 06 for work required on existing BAS networks.

2.6 Performance

.1 General:

.1 information transmission and display times are based upon network connections,

.2 test systems using manufacturer's recommended hardware and software for operator interface.

.2 Performance criteria:

.1 Graphic Display;

(a) display graphic with 50 dynamic points with current data within 10 seconds.

.2 Graphic Refresh;

(a) update graphic with 50 dynamic points with current data within 10 seconds and

(b) automatically refresh every 15 seconds.

.3 Configuration and Tuning Screens;

(a) special screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic to refresh every 5 seconds.

.4 Object Command response;

(a) time between command of binary object at GUI and onset of reaction by device to be less than 5 seconds,

(b) time between command of analog object at GUI and start of adjustment to be less than 5 seconds.

.5 Alarm Response Time;

(a) time between when an object goes into alarm and when it is annunciated at GUI to be less than 15 seconds.

.6 Program Execution Frequency;

(a) execution repeat frequency to be selected in manner consistent with process under control,

(b) custom and standard applications to be capable of executing as often as once every 5 seconds.

(c) programmable controllers to be able to perform PID control loop routines at selectable frequency, adjustable at GUI down to once every second.

(d) workstations connected to network to receive alarms with not more than 5 seconds spread between first and last annunciation.

2.7 Capacity for Future Expansion

.1 Tier 1 network;

.1 network backbone to have capacity for future 50 routers or building controller/routers in addition to connected devices at time of acceptance of the Work,

.2 each router or building controller/router on network backbone to have routing capacity for 50 controllers.

2.8 Wiring and Conduit

.1 Wire and conduit for power wiring, control wiring, and communication wiring to conform to specification section 20 05 12.

3 EXECUTION

3.1 Examination

.1 Inspect site and thoroughly examine documents to establish locations for control devices and equipment and report discrepancies, conflicts, or omissions for resolution before starting rough-in work.

.2 Be responsible for correction of defects caused through neglect of inspections and examinations or failure to report and resolve discrepancies.

3.2 Protection

.1 Protect work and material against damage during construction and be responsible for work and equipment until inspected, tested, and accepted.

.2 Protect material not immediately installed and seal connector terminations with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

.3 Protect electronic equipment from elements during construction.

3.3 Coordination

.1 Coordinate and schedule BAS work with other work in same area to ensure orderly progress.

.2 Testing and balancing:

.1 Supply sets of tools of sufficient quantity for Testing and Balancing Technicians to interface to control system, train these technicians in use of tools, and provide qualified Control Technician to assist with testing and balancing the first 10 terminal units.

.2 Tools to be turned over to Owners on completion of testing and balancing.

.3 Controls work by others:

.1 Integrate and coordinate this control work with controls and control devices provided or installed by others.

.2 Each supplier of control product to configure, program, start up, and test that product to satisfy requirements of Sequence of Operation regardless of where within contract documents product is specified or described.

.3 Resolve compatibility issues between control products provided under this Division and those provided under other Divisions of the Work.

3.4 General Workmanship

.1 Installation to be performed by skilled and certified technicians.

.2 Install equipment, piping, and wiring or raceways horizontally, vertically, and parallel to building lines.

.3 Provide sufficient slack and flexibility in connections to allow for vibration isolation between conduit, raceways, piping and equipment.

.4 Install instrumentation and devices in locations providing adequate ambient conditions.

.5 Protect components placed in areas of potentially high humidity.

3.5 Wiring for Power, Control and Communications

.1 Provide wire and raceways (conduit) for power wiring, control wiring, and communications wiring for BAS controllers and associated instrumentation and actuation devices, at voltages of 120 V and under, in accordance with specification section 20 05 12 and, for greater clarity, Schedule A appended to that specification section.

.2 Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.

3.6 Cleaning

.1 Clean up debris, remove packaging material, collect waste and place in designated location, on a daily basis.

.2 Keep work areas free from dust, dirt, and debris.

.3 On completion of work, check finish of equipment provided under this section for damage and repair damaged factory-finished paint, replace deformed cabinets and enclosures with new material, and repaint to match original.

.4 Prior to hand-over to the Owner, clean the inside of control panels;

.1 remove debris and vacuum clean internal components,

.2 the use of low-pressure dry nitrogen or inert compressed gases may be used to blow dust and debris out of panels where the use of such pressurized gases will not damage equipment or loosen wiring terminations,

.3 after cleaning, apply a label to the exterior side of the panel to identify the date the panel was cleaned and the initial of the person who cleaned the panel.

3.7 Field Quality Control

.1 Ensure work, materials, and equipment comply with this specification and reviewed shop drawings.

.2 Monitor field installation for applicable safety and building code compliance and workmanship quality.

.3 Arrange and pay for inspections by local or provincial authorities having jurisdiction over the work.

3.8 Identification of Equipment

.1 Manufacturers' nameplates and product certification labels to be visible and legible after equipment is installed.

.2 Identify discrete items of equipment with plastic nameplates or plasticized labels, identifying equipment and function. Identification plates are in addition to manufacturers nameplates.

.3 Identification plates:

.1 provided for equipment identified with number designations in schedules and equipment shop drawings.

.2 marked with equipment type, number and service following wording and numbering used in contract documents and shop drawings,

.3 plastic laminated labels,

.4 white face and black background field,

.5 minimum size 75 mm x 40 mm x 3 mm (3 in x 1½ in x 1/8 in),

.6 engraved or printed with 6.5 mm (1/4 in) high lettering.

.7 securely attached to equipment with brass chains.

.4 Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 50 mm (2 in) of termination.

.5 Label pneumatic tubing at each end within 50 mm (2 in) of termination with descriptive identifier.

.6 Permanently label or code each point of field terminal strips to show instrument or item served.

.7 Label each control component with permanent label. Label plug-in components so that label remains stationary during component replacement.

.8 Label room sensors related to terminal boxes or valves with nameplates. Place labels on back of sensors.

.9 Identify motor controllers that are remotely controlled by the BAS with self-adhesive labels, black letters on white background with a red border and electric shock warning icon, with wording as follows;

3.9 Checkout and Testing

.1 Provide schedule for start-up and testing.

.2 Calibrate and prepare for service equipment, instruments, controls, and accessories.

.3 Start-up testing to verify completion of control system before system demonstrations begin;

.1 verify that control wiring is connected and free of shorts and ground faults. Verify that terminations are tight,

.2 enable control systems and verify input device calibration,

.3 verify that binary output devices operate and that normal positions are correct,

.4 verify failure positions of dampers and control valves are correct when power/compressed air is deenergized to the device,

.5 verify that analog output devices are functional, that start and span are correct, and that direction and normal positions are correct,

.6 check control valves and automatic dampers for proper action and closure and adjust valve stroke/rotation and damper blade travel,

.7 verify that damper and control valve feedback signals are correct when device is stroked fully open and closed (two position) and at any opening position between zero and fully open (modulating devices),

.8 verify that system operates according to Sequences of Operation. Simulate changes in variables by overriding and varying inputs and schedules and observe and record each operational mode response.,

.9 tune PID loops and control routines to provide stabile operation and to minimize valve and damper hunting,

.10 check each alarm with an appropriate signal at value that will trip alarm,

.11 trip interlocks using field contacts to check logic and to ensure that actuators fail in proper direction,

.12 test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

.4 Prepare and submit test log documenting start-up testing of each input and output device and each control routine, with technician's initials certifying each device and each routine is functioning correctly and sensors have been calibrated. Include list of deficiencies and a workplan schedule setting out rectification program with time lines.

3.10 Testing of Integrated Life Safety and Fire Protection Systems

.1 Comply with the requirements of specification section 20 08 11 for the testing of the integration of controls and communications between the BAS and life safety and fire protection systems.

3.11 Control System Demonstration

.1 Obtain approval of start-up testing log and rectification program before scheduling demonstrations.

.2 Provide notification to Owner and Consultant not less than 10 business days before system demonstration begins.

.3 Demonstration to follow previously submitted and approved procedures;

.1 submit checklists and report forms for each system as part of demonstration,

.2 lists and forms to have initials of technicians conducting demonstrations,

.3 date of each demonstration and signatures of Owner's representatives witnessing each demonstration section.

.4 Prior to acceptance, perform the following operating tests in the presence of the Owner or Owner’s representative and Consultant to demonstrate system operation and compliance with specification after and in addition to tests specified above in article Checkout and Testing.

.5 Demonstrate field operation of;

.1 each Sequence of Operation,

.2 Operator Interface,

.3 control loop response with graphical trend data output showing;

(a) each control loop response to set point change producing an actuator position change of at least 25% of full range.

(b) trend sampling rate to be from 10 seconds to 3 minutes, depending on loop speed,

(c) loop trend data to show set point, actuator position, and controlled variable values,

(d) documentation of further tuning of any loop that displays significantly under- or over-damped control

.4 demand limiting routine with trend data output showing demand-limiting algorithm action;

(a) trend data to document action sampled each minute over at least 30-minute period and to show building kW, demand-limiting set point, and status of set-points and other affected equipment parameters.

.5 control integration with life safety and fire protection systems,

.6 trend logs for system points as selected by the Owner with;

(a) trend data to indicate set-points, operating points, valve positions, and other data as specified in points list provided with each Sequence of Operation,

(b) each log to cover three 48-hour periods and to have sample frequency not less than 10 minutes, except where a Control Sequence specifies other time intervals,

(c) show that trend logs are accessible through operator interface and can be retrieved for use in other software programs.

.7 substantiate calibration and response of any input and output points requested,

.8 provide at least two technicians equipped with two-way communication,

.9 provide and operate test equipment to establish calibration and prove system operation.

.6 Tests that fail to demonstrate system operation are to be repeated after repairs and/or revisions to hardware or software is completed.

3.12 Training

.1 Materials:

.1 provide course outline and materials for each class at least four (4) weeks before first class,

.2 provide training through instructor-led sessions, with computer-based, or web-based techniques,

.3 instructors to be factory-trained and experienced in presenting this material,

.4 perform classroom training using network of working controllers representative of installed hardware.

.2 Operating staff training:

.1 provide training for Owners operating staff using abovementioned training materials in self-paced mode, web-based or computer-based mode, classroom mode, or combination of these methods,

.2 allow for 1 repeat sessions for each category to cover operator shift rotation.

.3 Training to enable students to accomplish following objectives:

.1 Group 1:

(a) proficiently operate system,

(b) understand control system architecture and configuration,

(c) understand BAS system components,

(d) understand system operation, including BAS system control and optimizing routines (algorithms),
(e) understand Sequence of Operations,
(f) operate workstation and peripherals,
(g) log on and off system,
(h) access graphics, point reports, and logs,
(i) adjust and change system set-points, time schedules, and holiday schedules,
(j) recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools,
(k) understand system drawings and Operation and Maintenance manual,
(l) understand project layout and location of control components,
(m) access data from BAS controllers,
(n) set-up trend logs,
(o) operate portable operator's terminals

.2 Group 2:
(a) create and change system graphics,
(b) create, delete, and modify alarms, including configuring alarm reactions,
(c) create, delete, and modify point trend logs (graphs) and multi-point trend graphs,
(d) configure and run reports,
(e) add, remove, and modify system's physical points,
(f) create, modify, and delete application programming,
(g) add and configure GUIs,
(h) add new controller to system,
(i) download firmware and advanced applications programming to controller,
(j) configure and calibrate I/O points.

.3 Group 3:
(a) maintain software and prepare backups,
(b) interface with job-specific, third-party operator software,
(c) add new users and understand password security procedures.

.4 Divide presentation of objectives into three sessions:
.1 Group 1: Day-to-day Operators,
.2 Group 2: Advanced Operators,
.3 Group 3: System Managers and Administrator,
.4 participants will attend one or more sessions, depending on knowledge and expertise level required,
.5 provide each student with one copy of training material.

3.13 Acceptance

.1 Application for substantial performance of the Work requires as a prerequisite the completion of the BAS including testing, demonstration, and submittal of required documentation, except where the Owner agrees to differ any work to a later date.

.2 In support of an application for substantial performance, submit a signed declaration to the Owner certifying that:

.1 the BAS is complete and operating in accordance with the contract documents,

.2 control system checkout and testing is completed,

.3 control system demonstration is completed,

.4 training is completed,

.5 as-built documentation is completed and turned-over to the owner.

.3 Certification document may identify tests that cannot be performed due to extenuating circumstances such as weather conditions, where previously agreed to be deferred to a later date by the Owner. Append a program for completion of deferred work to the certification document for rectification and completing these tests during warranty period.

3.14 Correction After Completion

.1 After start-up, testing, and commissioning phase has been completed and satisfactory and reliable operation of equipment and systems has been demonstrated, acceptance of the system is to be given by Owner. Warranty period to begin on date established on certificate of acceptance.

.2 Provide updates and patches to resolve software deficiencies in operator workstation or web server software, project-specific software, graphic software, database software, and firmware during warranty period.

.3 Provide upgrades that improve routines and procedures of operator workstation software, web server software, project-specific software, graphic software, or database software, free of charge, during warranty period.

.4 Provide details of proposed changes and obtain written authorization from Owner before installation of updates, patches, or upgrades.

.5 Include preventative maintenance, with allowance for spare parts, labour, and emergency (24 hour) service for system and equipment during warranty period.

.6 Equipment manufacturers to submit written undertakings to make circuit board repairs and provide spare parts, software support and patches, and technical assistance for at least five years after acceptance is certified.

End of Section

WORK ON EXISTING BUILDING AUTOMATION
25 05 06

1 GENERAL

1.1 Scope

.1 Modifications to existing building control systems including:

.1 connection to of new BAS networks to the existing building BAS networks,

.2 connection of new control devices to existing BAS networks,

.3 selective demolition of existing building controls,

.4 modifications and upgrades of existing BAS.

1.2 Designated Controls Contractor

.1 BAS work shall be performed by ESC Automation/Ainsworth as the base building controls contractor authourized by the Owner to perform such Work.

1.3 Design Criteria

.1 Existing BAS networks:

.1 Tier 1: dedicated BACnet /IP

.2 Tier 2: BACnet MSTP

1.4 Submittals

.1 Shop drawings:

.1 In addition to the requirements of section 25 05 01, submit the following information as a shop drawing:

(a) documentation of existing sequence of operations for applicable equipment and systems affected by the Work.

2 PRODUCTS

2.1 General

.1 Conform to specification section 25 05 01 and other sections of Division 01 except as specified herein.

3 EXECUTION

3.1 Existing Equipment

.1 Reuse of control components:

.1 reuse existing equipment and components as listed below where condition and conformance with this specification permits;

(a) valves and operators,

(b) dampers and operators,

(c) compressed air system,

(d) thermocouple wells,

(e) freezestats,

(f) firestats,

(g) limit, end, or level switches and air or liquid flow switches,

(h) static pressure sensors and controllers,

(i) wiring and conduit for safety controls and I/O points,

(j) relays,

(k) cabinets,

(l) other items specifically noted as existing, to be re-used.

.2 Remove and replace existing temperature and humidity sensors with new units, throughout the installation,

.3 Check and re-calibrate existing indicator gauges,

.1 under no circumstances are existing gauges or thermometers be removed.

.4 Re-calibrate valves and dampers as part of installation of this system.

.5 Existing thermowells for conventional control system may be reused for new sensors,

.1 repack temperature wells, both new and reused, with heat conductive grease.

3.2 Existing Programming and Configuration

.1 Document existing control device programming, configuration, and setpoint values at the start of the work, prior to any demolition or other work on existing control equipment.

.2 For each NSC or ASC being replaced, review the existing control programming and/or configuration settings, and prepare a written sequence of operation in laymen terms that describes the operating control of each control device. Where multiple control devices of the same type exist (e.g. terminal units), review at least three (3) randomly selected controllers to verify the same control functions; a single written control sequence for each type controller is sufficient.

.3 Provide a copy of these documentation to the Owner.

.4 Except where otherwise specified for new sequence of operations, program and/or configure software for replacement NSC and ASC to achieve the same control functionality and sequence of operation of the pre-existing NSC and ASC controllers, and configure setpoints to match pre-existing controller values.

3.3 Existing Condition Survey

.1 Conduct a condition survey of existing control devices:

.1 test, inspect and report on existing devices which are to be incorporated into the BAS, for satisfactory operation within 30 days of award of contract and prior to installation of any new devices,

.2 for those items found in unacceptable condition, provide with report test data, original specification sheets or written functional requirements to confirm conclusion,

.3 Owner to arrange for repair or replacement of those existing items judged defective, but shown to be re-used in BAS and control system,

.4 items thus repaired or replaced by Owner will be returned to site and handed over to Contractor under this Section for storage, installation, testing, and commissioning.,

.5 warrant reused devices that have been rebuilt or repaired. Demonstrate satisfactory operating condition of reused devices at time of acceptance,

.6 responsibility for existing control devices that have been reused is to terminate at end of warranty period.

3.4 Demolition and Removals

.1 Unless specifically noted or shown otherwise, remove existing control components made redundant:

.1 room thermostats, controllers, auxiliary electronic devices, pneumatic controllers and relays, control valves, electronic sensors, and transmitters: to be removed and placed in storage as directed by Owner.

.2 local control panels: removed and placed in storage as directed by Owner.

.2 Remove and dispose of existing conduits, wiring and tubing in all areas (including above accessible ceilings) as they become redundant;

.1 remove existing control compressed air systems and, where applicable, connect to new control air system;

.2 existing hardwired interlocks to remain installed in systems.

.3 In existing areas not otherwise involved in renovations, arrange and pay for holes and marks left by decommissioning and removal of control components, wiring, conduit, and tubing to be patched and refinished to match existing.

3.5 Maintaining Existing System Operation

.1 Mechanical systems to remain in operation and to maintain space conditions between hours of 6 a.m. and 9 p.m., Monday through Friday.

.2 In these periods mechanical control system shut downs of up to 15 minutes may be permitted, after obtaining written agreement from Owner.

.3 When time required for cut-over of controls will not meet these constraints, perform work outside of operating hours after making application; outlining areas affected; and likely length of interruption, and obtain written agreement from Owner. .

.4 Maintain fan scheduling using existing or temporary time clocks or control systems throughout period of control system installation.

.5 Modify existing motor controllers to incorporate new local operator control switches for motors to be controlled through BAS system.

3.6 Installation of New Thermowells

.1 Existing piping services to remain in service during installation of thermowells.

.2 Coordinate with the trade contractor under Division 23 to install thermowells for new temperature sensors mounted on steel piping by hot-tapping in accordance with specification section 20 05 26.

3.7 Interfacing Between New and Existing Control Systems

.1 Certain building systems are to operate in event of building power failure or fire alarm. Under no circumstances should interfacing of equipment or controls modify these existing sequences of operation.

.2 Where tying new system into existing control equipment, show on shop drawings;

.1 signal levels,

.2 wire type,

.3 wire numbers, and

.4 terminal numbers.

.3 Before attempting replacement of existing control systems, install new field panels, controllers and associated devices loose-ended ready for system changeover.

.4 Submit written request to Owner setting out proposed starting time for changeover, duration of system down time, and establishing extent of interruption to operation of existing control system.

.5 Do not proceed with work until Owner's written approval of time for, duration of, and extent of interruption is received.

.6 Subsequent decommissioning and removal of control components to be carried out without interfering with normal operations or creating an interruption in service of any building systems except through an approval process similar to that noted above.

END OF SECTION

B.A.S. INSTRUMENTATION AND ACTUATORS
25 35 01

1 GENERAL

1.1 Scope

.1 Provide Instrumentation, dampers, control valves, and Actuators for Building Automation System.

.2 Provide actuators for operating dampers provided as part of factory built air handling units.

2 PRODUCTS

2.1 General

.1 Provide equipment which functions and meets detailed performance criteria when operating in following minimum ambient condition ranges:

.1 Temperature - 0°C to 32.2°C (32°F to 90°F)

.2 Relative Humidity 10% to 90% non -condensing

.3 Electrical power service of single phase, 120 VAC +/- 10%, 60 Hz nominal.

.2 Components installed within motor control devices to be designed to operate with transient electrical fields occurring within these devices.

2.2 Power Supplies and Line Filtering

.1 Power Supplies:

.1 control transformers to be UL listed,

.2 line voltage units to be CSA listed,

.3 provide over-current protection in primary and secondary circuits,

.4 limit connected loads to 80% of rated capacity.

.2 DC power supplies:

.1 output to match equipment current and voltage requirements,

.2 units to be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation to be 1.0% line and load combined, with 100-microsecond response time for 50% load changes,

.3 units to have built-in over-voltage and over-current protection and to be able to withstand 150% current overload for at least three seconds without trip-out or failure,

.4 units to operate between 0°C and 50°C (32°F and 120°F). EM/RF to meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.

.3 Power Line Filtering:

.1 provide internal or external transient voltage and surge suppression for workstations and control modules,

.2 surge protection:

(a) dielectric strength of 1000 V minimum,
(b) response time of 10 nanoseconds or less,
(c) transverse mode noise attenuation of 65 dB or greater,
(d) common mode noise attenuation of 150 dB or greater at 40-100 Hz.

2.3 Control Valves

.1 General:

.1 Body and trim materials selected in accordance with specification for globe valves, ball valves, or high performance butterfly valves, and in accordance with manufacturer's recommendations for design conditions and service.

.2 Size control valves for pressure drops and heating and cooling loads as scheduled with same pressure rating as globe valves under same service and pressure conditions.

.3 Size valves for two port and three port, two position service;

(a) line size,
(b) ball valves, sizes NPS 1 ½ and smaller,
(c) butterfly valves, sizes NPS 2 and larger.

.4 For two port and three port modulating service;

(a) use globe valves for CV rating 160 and smaller,
(b) use butterfly valves for CV rating above 160.

.5 Select butterfly valves based on CV rating at 70° rotation

.6 actuator and trim selected for close-off pressure ratings as follows;

(a) two-way modulating or two position service; 150% of pump shut off head.
(b) three-way modulating service; 300% of pressure differential between ports A and B at design flow or 100% of pump shut off head.
(c) shut off head to be based on maximum rpm when pump is fitted with VFD

.7 sized as follows;

(a) for two-position service; line size.
(b) for valves for radiation, terminal units and reheat coils;
- pressure drop of 7kPa (1 psig)

2.4 Electric/electronic actuators - valves

.1 Valve actuators for service other than radiation, radiant panel and reheat coil valve applications:

.1 sized and selected in accordance with manufacturer’s specifications,

.2 electric/electronic for two position, or proportional control action, coupled to valves with linkage,

.3 electronic interface control board, solid state drive, reversible motor, oil immersed gear train,

.4 electronic overload or digital rotation sensing circuitry to protect damper operator through entire range of rotation,

.5 span and zero travel adjustment,

.6 position feedback signal on actuators used for proportional control,

.7 provision for manual positioning of valve when actuator is not powered,

.8 spring return mechanism to return valve to “normal” position on power failure (i.e. Normally Open (NO), or Normally Closed (NC)),

.9 control signals:

(a) 0 to 10VDC or 0 to 20ma,
(b) modulate damper position with 2 to 10VDC or 4 to 20ma input signal operating range when in proportional service.
(c) input type and range as suitable for interfacing to output of BAS controller

.10 feedback signals:

(a) two independent adjustable travel limit switches and wiring to BAS for indication of valve position.

.11 general purpose, drip proof NEMA 2 die-cast housing with corrosion resistant steel cover for indoor applications, watertight NEMA 4 enclosure for outdoor use,

.12 electric actuators suitable for operation down to -35°C where installed outdoors.

.2 Valve actuators for service on radiation, radiant panel, and reheat coil valve applications:

.1 output shaft driven by gear train mechanism.

.2 reversible motor with automatic load limit,

.3 input type and range as suitable for interfacing to output of BAS controllers,

.4 adjustable span and offset travel ,

.5 position feedback signal on actuators used for proportional control,

.6 general purpose, dustproof, die-cast aluminum housing,

.7 actuator rotation limit.

2.5 Electrical devices

.1 Current sensing relays:

.1 metering transformer ranged to match load being metered,

.2 plug in base and shorting shunt to protect current transformer when relay is removed from socket,

.3 current transformer for single or three phase metering connected into single relay,

.4 adjustable latch level, adjustable delay on latch and minimum differential of 10% of latch setting between latch level and release level,

.5 discrimination between phases in three phase applications to allow worst case selection,

.6 mounted in motor starter enclosure and fed from starter control transformer,

.7 relay contacts capable of handling 10 amps at 240 volts.

.2 Current transducer:

.1 output signal proportional to measured line current,

.2 output signal in one of following ranges; 4-20 mA, 0-5 Vdc or 0-10 Vdc

.3 Control Relays:

.1 plug-in type, UL listed, with dust cover and LED "energized" indicator.

.2 contact rating, configuration, and coil voltage suitable for application.

.3 NEMA 1 enclosure for relays not installed in local control panels.

.4 Time Delay Relays:

.1 solid-state plug-in type, UL listed, with adjustable time delay adjustable ±100% from set point shown.

.2 contact rating, configuration, and coil voltage suitable for application.

.3 NEMA 1 enclosure for relays not installed in local control panels.

.5 Override Timers:

.1 spring-wound line voltage, UL Listed, with contact rating and configuration by application unless implemented in control software.

.2 0-6 hour calibrated dial.

.3 flush mounted on local control panel face.

.6 AC Current Transmitters:

.1 self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output.

.2 full-scale unit ranges of 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment.

.3 ±1% full-scale accuracy at 500 ohm maximum burden.

.4 UL/CSA listed and meet or exceed ANSI/ISSA 50.1 requirements.

.7 AC Current Transformers:

.1 UL/CSA listed

.2 completely encased (except for terminals) in approved plastic material.

.3 selected for appropriate current ratios with ±1% accuracy at full-scale output.

.4 fixed-core transformers for new wiring installation

.8 AC Voltage Transmitters:

.1 self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.

.2 adjustable full-scale unit ranges; 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac.

.3 ±1% full-scale accuracy at 500 ohm maximum burden.

.4 UL/CSA listed, 600 Vac rated and conforming to ANSI/ISSA 50.1.

.9 AC Voltage Transformers:

.1 UL/CSA listed, 600 Vac rated with built-in fuse protection.

.2 suitable for ambient temperatures of 4°C to 55°C (40°F to 130°F) and

.3 ±0.5% accuracy at 24 Vac and 5 Vac load.

.4 windings (except for terminals) enclosed with metal or plastic.

.10 Power Monitors:

.1 three-phase type with three-phase disconnect and shorting switch assembly,

.2 UL listed voltage transformers, and

.3 UL listed split-core current transformers.

.4 selectable output either rate pulse for kWh reading or 4-20 mA for kW reading.

.5 maximum error of ±2% at 1.0 power factor or ±2.5% at 0.5 power factor.

.11 Current Switches:

.1 self-powered, solid-state type with adjustable trip current

.2 integral current transformers and relays to indicate motor status

.3 SPDT output relay suitable for use as digital input

.4 field adjustable output relay trip setting, over 0-100% of range. Deadband adjustment to maximum of 10% of range

.5 integral zero-leakage LED’s indicating sensor power and switch status

.6 long term setting drift of current transformer and relay combination not more than 5% full range over 6 months

.7 over current and over voltage protection for current transformer and relay

.8 operating temperature range; -10°C to 50°C (14°F to 122°F)

.9 operating humidity range; 5% to 90% RH non condensing

.12 Electronic signal isolation transducers:

.1 provided whenever;

(a) an analog output signal from BAS is connected to an external control system as an input (such as chiller control panel) or
(b) BAS is to receive an analog input signal from an external remote system.

.2 designed for ground plane isolation between systems.

2.6 Wiring and Raceways

.1 Wiring, conduit, and raceways to Section 20 05 13.

.2 Wire used for power and control:

.1 insulated copper conductors,

.2 UL listed for minimum 90°C (200°F) service.

.3 Power wiring minimum 12 gauge.

.4 Control wiring for digital functions: 18 AWG minimum with 300 Volt insulation.

.5 Control wiring for analog functions: 18 AWG minimum with 300 Volt insulation, twisted and shielded, 2 or 3 wire to match analog function hardware.

.6 Transformer current wiring: 16 AWG minimum.

.7 Sensor wiring: 22 AWG minimum twisted and shielded, 2 or 3 wire to match analog function hardware. Provide additional conductors as to support supplemental features of sensor (i.e. set-point adjustment, override, etc.)

3 EXECUTION

3.1 Installation of Sensors

.1 General:

.1 Mount sensor assemblies and elements;

(a) in clean areas wherever possible,
(b) accessible to allow for replacement and servicing without interfering with access for adjacent equipment and personnel traffic in surrounding space,
(c) provide access doors where assemblies and elements are concealed.

.2 Install transmitters, transducers, controllers, solenoid air valves and relays in NEMA2 enclosures;

(a) install wiring and tubing within enclosures in trays or individually clipped to back of panel with identification tags and terminal numbers visible.

.3 Rigidly support field mounted transmitters, transducers, and sensors on pipe stands or channel brackets.

.4 Orient sensing elements to correctly sense measured variable and to be isolated from vibrations and environmental conditions that could affect measurement or calibration.

.5 Identify each cable and wire at every termination point.

.6 Air seal wires attached to sensors at entry into junction box.

.2 Temperature sensors:

.1 Install room temperature sensors on concealed junction boxes supported by wall framing.

.2 Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in serpentine manner vertically across duct. Support each bend with capillary clip.

.3 Install mixing plenum low-limit sensors in serpentine manner horizontally across duct. Support each bend with capillary clip. Provide sensor element length to coil area ratio of 3 m per 1 m^2 (1 ft per 1 sq ft).

.4 Install pipe-mounted liquid temperature sensors in wells with heat-conducting material. Where thermowell installation necessitates shutting down of pumps or draining of pumps, coordinate with Consultant and Owner.

.5 Cut and recover piping insulation to one foot either way for installation of strap-on temperature sensors. Provide removable insulation box over sensor and patch insulation to match existing.

.6 Install outdoor air temperature sensors on north facing wall with sun shield.

.7 Mount space temperature and humidity sensors 1200 mm (4 ft) above finished floor.

3.2 Actuators

.1 General:

.1 Mount actuators and adapters according to manufacturer's recommendations.

.2 Valve Actuators:

.1 Connect actuators to valves with adapters approved by actuator manufacturer.

END OF SECTION

B.A.S. SEQUENCE OF OPERATIONS
25 90 01

1 GENERAL

1.1 Definitions

.1 System Start: actions required at system start-up under schedule control or on re-start after power failure.

.2 Normal Operation: normal control sequence after initial start-up requirements are satisfied.

.3 Demand Limiting: special operation parameters during normal utility power outages (emergency generator operation)

.4 System Stop: shut-down of system under schedule control and fail-safe position of system in event of loss of normal power.

.5 Fire Alarm: action required in the event of a signal from the fire alarm system (FA).

.6 Schedule: scheduled operation of system

.7 Alarm: minimum alarm points required.

.8 Emergency Power: control system elements to be fed from emergency power, refer to electrical drawings.

2 EXECUTION

2.1 Sequence of operation and control drawings

.1 Control sequences that follow describe and detail suggested method of control of systems.

.2 Control drawings listed for each control sequence illustrate required inputs and outputs for the control and monitoring of systems.

.3 Review sequence of operation described for each system and allow for additional input and output points to achieve method of control described. Review documents to determine quantity of each piece of equipment or system.

.4 Sequences of Operation

- .1 CS 100 Split Air Conditioner – Cooling Only
- .2 CS 408 Existing AHU11 & AHU12
- .3 CS 436 Existing Residential Care Patient Room Ventilation & Temperature Control

END OF SECTION

CS-100 - Condensing Units - Cooling Only

Reference:

Applicable Systems: CU-2, CU-3

System Start: Outdoor air temperature TO above 18°C, field adjustable. CU units energized. Manual startup by building operator. BAS to notify building operator that CU units are energized.

Normal Operation: Condensing units operate to maintain a minimum supply air setpoint of no lower than 16°C, field adjustable. Monitored by duct mounted thermostat.

System Stop: Condensing unit stop unit stop is initiated by operator command through the BAS or when the supply air temperature drops cooling set point of 15.6°C.

Fire Alarm: N/A

Smoke Control: N/A

Schedule: Manual on/off switch (controlled by hospital staff) but when switched on system is in operation 24/7

Monitor: Space temperature from room thermostat and supply air temperature from duct mounted thermostat.

Alarm:

LT1	AHU supply temperature below 15.6°C.
T1	Space temperature out of range – high: 2°C above setpoint; low: 2°C below setpoint
HL1	Drip pan high level float switch.

Emergency Power: No

CS-408 – Existing AHU 11 AHU 12

*Fort St. John Residential Care Cooling Upgrade project changes to the base building sequence of operation will be marked in red.

1	**CS408 – AHU11/12**	
2	Air handlers AHU-11 and AHU12 each serve one of the residence buildings. Tempered fresh air is supplied to both floors of each building, and return/exhaust air is ducted back. Each AHU is located on the roof, and have a walk-in compartment for service and maintenance.	
4	Each air handling unit consists a supply fan c/w variable frequency drive (VFD), exhaust fans c/w variable frequency drive (VFD), a heat wheel c/w a variable frequency drive (VFD), a glycol heating and pre-heating coil complete with a modulating two 2-way control valves and a 'switching' isolation valve, an outdoor and exhaust air damper, a humidifier and filters. The following sequence of operation is typical of all 8 units.	
5	The supply fan and exhaust fan numbering on the air handling units is as follows: AHU-11: Supply Fans F-123 Exhaust Fans F-124 AHU-12: Supply Fans F-125 Exhaust Fans F-126	
6	Each air handling unit runs continuously.	
7		
8	1 ***Unoccupied Mode (In the event that an air handling unit needs to be turned off):***	
9	The supply fans and associated variable frequency drives are off.	
10	The exhaust fans and associated variable frequency drives are off.	
11	The heat wheel and associated variable frequency drive is off.	
12	The outdoor and exhaust air dampers are closed.	
13	The heating valve is modulated to maintain an heating plenum chamber temperature of 15degC (to avoid tripping the mechanical freeze stat safeties)	
14	The cooling valve is closed.	
15	2 The humidifier is off.	
16	***3***	
17	***4 Occupied Mode:***	
18	***System Start Up:***	
19	Upon system start up, the outdoor air and exhaust air dampers are commanded open.	
20	Once the outdoor air damper is proven open by the damper end-switch, the supply fan will ramp up to a minimum position of 30%. The fans variable frequency drives then controls the fans to maintain the static pressure setpoint. The static pressure setpoint (initially set at 250 Pa) will be set during balancing and commissioning.	
21	Once the exhaust air damper is proven open by the damper end-switch, the exhaust fan will ramp up to a minimum position of 30%. The fans variable frequency drives then controls the fans to maintain the static pressure setpoint. The static pressure setpoint (initially set at 250 Pa) will be set during balancing and commissioning.	
22	Outdoor air below 12°C: The supply air temperature setpoint will be initially set to 35°C as the dampers open. The increased setpoint will drive the valves open more, thus pre-loading the glycol coils for the sudden inrush of cold air. This will also avoid the chance of cold air reaching the water reheat coils in the space. Once the temperature sensors have had a few minutes to acclimatize, the setpoint will be reset down 0.5°C/minute until the system calculated operation setpoint is reached.	
23		
24	***Supply Air Temperature Control:***	
25	The supply air temperature setpoint (SAT_SP) is initially set to 14°C. The setpoint will be reset by the position status of the reheat coil valves. SAT_SP is decreased by 0.5°C every 15 minutes:	

	• Start decreasing when any reheat valve is fully closed • Stop decreasing when every reheat valve is greater than 10% open SAT_SP is increased by 0.5°C every 15 minutes: • Start increasing when every reheat valve is greater than 20% open • Stop increasing when one reheat valve is open less than 10% open SAT_SP is limited between 13°C and 23°C. *Note – Cooling is limited to the temperature of the outdoor air.*	
26	The supply air temperature controller will enable and modulate the heat wheel speed and cooling coil control valve to maintain the supply air temperature setpoint.	
27	Heat/cooling recovery is available when: Heating Recovery Available (yes) = RAT > (OAT+2.5°C) Heating Recovery Available (no) = RAT < (OAT+1) Cooling Recovery Available (yes) = RAT < (OAT-2.5°C) Cooling Recovery Available (yes)) = RAT > (OAT-1) *(Note – RAT = Return air temperature, OAT = Outdoor air temperature*	
28	Maintaining Supply Temperature Setpoint (Heating Demand): 1. 1st Stage: If heat recovery is available the heat-wheel will be enabled and the wheel speed will be modulated as the first stage of heat to maintain SAT_SP *(Speed = 30→100%)*. If heat recovery is not available, the heat-wheel will be disabled. 2. 2nd Stage: Water through the heating-coil will be modulated. Heating valve #1 will be modulated to 100% first, then heating valve #2	
29	Maintaining Supply Temperature Setpoint (Cooling Demand): 1. 1st Stage: If cooling recovery is available the heat-wheel will be enabled and the wheel speed will be modulated as the first stage of cooling to maintain SAT_SP *(Speed = 30→100%).* If heat recovery is not available, the heat-wheel will be disabled. ~~2. Without a cooling coil, this unit is limited to the outdoor air temperature for supply, and any reclaimed cooling from the recovery wheel.~~ 2. When outdoor air temperature above 18°C (field adjustable) CU-2 & CU-3 will energize. BAS will notify building operator that CU-2 & CU-3 are energized. Building operator will then manually turn on CU-2 & CU-3. 3. Cooling supply air setpoint to be no lower than 16°C (field adjustable). 4. Heating valves will be closed.	
30	Heating valves #1 and #2 will be staged for modulation. The lead/lag sequencing will be rotated to ensure equal valve wear. *(Switchover time can be adjusted on the graphics, initially set for 172hrs)*	
31	A 2-position switching valve isolates the heating coil. If there is a heat wheel or pre-heating coil fault, the switching valve will open and the heating-coil will be used. Once the fault is cleared, the operator will acknowledge on the graphics, and the switching valve will return to its normal operation (closed).	
32	If the heat wheel has been disabled for more than 24 hours, it will be enabled and rotated approximately 1-1/2 revolutions. *(Enabled at minimum 30% speed for the approximate time for the rotations)*	
33	A software safety will start to limit the speed of the supply fan in the event that the supply temperature starts to decrease below 10°C. This is in case of a situation where there is a heat wheel failure, and the heating valves are in the process of opening to recover.	
34		
35	***Heat Wheel Frost Control:***	
36	The frost point temperature will be calculated using the return air temperature/humidity and the outdoor air temperature plotted on a psychometric chart. A minimum setpoint for the exhaust air temperature will be created a degree above the frost temperature.	
37	As the exhaust air temperature reaches the frost point, the heating valve minimum limit will be increased from the starting value of 0%. This minimum limit will be modulated to maintain the exhaust temperature above its setpoint.	

38		
39	***Supply Fans Static Pressure Control:***	
40	The supply fans speeds will adjust to maintain the duct static pressure setpoint. The supply static pressure setpoint will be set during the balancing and commissioning phase.	
41	The static pressure on the discharge of the air handling units supply fans will be monitored and if the pressure reaches 1000 Pa the supply fans will shut down and an alarm will be generated on the DDC system. The fan system must be manually restarted from the DDC system.	
42		
43	***Exhaust Fans Static Pressure Control:***	
44	The exhaust fans speeds will adjust to maintain the duct static pressure setpoint. The supply static pressure setpoint will be set during the balancing and commissioning phase.	
45	The static pressure will be monitored and if the pressure reaches 1000 Pa the supply fans will shut down and an alarm will be generated on the DDC system. The fan system must be manually restarted from the DDC system.	
46		
47	***Humidifier Control:***	
48	Once the system status is proven, the humidifier will control to maintain a return air humidity setpoint (RA_HUM_SP) that is scheduled according to the outdoor air temperature (OAT): When OAT = -38°C RA_HUM_SP = 30%RH When OAT = 10°C RA_HUM_SP = 50%RH	
49	When the outdoor air temperature is over 10°C the humidifier will be disabled *(Setpoint adjustable in graphics)*	
50	As the humidifier valve modulates to maintain return air humidity, it will be limited from increasing further once a supply humidity of 80%RH is reached.	
51		
52	***Freeze Protection:***	
53	Though the AHU heating coils are glycol, the reheat coils in the building are only water. Hard-wired safeties have been installed to ensure low air temperatures do not reach any coils that have the potential for critical failure.	
54	Freeze stat Tripping: Due to the AHU size, multiple freeze stats are used to cover the interior area. All of these freeze stats are hardwired to a latching (resettable) relay. If any freeze stat senses temperature below 4°C it will pull in the freeze relay. Even if the freeze condition is no longer present, the relay will remain latched until it is manually acknowledged *(read below).*	
55	While the freeze relay is latched: • An DDC alarm will be generated • A 30mm red indication light on the outside of the AHU control panel will light • The supply fan and associated variable frequency drive is off (hardwired to VSD) • The exhaust fan and associated variable frequency drive is off (hardwired to VSD) • The outdoor air damper is closed (actuator power is cut, spring return closed) • The exhaust air damper is closed (actuator power is cut, spring return closed) • The humidifier valve is closed (actuator power is cut, spring return closed) • The heating valves will open (actuator power is cut, spring return open) • The cooling valve is closed • The heat wheel will be disabled	
56	Once the freeze conditions are no longer present, the freeze relay can be reset in two ways: 1. Pressing the labeled pushbutton located on the AHU control panel (near the red indication light) 2. Manually commanding a reset-relay on the DDC graphics (to allow for remote manual reset) *(Note – if the freeze condition is still present, trying to reset the freeze relay will do nothing; the indication light and alarm feedback will still remain)*	

57		
58	***Manual Override Operation:***	
59	The system operation can be manually overridden by using the BMS graphics by an operator with the proper authorization. The system can also be manually (mechanically) overridden if required.	
60	The speed drives on each of the fans each have a manual bypass; however there is a hardwired interlock to the dampers in order to ensure the fan is never dead-headed (over pressured). Throwing the fans into manual bypass (manual override on) will not initiate them until the dampers are opened.	
61	There are two options to manually override the dampers: 1. Use the provided hex crank to manually crank the Belimo damper actuator open 2. Open the control panel and override the DDC control output HOA for the damper. The output label will identify the output on the DDC control board. Open the cover to reveal a row of HOAs for each output.	
62	The valves can be similarly overridden as described in the above damper procedure.	
63		
64	***Alarms:***	
65	Supply fan variable frequency drive failure (typical).	
66	Exhaust fan variable frequency drive failure (typical).	
67	Heat wheel variable frequencies drive failure (typical).	
68	Freeze-stat alarm (mechanically set to 4°C)	
69	Outdoor air damper end-switch failure (typical).	
70	Exhaust air damper end-switch failure (typical).	
71	High and low supply static pressure (setpoint +/-50Pa)	
72	High and low supply air temperature (28°C /10.5°C)	
73	High supply duct humidity (>80%RH)	
74	Pre filter alarm (Initially set to 250kPa)	
75	Final filer alarm (Initially set to 350kPa)	
76	Return (Heat-wheel) filter alarm (Initially set to 250kPa)	
77	Hot water supply gauge pressure alarm (before valve/coil) (<35kPa)	
78	Supply air temperature below 15.6°C	
79	Space temperature out of range – high: 2°C above setpoint; low: 2°C below setpoint	
80	Drain pan high level float switch.	

CS-436 – Existing Residential Care Patient Room Ventilation & Temperature Control

*Fort St. John Residential Care Cooling Upgrade project changes to the base building sequence of operation will be marked in red.

1	**CS436 – Residential Care Patient Room Ventilation & Temperature Control**	
2	Zones: • Residential Care House A and B Patient Rooms	
3		
4	***1 Start-up / Shutdown:***	
5	System initiated synchronously with AHU11 and 12 operations through the BAS.	
4	System initiated to stop by operator through the BAS.	
5		
6	***2 Normal Operation:***	
7	**Heating Mode**	
8	Supply Air Temperature Sensor T2 modulates: • Duct-mounted Reheat Coil Valve V1 to maintain Supply Air Temperature T2 at 20ºC (field adjustable).	
9	Each patient Room Space temperature sensor T1A (B, C, D, E, F, etc) modulates: • Radiant Floor Heating System Control Valve V2A (B, C, D, E, F, etc) to maintain each Space Temperature T1A (B, C, D, E, F, etc) setpoint.	
10		
11	**Ventilation Mode**	
12	In summer or when outdoor temperature is over 18°C (field adjustable), Radian Floor Heating System Valve V3 closes.	
13	Duct-mounted Temperature Sensor T2 is to compare with each patient room's Space Temperature T1A (B, C, D, E, F, etc) and pick the lowest space temperature T1 and modulates the Duct-mounted Reheat Coil Valve V1 to maintain Space Temperature T1 setpoint at 22°C (field adjustable).	
14	If all Space Temperature T1A (B, C, D, E, F, etc) all exceed 22°C, Duct-mounted Reheat Coil Valve V1 fully closes and all rooms are in ventilation mode only, BAS ignores space temperature setpoint setting.	
15	In summer when outdoor temperature is over 19°C (field adjustable), CU-11 & CU-12 turn on and begin to cool the supply air temperature to cooling set point of 16°C (field adjustable no lower than 16°C).	
16	Space temperature setpoint T1 are as follows: • Winter: 22°C ± 2°C	
17		
18	**Window Contacts**	
19	BAS shall monitor window contact indicates window open/close status. BAS shall log window position status.	
20		
21	***Alarms:***	
22	Space temperature low limit (< 20°C)	