



**Mechanical
Specification**
FOR

**CEDARBROOK LODGE PROPOSED MODIFICATIONS
5TH AND 6TH FLOOR**

Unity Health Toronto
Cedarbrook Lodge Retirement Residence
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MECHANICAL GENERAL REQUIREMENTS

20 01 01

1 GENERAL

1.1 General Contract Documents

- .1 Comply with General Conditions of the Contract, Supplementary Conditions of the Contract, and Division 01 - General Requirements.
- .2 Where content in this Specification section duplicates requirements in various Division 01 Specification sections, this section and the applicable Division 01 sections are to be read together and the most stringent requirements apply.

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.
- .2 Read drawings and specifications together as a whole and in conjunction with other such documents included under the Construction Contract.

1.3 Document Organization

- .1 Applicable Divisions for Mechanical Work:
 - .1 Division 20 - Common Work for Mechanical
 - .2 Division 21 - Fire Protection
- .2 For clarity, any reference in the Contract Documents to Division 20 includes Divisions 21.
- .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 21

- .1 Division 20 contains common work requirements that are applicable as necessary to the Work of Divisions 21 and apply as if written in full within those Divisions.

1.5 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 a 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.

1.6 Definitions and Abbreviations

- .1 Specification section 20 01 13 *Definitions and Abbreviations – Mechanical* contains general definitions and abbreviations that apply to one or more specification sections of this Division of the Work. Other specification sections of the mechanical Divisions of the Work may also include additional specific definitions and/or abbreviations that apply to that specification section.

- .2 The following general terms apply to Divisions 20 to 25 of the Work:
- .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 Wherever the word "listed" is used in conjunction with a product and a product certification standard (including but not limited to CSA, ULC, CGSB, BNQ, UL), it shall be understood to mean that the product is "listed" by an accredited 3rd party testing laboratory as being certified to the referenced product standard.
 - .3 Wherever the words "approved", or similar words or phrases are used in the Specification they shall be understood, unless the context otherwise provides, to mean that material or item referred to shall be "approved by" the Owner.
 - .4 Wherever the words "satisfactory", "as directed", "submit", "permitted", "reviewed", or similar words or phrases are used in the Specification they shall be understood, unless the context otherwise provides, to mean that material or item referred to shall be "satisfactory to", "as directed by", "submitted to", "permitted by", or "reviewed by" the Consultant.
 - .5 Instructions using any form of the word:
 - (a) "install" means to place in position and activate for service or use,
 - (b) "supply" means to procure and deliver materials to the place of the Work, or to make available labour or services for the stated purpose,
 - (c) "provide" means to supply material, labour and services to install the referenced item.
 - .6 The term "building code" means the edition of the applicable building code at the time of obtaining a building permit.
 - .7 Wherever manufacturers or manufacturer's products are identified in lists under the phrase "Standard of Acceptance", these are manufacturers and/or products which meet the project standards in regard to performance, quality of material and workmanship.

1.7 Examination

- .1 Examine any existing buildings, local conditions, building site, the 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 Before commencing work under this Division, examine the work of other Divisions of the Work and report any defect or interference.

1.8 Design Services

- .1 Provide specialty design services for elements of the Work where specified in other sections of Division 20. Drawings and specifications prepared by such specialty design service providers shall be sealed by a professional engineer licensed in the jurisdiction of the Work.

1.9 Product Substitutions

- .1 The use of a substitute article or material which the manufacturer represents to be of at least equal quality and of the required characteristics for the purpose intended may be permitted, subject to the following provisions:
 - .1 a substitution will not be considered for reasons of meeting the construction schedule unless the contractor can demonstrate to the satisfaction of the Consultant they made all reasonable efforts to procure the specified product or material in a timely fashion,

- .2 the manufacturer must advise the Consultant of this intention to use an alternative article or material before doing so,
- .3 the burden of proof as to the quality and suitability of alternatives to be upon the manufacturer and they shall supply all information necessary as required by the Consultant at no additional costs to the contract,
- .4 the Consultant shall be the sole judge as to the quality and suitability of alternative materials and their decision to be final,
- .5 where use of an alternative material involves redesign or changes to other parts of the work, the costs and the time required to effect such redesign or changes will be considered in evaluating the suitability of the alternative materials,
- .6 no test or action relating to the approval of substitute materials is to be made until the request for substitution has been made in writing by the manufacturer and has been accompanied by complete data as to the quality of the materials proposed. Such request to be made in ample time to permit appropriate review without delaying the work, taking into consideration that such a substitution request may be rejected and require providing the product or material as originally specified,
- .7 whenever classification, listing, or other certification by a recognized standards body is a part of the specifications for any material, proposals for use of substitute materials is to be accompanied by reports from the equivalent body indicating compliance with the requirements of the specifications,
- .8 the costs of all testing required to prove equality of the material proposed to be borne by the manufacturer.

2 SHIPPING, HANDLING AND STORAGE

2.1 Shipping

- .1 Provide adequate protection of equipment during shipping and handling so as to provide equipment at the Work site in ex-works condition when handled by commercial carrier systems.
- .2 Provide, as necessary, removable bracing of the internal components in each item of equipment so that the equipment can be moved on its side or back, without sustaining damage.
- .3 Where removeable internal bracing has been provided, the equipment to be provided with warning labels to call for the removal of the shipping bracing prior to energization.
- .4 Any component that is packaged or shipped separately is to be individually crated and tagged with unit number and the equipment number of the assembly to which it belongs.
- .5 Provide each "shipping section" with a permanently-attached, readily-visible identification tag bearing the equipment number of the assembly of which it is a part.

2.2 Storage

- .1 Store equipment and materials at the worksite to protect them from any damage until placed into its final location. Maintain similar protection of installed equipment and materials to protect against damage until they are turned over to the Owner. Make good any damage to equipment or materials up to the time of substantial performance.
- .2 Store equipment in accordance with the manufacturer's instructions and not less than:
 - .1 stored in a dry, clean location,
 - .2 cover with polyethylene plastic sheeting,
 - .3 include a desiccant material under the protective sheeting to absorb moisture, or provide heated ventilated air

- .3 Provide adequate ventilation and temporary heating to prevent condensation of moisture within the equipment.

2.3 Provisions for Handling and Field Erection

- .1 For equipment that will require hoisting on site, provide removable side panels, lifting angles or lifting plates to accommodate the use of slings or crane hooks, for each shipping section.
- .2 For floor mounted equipment, provide on each shipping section removable steel channel base plates to permit use of pipe rollers or dollies without damaging the equipment.

3 OWNER'S SPECIAL REQUIREMENTS FOR EXISTING SITES

- .1 The following special requirements are in addition to the requirements of Division 01 of the Work.
- .2 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.
- .3 Security passes must be visibly worn at all times by all employees.
- .4 Trades people to strictly adhere to owner's building security procedures otherwise entrance into the building will be denied.
- .5 Trades people are to enter the entrance identified by the Owner.
- .6 Park vehicles in designated areas. Do not block driveways.
- .7 Use only the freight elevator to transport tools and material. Freight elevator door must be shut immediately after exiting the cab.
- .8 Do not disable or activate any electrical or mechanical system without prior approval by the Owner's Project Manager. Also, prior to disabling or activation of any electrical or mechanical system, obtain approval from Building Operations and Building Security.
- .9 Submit prior notification to Building Security Staff before any construction activity commences which will result in heat, smoke, dust or fumes, such as welding, saw cutting, soldering, spray painting, which might affect sensitive fire detection and protection equipment.
- .10 Provide at least 48 hours prior notification to Building Operations for any fire system isolation requests.
- .11 Schedule work and meet with sub-trades daily on site, to show trades people the work areas and work to be done.
- .12 Trades-people are to supply and use their own tools. No tools, ladders or equipment, etc. will be loaned by the Owner.
- .13 Provide environmental cleaning of the job site daily during construction and upon completion. This includes both under raised floor and above ceilings. Do not store materials or garbage on the loading dock.
- .14 Provide special care, attention and protection when transporting equipment and materials to prevent accidental damage to fire protection equipment, finishes, furnishings and fixtures.
- .15 "No Smoking" – this is a smoke-free building. Violators will be asked to leave and may be denied reentry. Smoking is not allowed on the roof.
- .16 [A security escort will be required for any work being done in secured areas, e.g. raised floor, computer room and mechanical/electrical rooms.]
- .17 If Building Operations deems that work on a particular system requires security escort, allow 48 hours to make appropriate arrangements.
- .18 For any open flame work, provide fire extinguishers and security fire watch.

- .19 Obtain the approval of the Building Manager for the storage of materials on site.
- .20 Perform a daily cleanup prior to leaving the site.
- .21 Secure oxygen and acetylene cylinders at all times and capped nightly.
- .22 Restore operating and redundant systems to their normal condition at the end of each work day unless otherwise approved by the Owner
- .23 At the conclusion of each work day, the Contractor's superintendent/supervisor is to advise the Building Manager on the day's activities and plans for the next day's work.

4 PROGRESS PAYMENT PROCEDURE

4.1 Schedule of Values

- .1 Provide schedule(s) of values for progress payments in accordance with this part.
- .2 Prepare and submit a schedule of values ("SOV") for the Division 20 Work.
- .3 Each SOV is to be in the sample format shown in Article "Attachments", specifically that the SOV is to include four sections for:
 - .1 Contract price work element breakdown, which includes:
 - (a) detailed breakdown by work element as agreed with the Consultant,
 - (b) line items for coordination drawings, as-built documents and operating manuals,
 - (c) a summary line item for authorized Cash Allowance disbursements (if applicable),
 - (d) line items for each Itemized Price (if applicable),
 - (e) line items for each Separate Price (if applicable and included in the Contract Price)
 - (f) a line item for the total of the original contract work element values,
 - (g) a summary line item for approved change instructions,
 - .2 Cash Allowance disbursement authorization, with separate work elements for each cash allowance,
 - .3 Approved Change Instructions, with separate work elements for each change instruction,
 - .4 Outstanding Change Instructions which are either not quoted or not yet approved.
- .4 Each work element in the SOV sections (except Outstanding Change Instructions) is to include:
 - .1 the original contract value and the percent of original contract total value (Contract Price section only),
 - .2 the completed to date amount and percent of original work element contract value,
 - .3 the previously billed amount and percent of original work element contract value,
 - .4 the current billing (payment request) amount and percent of original work element contract value, and
 - .5 the balance to complete amount and percentage of original work element contract value.
- .5 The required Contract Price work element breakdown will be determined by the Consultant, with the level of breakdown appropriate to the project such as
 - .1 by trade,
 - .2 by specification section or portion thereof,
 - .3 by labour vs material,
 - .4 by location in the building,

- .5 or any combination of the above.
- .6 Submit a draft SOV for review and approval by the Consultant at least three weeks before the first request for progress payment. Do not submit requests for progress payments until the SOV has been reviewed and there are no outstanding comments from the Consultant.
- .7 Make requests for progress payments using the values on the reviewed SOV.
- .8 When a change in the Work has been approved by the Owner, include the approved changes on the SOV for the next payment application, whether or not payment is requested in full or in part for that change in that payment request period.

5 CONSTRUCTION CHANGES

5.1 General

- .1 [The valuation method to be used for a change instruction to the Work is to be determined by the Consultant from the following methods:
 - .1 by labour and material when the change instruction is by a Change Directive;
 - .2 by unit prices set out in the Contract or subsequently agreed upon for other change instructions;
 - .3 by a detailed quotation for other change instructions; or
 - .4 by a Cash Allowance Disbursement instruction.

5.2 Definitions

- .1 The following definitions apply to this section
 - .1 **Allpricer** – the material pricing guide/service provided by Allpricer Limited.
 - .2 **MCAA manual** – the Mechanical Contractors Association of America publication *Labor Estimating Guide for Service* for labour units.
 - .3 **Base wage rate** – the hourly rate actually paid to the trades person, determined in accordance with applicable collective bargaining agreement, or in their absence the actual gross wages paid to the worker.
 - .4 **Job Site Impact Multiplier** – a multiplier expressed as a decimal number that is included in the Labour Rate to account for special job site conditions that affect labour availability, labour productivity, procurement of materials, and materials management, that are specific to the project and site conditions.
 - .5 **Indirect labour** – any labour that is neither journey person labour that directly performs the work nor labour that directly supervises journey person(s).
 - .6 **Labour Rate** – the actual fully burdened labour cost per hour of labour consumed by a trades person including statutory and regulatory burden, collective bargaining burden, and other project related burden. For greater clarity, the labour rate includes but is not limited to the following:
 - (a) base wage rate,
 - (b) vacation and statutory holiday pay,
 - (c) union deductions and additional union charges,
 - (d) Legislated burdens including EHT, WSIB, EI, CPP, RST on H/W
 - (e) wage-based taxes,
 - (f) job site impact multipliers,
 - (g) expendable small tools charge,
 - (h) project insurance,

- (i) financing of payroll,
 - (j) estimating,
 - (k) rest breaks and idle time,
 - (l) safety including training, safety meetings, WHMIS, fall protection, personnel protection equipment, and safety committees,
 - (m) preparation and handling of shop drawings and other submittals,
 - (n) preparation of as-built documents, including operation and maintenance manuals,
 - (o) labour warranties,
 - (p) site facilities,
 - (q) clean-up,
 - (r) parking.
- .7 **Foreperson** – a first level supervisory position having direct control over the work performed by journeypersons.
- .8 **Journeyman** – a person working in a skilled construction trade which may be prescribed by regulation, and includes apprentices.
- .9 **Labour Unit** – the number of journeyman labour hours or part thereof, required to perform a specific construction task, and includes but is not limited to:
- (a) receiving, unloading, stockpiling, distribution and handling of materials and equipment,
 - (b) rigging or erecting of materials or equipment,
 - (c) fitting and joining of materials,
 - (d) pressure testing of piping and ductwork systems,
 - (e) testing of equipment and systems.
- .10 **Line materials** – components that make up a distribution network for fluid, power, or electronic/digital information, and includes:
- (a) piping, pipe fittings, valves (of all kinds), pipe strainers and other pipe mounted equipment,
 - (b) ducting, duct fittings, duct balancing dampers and other duct mounted equipment,
 - (c) conduit, cable tray, cable, conductors, and wiring,
 - (d) supports, hangers and restraints,
 - (e) vibration isolators and seismic restraints associated with line materials,
 - (f) instrumentation including gauges and sensors/transmitters,
 - (g) electrical, pneumatic, and hydraulic actuators for valves and dampers, and
 - (h) any coatings or other protective elements applied thereto including insulation and painting.
- .11 **Overhead** – administrative expenses of the Contractor's business and the project which are not included in a Labour Rate or Labour Unit. For greater clarity, overhead includes but is not limited to the following:
- (a) company office, storage, and fabrication spaces, and associated maintenance, utilities, and expenses,
 - (b) project site office, fabrication and storage spaces, washrooms, break rooms, and associated maintenance, utilities, and expenses,
 - (c) company office equipment, furniture and supplies,
 - (d) project site office equipment, furniture and supplies,
 - (e) labour time for project managers and project assistants,
 - (f) project site security,

- (g) project site clean-up, recycling and waste disposal,
- (h) materials management,
- (i) property taxes, business licenses, and auto insurance,
- (j) dues and subscriptions,
- (k) postage and courier,
- (l) advertising, telephone, IT services and equipment,
- (m) legal and accounting fees and expenses,
- (n) sales and marketing,
- (o) salaries and benefits for company indirect labour including company management, sales force, dispatchers, estimators, clerical staff, and at-office general (non-trades) labour.
- (p) all other indirect labour.

.12 Senior Foreperson – the second (and subsequent) level supervisory position having direct control over one or more Forepersons, where the number of Forepersons supervised is in accordance with local regulatory requirements or collective bargaining agreements. (“Superintendent” or “Supervisor” has the same meaning).

5.3 Change Directive Method

- .1 Except where otherwise determined in the Construction Contract or Division 01 specification, the valuation of changes by the Change Directive method shall comply with the following:
 - .1 the form of presentation of costs and methods of measurement shall be agreed to by Consultant and Contractor before proceeding with the change,
 - .2 the adjustment in the Contract Price for a change carried out by way of Change Directive shall be determined on the basis of the cost of the Contractor’s actual expenditures and savings attributed to the Change Directive. For clarity and by example, savings for deductions of similar materials, equipment, labour or services shall be valued at the same amount as for expenditures for additions of same.
 - .3 labour costs will be determined based on actual time spent and the agreed labour rate, the actual cost of installed line materials and equipment, and the agreed fee for overhead and profit,
 - .4 if the change results in a net decrease in Contract cost, the contract price will be decreased by the net decrease in the cost, without adjustment for the Contractor’s percentage fee for overhead and profit,
 - .5 the Contractor shall keep accurate records, in an agreed upon form, of time, quantities and invoiced costs and present an account of the cost of the change in the Work, together with vouchers, material receipts and invoices,
 - .6 this time and material method shall be used until such time as a total cost estimate of the change is agreed between the Owner and the Contractor, at which time all payments made under this time and material method will be credited against the agreed total cost for the change.

5.4 Unit Price Method

- .1 Costing of changes by the Unit Price method:
 - .1 Costs for work identified by agreed unit costs shall be charged at those rates, unless the Owner agrees to other rates.

5.5 Proposed Changes; Other Change Instructions Method

- .1 For proposed changes to the Work or other similar instructions, submit a detailed quotation for approval.

- .2 The adjustment in the Contract Price for a change carried out by way of proposed change or other similar instruction shall be determined on the basis of the cost of the Contractor's actual expenditures and savings attributed to the Proposed Change. For clarity and by example, savings for deductions of similar materials, equipment, labour or services shall be valued at the same amount as for expenditures for additions of same.
- .3 Costs are to be approved by the Owner before the proposed change to the Work proceeds. The quotation for the change to the Work is to include a summary of charges made up of three components: labour charges, material costs and fees.
- .4 Labour Charges:
 - .1 The labour unit hour estimates are to be based on the current MCAA estimating manual unless otherwise agreed by the Consultant;
 - .2 The labour cost is to be determined using the agreed labour rates.
 - .3 Labour rates for Foreperson and Senior Foreperson shall be as per agreement, or in absence of such agreement shall be 1.15 times the journeyperson labour rate. The maximum allowable labour hours for supervision are not to exceed:
 - (a) for a Foreperson, a maximum of 10% of the total calculated journeyperson hours on a change, and
 - (b) for a Senior Foreperson of all levels, a maximum combined amount of 3% of the total calculated journeyperson hours on a change.
 - (c) no other supervisory hours will be permitted.
- .5 Material Charges:
 - .1 Material costs for line materials and installed equipment are to be net of trade discounts. The discount to be applied to list prices for items included in Allpricer manual shall not be less than:
 - (a) 20% for line materials, and
 - (b) 10% for equipment that is not line material.
- .6 Fees:
 - .1 The Contractor and any sub-contractor is allowed a combined overhead and profit fee of 15% for work to be performed by their own forces,
 - .2 The Contractor and any sub-contractor is allowed a combined overhead and profit fee of 5% for work performed by a sub-contractor (in the case of the Contractor) or a sub-sub-contractor (in the case of work performed for a sub-contractor),
 - .3 For clarity, the allowable fees on direct work and on sub-contracted work apply to a sub-sub-contractor of any tier.

5.6 Cash Allowances; Contingency Allowances

- .1 Instructions for changes to the Work to be performed under a cash allowance or contingency allowance ("Allowance") included in the contract price shall be authorized by a Cash Allowance Disbursement instruction.
- .2 Except as described below, the determination of costs for Work performed under an Allowance shall be in accordance with the procedure for proposed changes unless otherwise instructed to proceed with the work, in which case the cost of such work shall be valued in accordance with the procedures for Change Directive.
- .3 The contract price, not the Allowance, includes the overhead and profit fee for the value of the Allowance.
- .4 Except where otherwise specified in the Construction Contract, where the cost of the Work performed under a Cash Allowance Authorization;

- .1 is less than the Allowance value, the contract price includes the overhead and profit for the contractor and any sub-contractors. A change order will be issued for a credit for the balance of the Allowance, but shall not include the associated overhead and profit fee.
- .2 exceeds the Allowance value, a Change Order will be issued for the amount in excess of the Allowance, and the excess amount is to include the agree fee for overheat and profit.

6 SUBMITTALS

6.1 Shop Drawings and Product Data Sheets

- .1 Submit shop drawings, manufacturers product data and samples in accordance with the requirements of Specification sections of Division 01, this Part, and as further required in other Specification sections of Division 20.
- .2 Submit shop drawings in the same unit of measure as are used on the drawings. Both metric and U.S. customary units may be included.
- .3 Submit shop drawings by email to: shopdrawings@hhangus.com, except where a project document management web-service is used.
- .4 Include a H.H. Angus shop drawing cover sheet form prepared for this project for each shop drawing submittal (refer to part "Attachments" for an example of this form) , 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 category: architectural, structural, conveying equipment, user equipment, mechanical, electrical, telecommunications, civil or other.
 - (k) If a re-submission, the Consultant's previous submittal reference number.
- .5 Submit shop drawings in PDF format except as follows;
 - .1 if the Consultant agrees to a shop drawing to be 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 and digital scanning. Allow one additional week for processing of shop drawings submitted in hardcopy format.
- .6 Manufacturer's letter sized product data sheets for standard items are acceptable in place of shop drawings provided that physical characteristics are identified and are related to specification references.
- .7 Submit with manufacturers data sheets, typed schedules listing manufacturer's and supplier's name and catalogue model number.
- .8 For plumbing fixtures and other permeant fixtures, submit fixture sheets with catalogue numbers. Identify and arrange fixture sheets in the same sequence and using the same identification number as shown in specification fixture lists.
- .9 Shop drawings and/or product data sheets to show;

- (a) dimensioned outlines of equipment and construction details,
 - (b) equipment weights and center of gravity,
 - (c) performance ratings,
 - (d) dimensioned details showing service connection points,
 - (e) elevations illustrating locations of visible equipment such as gauges, pilot lights, breakers and their trip settings, windows, meters, and access doors,
 - (f) description of operation,
 - (g) single line diagrams,
 - (h) general routing of bus ducts and connecting services,
 - (i) mounting and fixing arrangements,
 - (j) operating and maintenance clearances,
 - (k) access door swing spaces, and
 - (l) where products are required to be certified to a published standard, the mark of the testing organization who certified the product and the standard reference number to which it is certified.
- .10 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.
- .11 Shop drawing and data sheet submission is taken as certification that the products are;
- .1 from the manufacturer's current production, and
 - .2 in compliance with applicable codes, standards, and regulations.
- .12 For standard catalogued (non-custom) products, do not submit drawings showing internal construction details, component assemblies or interior piping and wiring diagrams. Such information may be necessary to understand correct functioning of equipment and are to be submitted with operating and maintenance data.
- .13 Check and stamp each shop drawing as being correct before submission. Shop drawings without such stamps will be rejected and returned.
- .14 Keep one copy of each reviewed shop drawing and product data sheet on site and have them available for reference purposes.
- .15 Where equipment is delivered without reviewed shop drawings, equipment will be condemned and is to be removed from site and replaced with new equipment after shop drawings have been submitted and reviewed.

6.2 Coordination, Fabrication, or Installation Drawings

- .1 Contractor coordination, fabrication, installation and/or sleeving drawings are to be provided in accordance with specification Section 20 01 03 *Mechanical Coordination and Installation Design Services*.
- .2 Contractor's coordination, 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 as a shop drawing.
- .3 Maintain a copy on site of such drawings for reference by the Consultant.
- .4 The Consultant reserves the right to request selected Contractor's coordination, fabrication, or installation drawings for review.

6.3 Effect of Consultants Review of Submittals

- .1 Consultant's review of shop drawings is performed on a sampling basis only, to confirm to Consultant's satisfaction that the Contractor understands the Work to be performed and is interpreting the design documents correctly, and such reviews are performed for the benefit of the Owner.
- .2 For greater certainty, the review of shop drawings by Consultant does not constitute a quality control function for the benefit of Contractor, nor does such a review relieve Contractor of their responsibility for complying with the Contract documents.

7 APPLICABLE CODES, STANDARDS AND REGULATIONS; PERMITS

7.1 Codes, Standards and Regulations

- .1 Where a published product standard or installation code is adopted by statute or regulation by an applicable AHJ, the applicable edition of the standard or code is the one that has been adopted
 - .1 at the time of obtaining a permit for the applicable portion of the Work, or
 - .2 in the absence of a requirement for a permit, the start date of construction.
- .2 Where a published product standard or installation code is not adopted by statute or regulation, then the most current edition of that standard or code at the start date of construction applies.
- .3 Install mechanical and electrical systems in accordance with the applicable requirements adopted by the AHJ in the jurisdiction of the Work.
- .4 Where requirements of the Specifications exceed those of applicable codes, standards, and regulations the requirements of the Specifications is to govern.
- .5 In the event of a conflict between codes, bulletins, 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 the most demanding requirements.

7.2 Confined Spaces

- .1 Unless otherwise prescribed by the Constructor's / Owner's workplace safety program, treat spaces not designed and constructed for continuous human occupancy as confined spaces in accordance with applicable health and safety legislation, including but not limited to:
 - .1 horizontal and vertical service spaces, shafts, and tunnels,
 - .2 inside of equipment which permits entry of the head and/or whole body, and
 - .3 ceiling spaces which are identified as containing a hazardous substance.

7.3 Permits, Tests and Certificates

- .1 Arrange and pay for permits, tests, and Certificates of Inspection required by the AHJ applicable to the element of the Work.
- .2 Submit applications requiring Owner's signature before commencing work.
- .3 Obtain and submit applicable AHJ Inspection certificates or reports including but not limited to:
 - (a) Electrical inspection,
 - (b) Plumbing and drainage inspection,
 - (c) HVAC inspection,
 - (d) Pressure Vessel Inspection.
 - (e) Piping and Boiler Inspection.
 - (f) Fuel safety Inspection.

- .2 Renew certificates or reports so as to remain in force through the warranty period.
- .4 Co-ordinate and perform testing required by an AHJ in accordance with the Part on Testing in this Section.

8 COMMON PRODUCT REQUIREMENTS

8.1 Standard of Material and Equipment

- .1 Provide materials and equipment in accordance the requirements of Specification section of Division 01 and as follows.
- .2 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 (certified) to applicable standards in accordance with Specification sections of the Work and as required by authorities having jurisdiction,
 - .5 registered in accordance with the requirements of the applicable provincial pressure vessels regulation and registered in accordance with CSA B51 for Canadian Registration Numbers, as applicable,
 - .6 in compliance with Standards and Regulations including but not limited 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 by the same manufacturer. ,
 - .8 identical component parts of same manufacturer in similar units of equipment, but various component parts of each unit need not be from one manufacturer.
- .3 Materials and equipment are described to establish standards of construction and workmanship. Where manufacturers and/or products are listed under "Standard of Acceptance", select manufacturers and or products from these lists. Use of manufacturers or products other than as listed are subject to specification requirements concerning requests for substitution.
- .4 Include items of material and equipment not specifically noted on Drawings or mentioned in Specifications but which are required to make a complete and operating system.
- .5 Confirm capacity or ratings of equipment being provided, when based on ratings of equipment being provided under other trade Sections, before such items are purchased.
- .6 Factory fabricated control panels and component assemblies are to be listed for electrical safety requirements.
- .7 Select materials and equipment in accordance with manufacturer's recommendations and these Specifications, and install same in accordance with manufacturer's instructions and these Specifications.
- .8 Materials and equipment not satisfying these selection criteria will be condemned. Remove condemned materials from job site and provide properly selected and approved materials.

8.2 Manufacturers Nameplates

- .1 Provide manufactured equipment with metal nameplate with raised or recessed lettering, mounted on each piece of equipment. On insulated equipment, mechanically fasten plates on metal stand-off bracket arranged to clear insulation.
- .2 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.
- .3 Certified products are to clearly show the mark of the certification agency when in the final installed state.

8.3 Factory Applied Painting

- .1 Protect factory finished equipment during construction, and clean at completion of work.
- .2 Touch-up factory painted prime and/or final coats damaged during construction, with colour matching paint recommended by the equipment manufacturer.
- .3 Use heat resistant paint where conditions require.

8.4 Factory Applied Prime Painting

- .1 Factory-prime paint other equipment fabricated from iron or steel, including equipment supports and hangers, access platforms, access doors, registers, grilles, diffusers, dampers, metal radiation enclosures and fire hose cabinets where separate product specifications do not require a factory applied final coat.

8.5 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 decorative 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, provide corrosion coatings and floor sealers in accordance with specification section 20 05 02 *Painting for Mechanical Services*.
- .4 In addition, apply prime and/or final paint coats to equipment and materials where specifically detailed in other Sections of these Divisions.

8.6 Provision for Future

- .1 Where space is indicated as reserved for future equipment or for future extension to building, leave such space clear and install piping, raceways and equipment so that connections can be made to future apparatus or building.
- .2 Identify provisions and service terminations for future on Record Drawings.

8.7 Maintenance of Bearings

- .1 Turn-over rotating equipment at least once a month from delivery to site until start-up.
- .2 Run-in sleeve type bearings in accordance with manufacturer's written recommendation. After "run-in", drain, flush out and refill with new charge of oil or grease.
- .3 Protect bearings, shafts and sheaves against damage, corrosion and dust accumulation during building construction.

8.8 Pre-purchased Equipment; Damage and Ownership

- .1 At time of receipt of pre-purchased or pre-tendered equipment at the job site by the installing mechanical contractor, provide the services of the manufacturer/distributor/supplier's technical representative to:
 - .1 inspect the equipment prior to unloading,
 - .2 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, and
 - .3 report any damage to the Consultant.
- .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 of the damaged equipment to the satisfaction of the Owner.

9 OFFICE AND STORAGE; TOOLS

9.1 Office and Storage

- .1 Provide temporary office, washroom and lunchroom facilities, workshop, and tools and material storage space. Facilities may be site trailers or as otherwise approved by the General Contractor/Construction Manager.
- .2 Assume responsibility for security of these facilities.
- .3 Provide heat, light and telephone and Internet service
- .4 Owners cafeteria is off limits.

9.2 Tools, Temporary Equipment and Materials

- .1 Provide tools, equipment, scaffolding, extension cords, lamps and miscellaneous consumable materials, required to carry out the Work.

10 COORDINATION; INSTALLATION DRAWINGS

10.1 Coordination

- .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.

10.2 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 the work 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,
- .2 Circulate drawings to other trades involved in each area, and conduct coordination meetings with those trades.

11 ANCHORS AND INSERTS

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

12 CUTTING, PATCHING AND REMEDIAL WORK

12.1 General

- .1 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 and pay for any resulting costs.
- .2 Neatly cut or drill holes required in existing building elements to accommodate building services including ductwork, piping, cable, raceways, bus duct or cable tray.
- .3 Arrange and pay for all cutting and patching as required for the 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, moisture-resistant elements or sight-exposed surfaces.

12.2 Structure Scanning and Cutting

- .1 Layout cutting of structural elements, such as floors slabs, walls, columns or beams and obtain approval before starting work. Conduct an initial electromagnetic scan of reinforcing rods and electrical conduit, and review with structural engineering Consultant.

Standard of Acceptance

- ° Hilti - fig. PS 300 Ferroscan

- .1 [Radiographic examination of the building structure is not permitted.] [Based on the preceding results, arrange and pay for supplemental radiographic examination where necessary to improve on locating concrete reinforcement, conduits and other embedment's.
 - .1 submit radiographic results to the structural engineer and obtain comments before starting work,
 - .2 the use of radiographic imaging methods is subject to approval by the Owner on a case by case basis.
- .2 As an alternative to radiographic examination for areas where the Owner does not permit radiographic examination, based] on the preceding results, provide two-dimensional ground penetrating radar scans to locate concrete reinforcement, conduits and other embedment's. Scanners to be operated by personnel trained by the measurement device manufacturer.

Standard of Acceptance

- ° Hilti PS1000 X-SCAN

- .3 Relocate core drilling location if steel or conduit is found in the proposed location and repeat procedure. Reroute any circuits damaged by core drilling.
- .4 Scan for all shots and anchors in floors, walls, and ceilings.

13 PROTECTION OF PERSONNEL, WORK, AND PROPERTY

13.1 Personnel Protection

- .1 Without limiting the Contractor's responsibilities regarding occupational health and safety requirements at the construction site, provide specific personnel protection as follows:
 - .1 protect exposed live equipment during construction for personnel safety,
 - .2 shield and mark live parts "LIVE 120 VOLTS", or with appropriate voltage,
 - .3 arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician,
 - .4 do not leave conduit, wires, cables, tools, equipment or materials in such a way that they constitute a hazard,
 - .5 provide toe guards around openings in the roof or floor to prevent materials or debris from dropping down to a lower level,
 - .6 remove loose equipment and tools from overhead areas before leaving each day,
 - .7 cut off bolts at floor level to eliminate a possible tripping hazard.

13.2 Protection During Construction

- .1 Provide protection required to enable existing building and equipment to remain in continuous and normal operation.
- .2 Take the necessary precautions to protect equipment, existing building and service from damage during the Work. Accept responsibility for any damage and make good without cost to the Owner.
- .3 Protect existing surfaces and items so that they are not damaged in any way whatsoever by the work of all trades. Take precautions as necessary to prevent damage to walls, floors, ceilings, windows, doors, door frames, moldings, finishes, piping, ductwork, light fixtures, etc. Provide protection, hoarding, tarpaulins, dust sleeves etc., as required. Any damage caused because of lack of adequate protection to be made good at no cost to the Owner.
- .4 Take care when working above or around equipment that must remain in service.

- .5 Take care to eliminate dust in equipment areas.
- .6 Protect switchgear fronts from accidental breaker trips when working around or above them. Provide an extended shield constructed of 12 mm (½") fire retardant plywood a minimum of 450 mm (18") from board front to allow access to board.

13.3 Core Drilling

- .1 Wherever core drilling is required, provide temporary dust proof screens.
- .2 In areas where core drilling through a slab in an operating facility is necessary, clearly mark out the areas to be drilled on the underside of slab. Owner's representative to be notified at least 1 week prior to core drilling operation. Provide tarping of equipment supervised by the Owner.
- .3 During core drilling operations, station at least one person directly below the area of drilling with a large plastic container pressed to underside of slab to capture and hold core and water upon completion of operations.
- .4 Continuously use a wet/dry commercial quality vacuum at location of drilling operation to remove all excess water from the area.

13.4 Temporary Dust Proof Screens

- .1 Provide temporary dust proof screens where required to separate work areas from completed areas and/or existing areas, to prevent dust from settling on the Owner's plant and equipment.
- .2 Dust proof material to be neoprene coated nylon tarpaulin or other types of fabric.
- .3 Provide temporary framing as required.
- .4 Extend dust proof screens from floor to underside of ceiling, floor, or roof above. Lap sections of screen sheets 150 mm (6") minimum and tape joints.
- .5 Secure screen sheets at top, bottom and ends and tape perimeter.
- .6 Provide temporary doors and frames with weather seals to provide frequent access to the work zone. Other closure methods may be used where infrequent access or short term access (less than one week) only is required.
- .7 Co-operate with Owner in the erection of temporary dust proof screens.
- .8 Provide yellow-black warning tape along perimeter of the screen junction with the floor.
- .9 Remove screens when and as directed by Consultant.

13.5 Protection of Floors During Equipment Installation

- .1 Provide protection of floor finishes during installation or removal of equipment, and at any other time when moving or installing heavy equipment.
- .2 Install 19mm (¾") plywood over 6 mil plastic over finished floor areas when moving heavy equipment that could damage floor finish, or when installing equipment or line materials overhead.
- .3 Repaint or re-tile any floors or walls damaged or scratched during construction.

13.6 Housekeeping

- .1 Maintain a high level of cleanliness.
- .2 Remove scrap and refuse from the work area daily.
- .3 Whenever possible, clean up immediately following completion of work.
- .4 Deposit oily and waste solvent rags in approved containers to minimize the fire hazard.
- .5 Sweep and damp mop daily.

14 WORK IN EXISTING BUILDING

14.1 General

- .1 Comply with Specification section of Division 01 for restrictions on working in existing occupied buildings and as follows.
- .2 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.
- .3 The 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.
- .4 Perform core drilling [any day between 7 pm and 7 am.][on weekends and holidays.][on Sundays between 1am-7am.][at any time] Coordinate with Owner for specific times.
- .5 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.
- .6 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.
- .7 Unless noted otherwise removed materials and equipment become the property of the Contractor and are to be taken from the site and disposed of appropriately.
- .8 On completion of relocations, confirm relocated equipment are in proper working order.
- .9 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.

14.2 Continuity of Services

- .1 Keep existing buildings in operation with minimum length of shutdown periods.
- .2 Make connections to existing systems at approved times.
- .3 Obtain written approval recording times when connections can be made.
- .4 Arrange work so that physical access to existing buildings is not unduly interrupted.
- .5 Be responsible for and make good any damages caused to existing systems when making connections.
- .6 Provide premium time labour to tie-in to services at night or on weekends.

- .7 For piping systems, make connections to existing piping by draining down the existing piping system. Use of hot-tapping or freezing of piping is only permitted where approved by the Owner and a specification section for such work has been included in the project specifications.
- .8 Provide temporary services to drain down existing piping systems which convey liquids or steam condensate, including provision of temporary hoses, etc., and provide services to perform the drain down of these systems, except where the Owner elects to perform such drain-downs.
- .9 For piping systems conveying liquids, after completion of new work to existing piping systems, refill the existing and new piping systems including provision of cleaning of new piping and addition of chemical treatments, as applicable, in accordance with the requirements of other sections of Division 20. Include for addition of replenishing chemical treatment for existing piping systems in accordance with the Owner's existing chemical treatment program, or in the absence of such, in accordance with the chemical water treatment requirements specified in other Sections of Division 20.

15 MOVING AND SETTING IN PLACE OF OWNER-SUPPLIED PRODUCTS

15.1 General

- .1 The requirements of this Part applies to;
 - .1 Division 20 equipment that has been directly purchased by the Owner, and
 - .2 other Owner-supplied products or equipment (i.e. process equipment) that has building services requirements.

15.2 Owner-Supplied Products (Supplied by Owner Equipment – “SBO”)

- .1 Items marked SBO on drawings are to be;
 - .1 purchased by the Owner,
 - .2 received, checked, and stored by the Contractor, and
 - .3 subsequently unpacked, uncrated, assembled and located in its final location by the Contractor, and installed in accordance with the manufacturer instructions,
 - .4 participate in the start-up and testing of the equipment and placing into service.
- .2 Provide mechanical and electrical services to SBO equipment in accordance with the SBO equipment manufacturer's instructions and as otherwise shown.

15.3 Existing Owners Equipment to be Relocated (E.R. or Ex. Rel.)

- .1 Applies to owners existing equipment which has mechanical and electrical services, and marked on the drawings as E.R. Ex.Rel. or otherwise so identified.
- .2 Items so marked on drawings are to be moved from their present location and reinstalled by the Contractor.
- .3 Disconnect and reconnect mechanical and electrical services to accommodate this equipment relocation.

16 TEMPORARY HEATING

16.1 During Construction

- .1 Temporary heating required while building is under construction will be provided under Division 01.
- .2 Permanent heating system may be used for temporary heating, when this equipment is installed in its permanent location and the building is closed-in and Contractor under Division 1 provides staff for operation and maintenance whenever permanent heating system is being used for temporary heating.

- .3 Hot water boilers may not be used unless heating units, radiation, pumps and piping are complete, the piping system has been pressure tested, cleaned, and final chemical water treatment is in operation.
- .4 Permanent heating equipment used for temporary heating to be thoroughly cleaned and put in first class operating condition and appearance at completion of the Work, as approved by the Owner.

17 FINAL CLEANING AND ADJUSTMENTS

17.1 Final Cleaning

- .1 Conduct final cleaning as specified herein.
- .2 Perform final cleaning after construction activities that create dust have been completed.
- .3 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 immediately prior to handover of the building to the Owner.
- .4 HEPA vacuum the top and interiors of motor controllers, VFDs, control panels, and control cabinets followed by a thorough HEPA vacuuming of the service room floors. Thoroughly wash floors with wet mop and clean water. Control access to the room after cleaning. Provide temporary filter media on air supply ducts to these rooms to prevent re-contamination from other areas of construction.
- .5 Remove tools and waste materials on completion of work and leave work in clean and perfect condition.

17.2 Final Adjustments

- .1 Calibrate components and controls and check function and sequencing of systems under operating conditions.
- .2 Supply lubricating oils and greases for proper operation of equipment and systems until work has been accepted.

18 RECORD DRAWINGS

18.1 Record Drawings

- .1 Maintain record drawings in accordance with the course of the Work and as follows.
- .2 A set of design drawings in AutoCad, Revit, or PDF format (as determined by the Consultant) will be provided by the Consultant. Record changes in actual installation as the Work progresses by the following method:
 - .1 make sets of white prints for each phase of Work and mark-up the print drawings, or
 - .2 revise the AutoCad or Revit file directly, and identify all changes made.
- .3 Mark-up these record drawings to provide dimensioned 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.
- .4 Retain on-site the survey information from excavation and backfill of site services, and after approval, transfer this information to the record documents.
- .5 Retain these drawings and make available to Consultant for periodic review.
- .6 At 50%, 75% and 90% project completion, scan marked-up drawings to PDF format and submit copy to the Consultant, or to the project on-line document management service if one is used.

18.2 As-Built Drawings

- .1 Prior to testing, balancing and adjusting, transfer site record drawing information to a copy of the computer aided drafting/design program ("CAD") files, in the same software format used for the Consultants design drawings, to record final as-built condition.

- .2 Obtain a current set of CAD files from the Consultant. The Consultant's CAD files may not reflect all or any construction changes.
- .3 Drawings are to remain set to and follow Consultants CAD Standards - do not alter drawing scales, reference files, colours, layers or text styles,
- .4 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.
- .5 Show on mechanical as-built drawings final location of piping, ductwork, switches, starters, Motor Control Centres, thermostats, and equipment.
- .6 Show on site services as-built drawings survey information provided by an accredited land surveying service.
- .7 Identify each drawing in lower right hand corner in letters at least 12 mm (½ in) high with a note as follows:

AS-BUILT DRAWINGS. This drawing has been revised to show systems as installed (Signature of Contractor) (Date).
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- .8 The site services drawings are to include the signature and stamp of the accredited surveyor adjacent to the note.
- .9 Submit one (1) set of white prints of the draft as-built CAD files for Consultant's review.
- .10 Once "AS BUILT DRAWINGS" white prints are reviewed, transfer Consultant's comments to the CAD files. Return CAD files modified to "As Built" condition to Consultants electronically by removable mass storage device or by electronic file transfer as designed by the Consultant.
- .11 Submit three (3) sets of white prints and one (1) electronic copy of CAD files with Operating and Maintenance Manuals to the Owner.

19 OPERATING AND MAINTENANCE INSTRUCTIONS

19.1 Operating and Maintenance Manuals

- .1 Provide operating and maintenance manuals in accordance with Section [01 78 00 *Closeout Submittals*] and as follows.
- .2 Provide operation and maintenance data bound in vinyl covered, hard back, three-ring covers, nominally 50 mm (2 in) thick, suitable for paper size of 210 mm x 300 mm (8½ in x 11 in);
 - .1 organize material in volumes, generally grouped by Trade section;
 - (a) Table of Contents,
 - (b) General Information,
 - (c) Sub-contractors (list),
 - (d) Site services,
 - (e) Fire Protection,
 - (f) Plumbing,
 - (g) Heating and Cooling Plant and Distribution,
 - (h) Air Handling Equipment and Distribution,
 - (i) Building automation, Controls and Instrumentation,

- (j) Testing Reports,
 - (k) As-Built Drawings,
 - (l) Warranties.
- .2 Title sheet in each volume to be labeled "Operating and Maintenance Manual" and to bear;
 - (a) Project Name,
 - (b) Project Number,
 - (c) Date,
 - (d) Trade Section,
 - (e) List of Contents.
- .3 Provide three hard-copies to Owner.
- .3 In addition, provide 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 PDF Bookmarks to create a Table of Contents for each file.
- .4 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 valve schedules and flow diagrams,
 - .7 service piping identification charts.
- .5 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.
- .6 Approval procedure;
 - .1 submit one set of first draft of Operating and Maintenance Manuals for approval at least one month prior to planned substantial performance date,
 - .2 make corrections and resubmit for a final review,
 - .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 (2) hard-copies and one (1) PDF copy on removable storage device of the Operating and Maintenance Manuals to the Owner's operating staff and obtain written confirmation of delivery. Provide a copy of the delivery record to the Consultant.

19.2 Operating and Maintenance Training

- .1 Provide operating and maintenance training and as follows.
- .2 Provide training 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.
- .3 Develop the proposed training plan, and submit an outline of the training program for review, adjustment and approval by the Owner.
- .4 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.
- .5 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 topic, separated by approximately one week each. Develop the proposed training plan and obtain approval from the Owner before commencing training.
- .6 All training to be scheduled and provided between the hours of 7 am to 5 pm, Monday to Friday. Where training is required to be performed outside of these hours due to availability of Owners operations personnel, if the trainers are paid for overtime outside of these hours, the overtime portion only is eligible to be paid by the Owner as an extra cost.
- .7 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.
- .8 Organize each training sessions as follows:
 - .1 Fire Protection - Division 21
 - .2 Plumbing – Division 22
 - .3 HVAC – Division 23
 - .4 Building Management System – Division 25
- .9 Keep records of date and duration of each instruction period together with names of persons attending. Submit signed records at completion of instruction.
- .10 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.
- .11 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 PDF format, in accordance with article on Operating and Maintenance Manuals.
- .12 Sessions may be video recorded by the Owner as an aid to ongoing training of Owners staff.

20 CARE, OPERATION AND START-UP

- .1 Provide all labour and materials as necessary to perform start-up and testing of equipment and systems.
- .2 Arrange and pay for services of manufacturer's factory service technician to supervise start-up of the installation, check, adjust, balance and calibrate components and equipment as specified in the specification sections of Division 20.
- .3 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.
- .4 Arrange and pay for services of applicable manufacturer's factory service engineer or certified independent testing organization to supervise initial start-up of specialized portions of installation and to check, adjust, balance and calibrate components including related wiring and controls. Provide these services for such periods, and for as many visits as may be necessary to put applicable portion of the installation in complete working order. Provide a certificate indicating that the equipment is free and clear of deficiencies.

21 TESTING

21.1 General

- .1 The following describes the general requirements for testing of mechanical systems; refer to additional testing requirements in applicable sections of Division 20 of the Work.
- .2 Conduct tests during progress of Work and at its completion to verify equipment and systems meet the contract documents. 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, to the Inspection Authority and personnel witnessing tests.
- .5 The Owner reserves the right to witness any test; any such witnessing activity shall not be construed as acceptance of the system or equipment by the Owner.
- .6 Conduct tests before application of external insulation and before any portion of pipes, ducts or equipment is concealed.
- .7 Do not subject expansion joints, flexible pipe connections, meters, control valves, convertors, and fixtures, to test pressures greater than the 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.
- .8 Should section of pipe, duct, or electrical cable fail under test, replace faulty piping, duct, or cable with new fittings, pipe, duct or cable and then retest. Do not repair threaded pipe joints by caulking nor welded joints by peening. Repeat tests until results are satisfactory.
- .9 Where it is necessary to test portions of piping, ductwork or electrical cable system before system is complete, overlap successive tests so that no joint or section of duct or pipe is missed in testing.

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

21.2 Testing of Integrated Life Safety and Fire Protections Systems

- .1 Conduct testing of integrated life safety and fire protection systems in accordance with specification Section 20 08 11 *Testing of Integrated Electrical Life Safety and Fire Protection Systems*.

21.3 Testing - Potable Water Piping

- .1 Except where otherwise specified in other sections of Division 22, test potable water systems with water or air as required by the plumbing code in effect at the location of the Work.
- .2 For water service pipes 100 mm (4") and larger, disinfect the pipe with chlorine ("hyper-chlorinate") from the street valve to the first shut-off valve inside the building. At completion of disinfection, take water samples just before the utility meter and pay for the samples to be tested by an accredited testing laboratory. Test the water samples for contaminants and to measure the residual chlorine concentration and provide test certificate confirming water contaminates are below the threshold values proscribed by applicable legislation.
- .3 Where stainless steel piping is used in the domestic water system, between the entry point in the building and the utility water meter, after taking the water sample for laboratory testing, immediately drain down the incoming service piping up to the utility meter and then flush with clean city water until a site test of the drain water shows a residual chlorin level not greater than the incoming city water supply.
- .4 Where stainless steel piping is used in potable water piping inside the building (i.e. downstream of the utility meter), do not allow any hyper-chlorinated water used for disinfection of piping to come into contact with the stainless steel piping.

21.4 Testing - Other Piping

- .1 Except where otherwise specified in other sections of Divisions 21, 22 or 23, hydraulically pressure test other water piping systems at 1½ times system design pressure (relief valve setting) or 1000 kPa (150 psi), whichever is greater, for 10 minutes then reduce the test pressure and hold 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.
 - .1 Alternatively, hold the pressure at the design pressure and testing all joints with a soap test.
- .2 Test natural gas system in accordance with CSA B149.1 *Natural Gas and Propane Piping Code*.
- .3 Test fuel oil systems in accordance with CSA B139 *Installation Code for Oil Burning Equipment*.
- .4 Test drainage, waste and vent piping for tightness and grade as required by the plumbing code in effect at the location of the Work.
- .5 Test special service piping as detailed in other sections of Divisions 21, 22 and 23.

21.5 Testing - Ventilation

- .1 Pressure test ductwork in accordance with section 23 31 13 *Ductwork*, or other applicable sections of Division 23.

21.6 Testing - Electrical

- .1 Make tests of equipment and wiring. Test wiring systems in accordance with section 20 05 12 *Wiring Requirements for Mechanical*.
- .2 Replace defective equipment and wiring with new material.

22 COMMISSIONING

- .1 Participate in commissioning of equipment and systems in accordance with Section 20 08 15 *Mechanical Commissioning*.
- .2 Equipment supplied on this project will be subject to detailed factory inspection and/or on-site testing and commissioning prior to being placed in service. The electrical contractor, their major system and equipment suppliers, and the Independent Testing Agent (ITA) will be required to participate in special commissioning meetings to review progress and status of the commissioning program.
- .3 Include in Bid amount for licensed electricians to participate in the commissioning program, to undertake temporary power connections, operation of equipment, opening and closing of panel boards and switchboards, testing of power and control wiring, and assisting the ITA and the equipment suppliers' field personnel in the startup and testing of the equipment.
- .4 The contractor and equipment suppliers to include in the Bid amount the costs to accommodate and undertake factory and site testing.]

23 TEMPORARY AND TRIAL USAGE

- .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 warranty.

24 SPECIAL TOOLS AND SPARE PARTS

24.1 Spare Parts

- .1 Prior to application for Substantial Performance, furnish spare parts as follows;
 - .1 one set of mechanical seals for one pump of each model size,
 - .2 one pump casing joint gasket for each model size,
 - .3 one head gasket for each shell-and-tube heat exchanger with removable heads,
 - .4 one glass for each gauge glass,
 - .5 one set of V-belts for each drive of the same model size,
 - .6 one set of filter cartridges for each filter or filter bank installed.
- .2 Maintain an inventory record and delivery receipt record of spare parts delivered to the Owner, and include them in the Operating and Maintenance manuals.

25 CONSULTANT REVIEWS

25.1 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 as required by the local authority have jurisdiction. It is the Contractor's responsibility to ensure that the Work is complete and constructed in accordance with the design documents.

25.2 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, readily noticeable deficiencies may be recorded by the Consultant where the deficient 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, specifically in identification and rectification of deficiencies or incomplete 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.

25.3 Milestone Reviews

- .1 Specific milestone reviews may be conducted at key stages by the Consultant, including;
 - .1 before backfilling of buried drainage,
 - .2 before closing of shafts,
 - .3 before closing of ceilings,
 - .4 before closing of walls,
 - .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 by the Consultant 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.

25.4 Partial Occupancy Reviews

- .1 Where the Work is planned to include occupancy by the Owner of a part of the Work but not the entire Work ("partial occupancy"), the procedures specified for Substantial Performance Review will apply to the portion of the Work being considered for partial occupancy.

25.5 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.

25.6 Final Review

- .1 At project completion submit written request for final review of mechanical and electrical systems. 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 equipment/line material 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.

26 CONTRACTOR INSPECTIONS

26.1 General

- .1 The Division 20 contractor shall assign one person responsible for ensuring that Work from all mechanical trades is complete prior to;
 - .1 closing in wall, ceilings or burying of services,
 - .2 partial-occupancy reviews, and
 - .3 substantial performance reviews.
- .2 In conjunction with the Contractor's Mechanical and Electrical sub-contractors, the Contractor shall walk the site and thoroughly inspect that the work is complete, in good workmanship and installed according to the contract documents and derived documents therefrom. The Contractor shall then submit a report attesting to the completed state of the Work (the "Statement of Completion" report, as detailed later in this part).
- .3 In the case of Contractor inspections for partial-occupancy or substantial performance, submit the Statement of Completion report at least 24 hours prior to the scheduled review by the Consultant

26.2 Concealed Space Digital Image Records

- .1 Where services are to be concealed behind walls, ceilings, or buried, the Contractor shall make a digital photo or digitally scanned record of the Work, and assemble these digital records in a logical file structure, organized by floor or department, with each record filename including the room number, so as to form a comprehensive documentation of the completed services.
- .2 The digital files and folders are to be turned over to the Consultant for review prior to the Consultant's reviews for partial- occupancy or substantial performance.
- .3 As part of the request for substantial performance of the Work, submit two (2) copies of the digital record on separate removable storage devices to the Owner for their use. These records are in addition to other construction records including as-built documentation.

26.3 Contractor Inspections for Partial Occupancy and Substantial Performance

- .1 In preparation for the Consultants general review for partial-occupancy and/or substantial performance of the Work, the Contractor shall perform a comprehensive inspection of the Work to ensure that their contractual obligations are met before requesting a Consultant's review of the Work. In performing this inspection, the Contractor shall create a Statement of Completion report which is to include;
 - .1 date and time of the Contractor's inspection, signed by the person who conducted the inspection,
 - .2 names of the mechanical contractor's personnel who participated in the inspection,
 - .3 confirmation that previously noted deficiencies have been completed,

- .4 confirmation that the work is 100% complete, tested, balanced and free of deficiencies, or include a list of outstanding deficiencies and incomplete Work with;
 - (a) a reason why the Work has not been completed (i.e. another trade has to complete their work)
 - (b) a plan of action to complete the Work, and
 - (c) a commitment date for completion of the Work including rectification of all deficiencies.
- .2 The format of the Statement of Completion shall be approved by the Consultant.
- .3 The Consultant shall review and sign-off the Statement of Completion Report and return a copy to the Contractor. The Contractor shall retain on-site a log of all signed off Statement of Completion reports.
- .4 If a required Statement of Completion report is not received, the Consultant reserves the right to withhold conducting a review for partial-occupancy or substantial performance.
- .5 After receipt of the Contractor's Statement of Completion report, if upon entering an area of the work covered by the Statement of Completion report the Consultant determines, in its sole opinion, that the applicable Work is not ready for review, the Consultant may elect to cancel the review of the Work or the affected portion of the Work, and shall assume no responsibility for any damages or losses as a result of cancellation of the review. The Contractor shall remedy the incomplete work and request another review with 72 hours prior written notice, and shall resubmit the revised Statement of Completion at least 24 hours prior to the new review.

27 CORRECTION AFTER COMPLETION

- .1 At completion, submit a written warranty undertaking to remedy defects in work for a period of one year from date of substantial performance of the Work. This warranty is not to supplant other warranties of longer period called for on certain equipment or materials.
- .2 Warranties are to encompass replacement of defective parts, materials or equipment, and to include incidental fluids, gaskets, lubricants, supplies, and labour for removal and reinstallation of the corrected Work.
- .3 Submit similar warranties for one year from date of acceptance for any part of work accepted by Owner, before completion of the whole Work.

28 ATTACHMENTS

28.1 Schedule of Values Form

- .1 Attached sample of the Schedule of Values form layout.

28.2 Shop Drawing Submittal Form

- .1 Attached sample of shop drawings submittal form.

SCHEDULE OF VALUES

Project Name: <<name of project>>
Owner Name: <<owner name>>
Contractor Name: <<name of trade contractor: mechanical, electrical, etc>>
Division(s) of the Work: <<i.e. 20, 21, 22...>>
For the billing period ending: dd-mmm-yyy

This sheet is an example of a required schedule of values to be developed by the Contractor, to be submitted with each progress payment request.
Specific level of detail for each work element to be approved by the Consultant.

Item	Base Contract Element	Contract Value		Complete to Date		Previously Billed		This Billing		Balance to Complete	
		\$	%	\$	%	\$	%	\$	%	\$	%
1.1	<<work element>>	1,000,000.00	65.9%	400,000.00	40.0%	225,000.00	22.5%	175,000.00	17.5%	600,000.00	60.0%
1.2	<<work element>>	250,000.00	16.5%	30,000.00	12.0%	5,000.00	2.0%	25,000.00	10.0%	220,000.00	88.0%
1.3	<<work element>>	125,000.00	8.2%	50,000.00	40.0%	22,000.00	17.6%	28,000.00	22.4%	75,000.00	60.0%
X X	Itemized Price No. 1	25,000.00	1.6%	0.00	0.0%	0.00	0.0%	0.00	0.0%	25,000.00	100.0%
X X	Separate Price No. 1	12,500.00	0.8%	5,000.00	40.0%	0.00	0.0%	5,000.00	40.0%	7,500.00	60.0%
CCA.1	Cash Allowance Disbursements Summary	75,000.00	4.9%	34,000.00	0.0%	8,000.00	0.0%	26,000.00	0.0%	41,000.00	0.0%
X X	Coordination drawings	15,000.00	1.0%								
X X	As-built documents and operating manuals	15,000.00	1.0%								
	Original Contract Values	1,517,500.00	100.0%	519,000.00	34.2%	260,000.00	17.1%	259,000.00	17.1%	968,500.00	63.8%
CO.1	Approved Changes Summary	13,400.00		5,200.00	38.8%	2,000.00	14.9%	3,200.00	23.9%	8,200.00	61.2%
	Total Current Contract Values	1,530,900.00		524,200.00	34.2%	262,000.00	17.1%	262,200.00	17.1%	976,700.00	63.8%

Reference	Cash Allowance Disbursement	CA Value		Complete to Date		Previously Billed		This Billing		Balance to Complete	
		\$	%	\$	%	\$	%	\$	%	\$	%
CAA_1	<<description of cash allowance>>	20,000.00		20,000.00	100.0%	8,000.00	40.0%	12,000.00	60.0%	0.00	0.0%
CAA_2	<<description of cash allowance>>	55,000.00		14,000.00	25.5%	-	0.0%	14,000.00	25.5%	41,000.00	74.5%
					0.0%		0.0%	0.00	0.0%	0.00	0.0%
Total		75,000.00		34,000.00	45.3%	8,000.00	10.7%	26,000.00	34.7%	41,000.00	54.7%

Reference	Approved Changes	Change Value		Complete to Date		Previously Billed		This Billing		Balance to Complete	
		\$	%	\$	%	\$	%	\$	%	\$	%
CO_01	<<description of change of work>>	5,800.00		-	0.0%	-	0.0%	0.00	0.0%	5,800.00	100.0%
CD-01	<<description of change of work>>	7,600.00		5,200.00	68.4%	2,000.00	26.3%	3,200.00	42.1%	2,400.00	31.6%
					0.0%		0.0%	0.00	0.0%	0.00	0.0%
Total		13,400.00		5,200.00	38.8%	2,000.00	14.9%	3,200.00	23.9%	8,200.00	61.2%

Reference	Unquoted/Unapproved Changes	Status	Quotation	
			\$	%
CCN-01	<<description of change of work>>	Waitinf for approval	12,000.00	
CCN-02	<<description of change of work>>	Unquoted		
Total			12,000.00	



Toronto Montreal Vancouver Dallas Chicago

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: Click or tap here to enter text.

Project Name: Click or tap here to enter text.

HHA Project No: Click or tap here to enter text.

Contractor to complete the following for each submission.

Date: _____

Contractor Name: _____ Ref. No: _____

Manufacturer Name: _____

Product Type/Description: _____

Specification section number: _____

Contractor Trade Category:

- | | | | |
|--|-------------------------------------|--|---|
| ☐ Architectural | ☐ Structural | ☐ Conveying Equipment | ☐ User Equipment |
| ☐ Mechanical | ☐ Electrical | ☐ Telecommunications | ☐ Civil |
| ☐ Other | | | |

If this is a resubmission, check here: ☐

Previous submission HHA reference no.: _____

hhangus.com



END OF SECTION

QUALIFICATIONS AND AUTHORITIES – BRITISH COLUMBIA 20 01 02

1 GENERAL

1.1 Scope

- .1 This 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 **TSBC:** Technical Safety B.C.
- .2 **MBD** Municipal building department

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 competency 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	MBD
Plumbing	Municipal Building Department	MBD
HVAC	Municipal Building Department	MBD
Flammable and Combustible Liquids	Fire Department	MBD
Liquid fuels (for vehicle refueling)	TSBC	TSBC (FS)
Heating Oil and Diesel Fuel	TSBC	TSBC (FS)
Natural Gas, Propane	TSBC	TSBC (FS)
Natural Gas, Propane	Municipal Building Department	MBD
Pressure Piping	TSBC	TSBC (BPV)
Refrigeration	TSBC	TSBC (BPV)
Licensed Plant Operators	TSBC	TSBC (OE)
Electrical	TSBC	TSBC (ES)
Electrical	Municipal Building Department	MBD

4 PERMITS, REGISTRATION AND INSPECTION

4.1 Building Code Permits

- .1 Application for Building Permit including plumbing and HVAC has been made by the Owner. Arrange and coordinate for municipal inspections as required under the BC Building Code.

4.2 Other Work Permits, Registration and Inspection

- .1 Arrange, provide documentation, and pay for permits, 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 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 construction contract. In the absence of any requirements in the project construction contract, 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.
- .2 The use of Consultant's drawings directly for construction, without preparation of Contractor detailed coordination, fabrication, and installation design drawings, is at the Contractors risk.

1.4 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 may be returned by Consultant for re-submission to include proposed resolution.

2 WORK RESTRICTIONS

- .1 The following commentary describes work restrictions that may affect the Contractors construction schedule and/or means and methods of construction, and are to be taken into consideration by the Contractor when estimating the cost and duration of 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 ● << restricted access to confined spaces >>
 - .3 ● << unknown structural conditions >>
 - .4 ● << hidden conduit in slabs and walls >>
 - .5 ● << availability of existing documentation >>

3 INTERFERENCE CO-ORDINATION DRAWINGS

3.1 General

- .1 Take information involving accurate measurements from dimensioned Architectural Drawings or at building.
- .2 Install services and equipment which are to be concealed, close to building structure so that furring is kept to minimum dimensions.
- .3 Location of equipment and associated service connections are diagrammatic and based on manufacturer information available at the time of design. Include suitable allowances for and make adjustments to installation of actual equipment, including but not limited to size of housekeeping pads, methods of support, routing of pipe, duct, conduit and other services around and to the equipment, and location of services connection points to the equipment, at no change to the Construction Price.
- .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.
- .7 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.

3.2 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 a note in the 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 Documents have been circled for Consultants' general review"
 - .2 Drawing scale to be minimum 1:50 (1/4"=1'-0").
 - .3 Produce coordination drawings, preferably in 3D AutoCad MEP or Revit format, and keep a set of drawings on site for Consultant's general review.

- .4 Obtain Consultant's drawing files for background information, pending completion and return of any electronic file waiver forms.

3.3 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.

3.4 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.
- .2 Maintain these interconnection drawings through the course of the Work and include a final updated version with the Operating and Maintenance instructions.

3.5 Fire Alarm and Building Automation System

- .1 Provide a wiring coordination interface drawing for termination of fire alarm annunciation circuits to Building Automation System I/O equipment and/or motor starters, adjustable frequency drives, dampers, and motorized fire dampers.
- .2 Drawings to include wiring terminal numbers and description label for FAS annunciation zone.
- .3 Submit interface drawings as a shop drawing for Consultants review.
- .4 Maintain these interconnection drawings through the course of the Work and include a final updated version with the Operating and Maintenance instructions.

4 OWNERS EQUIPMENT AND RELOCATED EQUIPMENT

- .1 The service provisions shown for Owner's supplied equipment and/or relocated equipment is based on the available information at the time of design. Examine the actual service requirements for this equipment and make adjustments as necessary to connection sizes of service drops to suit. A change (increase or decrease) in one trade size for piping, tubing, electrical conductors and conduit, and a change of up to 25% in duct cross-sectional area will be provided at no change to the construction cost.
- .2 Where actual service requirements (except as described above for size) are different between the Consultant's drawings and Owner's equipment requirements, submit proposal for new or deleted services or capacities to the Consultant for review.

5 FABRICATION AND INSTALLATION DRAWINGS

- .1 On an as-needed basis, prepare fabrication, spooling, and/or installation drawings based on the completed interference coordination drawings. Such drawings are to be 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 and 21
- .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

- .1 General definitions:

Authority 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%.

Building Automation System ("BAS"): the building control systems as specified in Division 25.

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 required 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

AMCA	Air Movement and Control Association International
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
MCAA	Mechanical Contractors Association of America
MCAC	Mechanical Contractors Association of Canada
MSS	Manufacturers Standardization Society
NECA	National Electrical Contractors Association
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, and applicable to each Section of Division 20 to 25.

2 ACCESSIBILITY FOR BUILDING CONTROL DEVICES

- .1 Mount control devices, intended to be adjusted or to otherwise be operated by the occupant for the operation of building services or safety devices, as follows:
 - .1 room environmental controls, including thermostats/adjustable room temperature sensors: at 1200 (47 in) above the finished floor,
 - .2 all other controls: between 900 and 1100 mm (36 in. and 43 in.) above the finished floor.
 - .3 be positioned to have a clear space in front of and centered on the control device, of 810 x 375 mm (32 x 15 in).
 - .4 be operable using a closed fist and with a force not exceeding 22.2 N (5 lbf).
- .2 The above requirements do not apply to control devices that are solely located and used by the building operations staff.

3 ACCESS DOORS

3.1 General

- .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.

Standard of Acceptance

- Williams Brothers – fig. GP
- Elmdor/Acorn - fig. DW
- Mifab - fig. UA

3.2 Applicable Product Standards

- .1 CAN/ULC-S104 Standard Method for Fire Testing of Door Assemblies

3.3 Construction:

- .1 Standard access door:
 - .1 1.6 mm (16 ga) carbon steel door and door-frame with white satin coat prime coat finish, with door edges turned back to frame for rigidity,
 - .2 flush mounted with 180° opening door, round safety corners, concealed hinges, plaster lock and anchor straps,
 - .3 latch: screw driver operated,
 - .4 access doors in ceilings, where acoustic tile is applied to plaster or gypsum board, to be dish type designed to receive tile insert.
 - .5 size:
 - (a) 600 mm x 600 mm (24 in x 24 in) for personnel entry,
 - (b) 300 mm x 450 mm (12 in x 18 in) for hand entry,

.2 Variations:**.1 stainless steel variant:**

- (a) Type 304 stainless steel with No. 4 brush satin finish.

.2 waterproof variant:

- (a) Type 304 stainless steel with No. 4 brush satin finish, with neoprene gasketed door.

.3 security access variant:

- (a) keyed cylinder, with all cylinders keyed alike,

.4 fire rated variant:

- (a) where access door is located in a horizontal or vertical fire separation that has a fire resistance rating of 2 hours or less,
- (b) insulated door with 50 mm (2 in) fire retardant mineral wool insulation, and 0.95 mm (20 ga.) back liner,
- (c) heavy duty spring for self-closing door action,
- (d) rated for installation in masonry walls and fire rated shaft wall construction, or fire rated ceiling construction as applicable to the installation,
- (e) listed to CAN/ULC-S104 for minimum 1.5 hour closure ratings.

.5 Submit shop drawings showing access door size, type and location.**3.4 Installation:****.1 Access doors are 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.

.2 Supply access doors and make arrangements and pay for installation by Division in whose work they occur.**.3 Supply access doors with the required variations in accordance with the following table:**

Space Type	Wall or Ceiling Finish	Variants		
		Stainless Steel	Water-proof	Key lock
Service rooms, Service corridors,	Drywall	---	---	---

Space Type	Wall or Ceiling Finish	Variants		
		Stainless Steel	Water-proof	Key lock
Public spaces and corridors - more than 2.4 m (8 ft) above the floor, Private spaces, washrooms	Tile or other hard finished surfaces	Yes	---	---
Public spaces and corridors - 2.4 m (8 ft) or less above the floor, Mental health patient areas, Public washrooms	Drywall	---	---	Yes
	Tile or other Hard Surfaces	Yes	---	Yes
Shower rooms, bathtub rooms, Pools, saunas, Kitchens, laundries, Other damp, washdown or high humidity spaces	All	Yes	Yes	Yes

- .4 Provide fire rated variant in addition to the above table variants, as applicable to the wall or ceiling construction.
- .5 Size and locate access doors in applied tile, block or in glazed or unglazed structural tile to suit joint patterns.
- .6 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.
- .7 At time of instruction of owners operating staff, hand-over and obtain signed receipt for 4 sets of each type of key used for access doors with key-lock cylinders.

4 DIELECTRIC FITTINGS

4.1 General

- .1 Provide dielectric fittings for connection between carbon/galvanized steel piping and either copper tube or stainless steel tube/piping in the following pipe systems:
 - .1 Non-Potable Water (NPW) piping systems which do not have any chemical treatment,
 - .2 Domestic hot water systems where galvanized steel pipe is used, including at connections to hot water heating equipment.

4.2 Products

- .1 Dielectric unions – NPS 2 and under:
 - .1 body and union nut material selected to suit connecting piping materials, including carbon steel/copper, carbon steel/stainless steel, and copper/stainless steel,
 - .2 flat-face union design,
 - .3 tail-piece with NFPT ends with thermobaked epoxy coating, and Teflon shoulder gasket,
 - .4 head-piece with integral O-ring, with threaded or sweat pipe ends.

- .5 union nut,
- .6 pressure rating: Class 3000.
- .7 dielectric coating resistance rating: minimum 500 V/mil thickness.

Standard of Acceptance

- Hart Industrial Unions - fig. D-3136 series

.2 Dielectric nipples – NPS 3 and smaller:

- .1 for connecting copper to carbon steel piping,
- .2 fitting body: Zinc-plated carbon steel tube to ASTM A513,
- .3 liner: polypropylene covering entire inner surface of fitting body,
- .4 fitting ends: threaded to ASME B1.20.1.
- .5 design pressure: 2000 kPa (300 psi) at design temperature,
- .6 design temperature: -40 to +110°C (-40 to +230°F)

Standard of Acceptance

- ASC - fig. 7090

.3 Dielectric insulating flanges – NPS 2-1/2 to NPS 4;

- .1 For connecting copper to carbon steel piping.
- .2 Ductile iron flanges, Class 125 to ANSI B16.42.
- .3 Copper tailpiece for soldered joint,
- .4 NFPT thread to AMSE B1.20.1 x copper solder joint,
- .5 BUNA-N gasket,
- .6 lead free materials to NSF 61+G.
- .7 maximum design pressure: 1200 kPa (175 psi)
- .8 maximum operating temperature: 82°C (180°F)

Standard of Acceptance

- Watts No. LF3100

.4 Dielectric insulated flange – single face with copper tube tailpiece – NPS 2-1/2 to NPS 4;

- .1 For connecting copper to carbon steel piping.
- .2 Van Stone style carbon steel flange with copper tailpiece with flared flaired end,
- .3 carbon steel flange, Class 150 to ANSI B16.5, with powder coated finish.
- .4 copper tailpiece with rolled flange face-end, and EPDM insulating gasket isolating the copper tube from the steel flange.

Standard of Acceptance

- CTS Flange Canada - fig. CTS Copper Flange Adaptor

.5 Dielectric Insulating gaskets for flanges NPS 6 and over:

- .1 for use with ASME Class 150 and 300 dimensional flanges.
- .2 suitable for connecting dissimilar piping materials, including carbon steel/copper, carbon steel/stainless steel, and copper/stainless steel,
- .3 compatible with pressure and temperature service,
- .4 BUNA-N or EPDM gasket seals compatible with potable water
- .5 flange bolts run in insulating sleeves with insulating washers under nuts.

Standard of Acceptance

- Advance Products and Systems

4.3 Installation

- .1 Provide dielectric isolation on specified piping systems between pipes of dissimilar metals with suitable insulating dielectric unions, dielectric nipples, 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.

◦

5 DRAIN VALVES

- .1 Provide drain points with drain valves at low points of piping systems and at section isolating valves.
- .2 Drain valves:
 - .1 NPS ¾ drain and valve for service pipes NPS 2-1/2 and smaller, complete with hose end male thread, cap and chain,
 - .2 NPS 2 drain and valve for services pipes NPS 3 and larger, complete with female Camlock coupling and dustcap.
- .3 Where mechanical-compression fittings are used in the piping system, use only threaded fittings for the construction of the drain piping.

6 V-BELT DRIVES

6.1 Products

- .1 Provide V-belt drive for each motor driven device which is not directly connected to the motor. Keep overhung loads on prime mover shafts within manufacturer's design guidelines.
- .2 Sheaves for motors 7.5 kW (10 hp) and less, with not more than two belts:
 - .1 cast iron or steel secured to shafts with removable keys.
 - .2 adjustable pitch on motor, fixed pitch on driven device, giving plus or minus 10% speed range,
 - .3 selected to meet specified operating condition at mid position in pitch adjustment.
- .3 Sheaves for motors greater than 7.5 kW (10 hp) or drives with three or more belts:
 - .1 cast iron or steel with split tapered bushing and keyway.
 - .2 fixed pitch.
- .4 Belts:
 - .1 matched sets of 'B' section, selected for service factor of 2.0 times installed motor horsepower.
 - .2 capable of carrying load with one belt broken.

- .5 Motor slide rails:
 - .1 adjustment plates for centre line alignment
 - .2 belt tension adjusting screws.

6.2 Installation

- .1 Tension belts to manufacturer's recommendations before start-up and after first 100 hr of operation using calibrated belt tensioning gauge.
- .2 Provide replacement pulleys and belts during start-up and balancing to suit field operating conditions.

7 DRIVE AND COUPLING GUARDS

7.1 Products

- .1 Provide guards to protect belt drives, flywheels, rotating couplings on equipment and fan inlet and outlets.
- .2 Guards:
 - .1 removable for servicing,
 - .2 arranged to permit lubrication with guards in place.
- .3 Guards for belt drives:
 - .1 expanded metal screen welded to steel bar stock or angle frame,
 - .2 minimum 1.2 mm (18 ga) thick galvanized sheet metal tops and bottoms,
 - .3 40 mm (1½") diameter holes at both shaft centres for insertion of tachometer.
- .4 Flexible coupling and flywheel guards:
 - .1 Removable "U" shaped, minimum 1.6 mm (16 ga) thick galvanized mild steel or expanded metal mesh on substantial welded angle iron or round barstock frame.
- .5 Guards on unprotected fan inlets and outlets:
 - .1 Minimum 20 mm (¾ in) galvanized wire mesh or expanded metal screen with net free area of guard not less than 80% of fan opening.

7.2 Installation

- .1 Belt guards to accommodate movement of motors for belt tension adjustment.
- .2 Where equipment is installed on resiliently mounted base frame or pad, attach belt guard to this base
- .3 Belt guards and fan inlet guards may be omitted where fan and motor is installed in plenum less than 1.4 m (4 ft) high and disconnect for fan motor is mounted adjacent to and outside access door to plenum.
- .4 Fan inlet guards may be omitted where fan is fitted with inlet guide vanes.

8 SLEEVES

8.1 General

- .1 Provided sleeves for pipes, ducts and conduits passing through walls, floors and roofs.
- .2 Maintain fire-resistance integrity where pipes and ducts pass through walls, floors and partitions which are or form part of a fire separation.

- .3 Manufactured sleeves and integral sleeves with firestopping may be used provided they meet the same performance requirements as specified for fabricated sleeves.

Standard of Acceptance

- Hilti
- 3M
- Marfab Metal Products

8.2 Floor and Wall Sleeves – Dry Locations (“Standard Sleeves”)

- .1 Sleeve dimensions in floor and wall fire separations having a fire-resistance rating:
- .1 For piping, insulated piping, and conduit:
- (a) opening sized to suit fire stopping methods employed but in no case having an inside dimension more than 50 mm (2 in.) larger than the outside dimension of the service.
 - (b) sleeves may be permanent or only provided as formwork in concrete and masonry construction,
- .2 For ductwork:
- (a) opening sized to suit duct fire damper and/or smoke damper with clearance required for thermal expansion between the wall/floor opening and the fire/smoke damper sleeve in accordance with the fire/smoke damper manufacturer installation instructions.
 - (b) opening sleeves may be permanent or only provided as formwork in concrete and masonry construction,
 - (c) in gypsum-board construction provide permanent opening sleeves or ensure that steel-stud framing is provided to line the opening in the construction.
- .3 Sleeve length – permanent type:
- (a) piping: extend 25 mm (1 in.) past each face of fire separation.
 - (b) ductwork fire damper sleeve: as required to allow for installation of retaining angles and installation of required access door.
- .2 Sleeve dimensions for all other wall and floor types (except waterproof floors):
- .1 For all services:
- (a) opening sized to suit the outside dimension of the service, but in no case having an inside dimension of not less than 12 mm (1/2 in.) and not more than 50 mm (2 in.) larger than the outside dimension of the service.
 - (b) for clarity, for insulated pipes and insulated ducts the outside dimension of the service includes the insulation thickness.
- .2 Sleeve length:
- (a) extend 25 mm (1 in.) past each face of wall or floor construction.
- .3 Sleeve construction for pipes and conduits:
- .1 for all types of floor and wall construction:
- (a) minimum schedule 10 steel pipe, or
 - (b) fabricated carbon steel sheet of same thickness as schedule 10 pipe, rolled to dimension, lapped and spot welded.
- .4 Sleeve construction for ducts smaller than 0.4 m² (4 sq ft) cross sectional area including insulation:
- .1 for wall construction other than as fire separations having a fire-resistance rating:
- (a) 1 mm (20 ga) minimum sheet metal, lapped and spot welded with 20 mm (¾ in) lip flange at one end.

- .2 for floors and walls that are fire separations with required fire-resistance rating:
 - (a) as required by fire and/or smoke damper listing.
- .5 Sleeve construction for ducts of 0.4 m² (4 sq ft) and larger cross sectional area including insulation through walls and floors:
 - .1 for wall construction other than fire separations having a fire-resistance rating:
 - (a) 1.6 mm (16 ga) minimum sheet metal, lapped and spot welded with 20 mm (¾ in) lip flange at one end.
 - .2 for floors and walls that are fire separations with required fire-resistance rating:
 - (a) as required by fire and/or smoke damper listing.
- .6 Manufactured floor sleeves with integral fire stopping:
 - .1 floor sleeve with integrated firestopping, for insulated and non-insulated metal pipes, and plastic pipes,
 - .2 for installation in concrete floors and metal deck/concrete floors,
 - .3 adaptors for support or pipe riser clamps,
 - .4 listed to CAN/ULC-S115.

Standard of Acceptance

- Hilti - fig. CP 680 series

8.3 Slot Sleeves

- .1 Application:
 - .1 where multiple pipes or conduits are grouped together in a linear arrangement to pass through a concrete floor or wall, or masonry wall, a common slot sleeve may be used,
 - .2 where slot openings are not shown on structural drawings, Contractor may propose location and sizes of slot openings for approval by the structural engineer. Where such approval is denied, use individual sleeves for each pipe or conduit.
- .2 Formwork:
 - .1 provide removable formwork or instruct the contractor under Division 03 of the Work to set formwork for the required slot dimensions prior to pouring concrete or setting of masonry units.
- .3 Slot dimensions:
 - .1 slot sleeve dimensions, pipe and conduit sizes, and location of services within the slot are subject to firestopping listing requirements.

8.4 Waterproof Floor Sleeves - Indoors

- .1 Applications:
 - .1 where pipes, conduits and ducts pass through floors in areas subject to water, in building service rooms, in kitchens, in washing areas and in slabs over electric and telephone rooms.
- .2 Fabricated waterproof sleeves for pipes and conduits, :
 - .1 minimum schedule 10 carbon steel pipe with either:
 - (a) hot dip galvanized to ASTM A123 after fabrication, or
 - (b) internally and externally painted with industrial anti-corrosion paint in accordance with Specification section 20 05 02 *Painting for Mechanical Services*, or

- .2 schedule 10 stainless steel pipe,
- .3 provided with water bars: 75 mm (3 in.) wide annular water bar flange continuously welded to sleeve.
- .3 Fabricated waterproof sleeves for ducts:
 - .1 fabricated carbon steel sheet sleeve, continuously welded seams and joints, with angle-channel water bar welded to side of sleeve,
 - (a) 1 mm (20 ga) thick for ducts of less than 0.4 m² (4 sq ft) cross-section area including insulation,
 - (b) 1.6 mm (16 ga) thick for ducts 0.4 m² (4 sq ft) and larger cross-section area including insulation, and for openings with multiple ducts:
 - .2 sleeves internally and externally painted with industrial anti-corrosion paint in accordance with Specification section 20 05 02 *Painting for Mechanical Services*,
 - .3 water bars:
 - (a) new construction, embedded into floor concrete: 75 x 75 mm (3 x 3 in.) galvanized-steel angle channel continuously welded to sleeve,
 - (b) existing or new construction, surface mounted: 75 x 50 mm (3 x 2 in.) carbon steel angle channel, surface mounted to top of concrete housekeeping curb.
- .4 Location of water bars:
 - .1 placed at mid-height of floor construction thickness in new floor construction,
 - .2 surface mounted on and fastened to top of concrete housekeeping curb in existing buildings or in new floor construction.

8.5 Foundation Wall Sleeves

- .1 For installation in poured concrete foundation walls.
- .2 Manufactured foundation wall sleeves:
 - .1 PVC wall sleeve with 50 mm (2 in) wide water bar,
 - .2 sized to suit pipe OD and pipe link-seal.

Standard of Acceptance

- Metraflex

- .3 Fabricated wall sleeve:
 - .1 Method 1:
 - (a) schedule 10 Type 304 stainless steel pipe with 75 mm (3 in) wide water bar welded to mid-point of sleeve,
 - .2 Method 2:
 - (a) schedule 40 carbon steel pipe with 75 mm (3 in) wide water bar welded to mid-point of sleeve,
 - (b) sleeves internally and externally painted with industrial anti-corrosion paint in accordance with Specification section 20 05 02 *Painting for Mechanical Services*,
 - .3 sized to suit pipe OD and pipe link-seal.

8.6 Roof Sleeves for Pipe and Conduit

- .1 Manufactured roof sleeves:

- .1 one-piece spun aluminium sleeve, minimum 1.6 mm (0.064 in) wall thickness, with integral continuous welded flashing,
- .2 insulated with polyurethane insulation for hot and cold piping,
- .3 with 135° gooseneck for flexible electrical conduit, with minimum clearance from gooseneck outlet to flashing flange of:
 - (a) minimum 300 mm (12 in) for installation on conventional roofs,
 - (b) minimum 450 mm (18 in) for installation on inverted roofs.
- .4 with vented flashing insert and flashing cap for hot piping,
- .5 with ventilation perforations at top of sleeve and a flashing cap for natural gas piping,
- .6 stainless steel fasteners,
- .7 EPDM base seal between conduit or pipe and bottom of sleeve,
- .8 EPDM top seal, with triple pressure seal, either integral to the sleeve or as a two-piece sleeve and flashing cap,
- .9 sleeve height: 300 mm (12 in),
- .10 suitable for hot and cold piping, with or without pipe insulation, and rigid and flexible electrical conduit.

Standard of Acceptance

- ° Thaler – fig. MEF series

Application	Thaler Model
Hot piping	MEF-3A
Cold piping	MEF-3A
Natural gas piping	MEF-9
Rigid electrical conduit	MEF-1
Flexible electrical conduit	MEF-2A

8.7 Installation

- .1 Provide sleeves for the passage of services through walls, floors and roofs in accordance with the following table:

Construction Element	Fire Resistance Rating	Element Construction	Mechanical Service	Opening Sleeve Required
Roof	Any or none	All	All	Yes
Walls	>0 hrs	Concrete, Masonry Units	Pipe and Conduit	As required for formwork
			Ductwork	As required for formwork

		Gypsum Board	Pipe and Conduit	Yes
			Ductwork	As required by fire or smoke damper listing
Wall (smoke barrier)	0 hrs	All	All	Yes, or wall tightly finished to sides of service
Acoustic Isolation Walls	None [1]	All	All	Yes
All other walls	None [1]	All	All	None unless otherwise shown
Floors	>0 hrs	Concrete	Pipe and Conduit	As required for formwork
			Ductwork	As required by fire or smoke damper listing
Waterproof Floors	Any or none	Concrete	Pipe and Conduit	Yes
			Ductwork	Yes or Curb

Notes:

[1] Walls are not fire separations of any type.

- .2 Place and secure sleeves in concrete form work for floors, walls and roofs.
- .3 Supply sleeves to be set in masonry walls with installation detail drawings setting out locations of sleeves.
- .4 Standard sleeves:
 - .1 terminate flush with surfaces of concrete and masonry walls.
 - .2 standard sleeves may be omitted where the services pass through walls which are not fire-separations and are concealed above opaque ceilings.
- .5 Waterproof sleeves in new construction:
 - .1 extend sleeves 50 mm (2 in.) above top of housekeeping curbs,
 - .2 extend sleeves 150 mm (6 in.) above finished floors where housekeeping curbs are not used,
 - .3 install sleeves with water bar embedded within the concrete floor or with water bar sitting on top of concrete housekeeping curb. Where mounted on top of housekeeping pad, mechanically fasten sleeve and water bar to concrete housekeeping curb.
 - .4 where water bars are exposed, grind smooth any edges to allow application and adhesion of floor/curb paint finishes.
- .6 Waterproof sleeves in existing concrete buildings:
 - .1 install sleeves in neatly cut or drilled holes in existing construction,
 - .2 carry out cutting and drilling of structural elements, such as floors, slabs, and walls in accordance with procedure set out in Article "Cutting and Patching".
 - .3 provide 150 wide x 150 high mm (6 x 6 in.) housekeeping curb for each penetration.
 - .4 extend sleeves 50 mm (2 in.) above top of housekeeping curbs, with water bar mechanically fastened to curb,
- .7 Seal the void between sleeve and service:

- .1 except for sleeves for fire dampers and smoke dampers, fill void between sleeve and pipe, conduit or duct in accordance with Article "Fire Stopping and Smoke Seals" in this Section for sleeves located in fire separations,
 - (a) for waterproof sleeves, use firestopping material which is also suitable for exposure to water under normal operating conditions.
- .2 at other locations, pack the void between sleeve and pipe, conduit or duct for full depth of sleeve, with mineral wool insulation and seal both ends with silicone-free caulking compound.
- .8 Roof sleeves for pipe and conduit:
 - .1 install manufactured roof flashing sleeves in accordance with manufacturer instructions, specifically in accordance with requirements applicable to the type of roofing membrane requirements,
 - .2 where limestone ballast is used, apply asphalt or similar protective coating onto flashing sleeve to a height of 50 mm (2 in) above ballast layer.
- .9 Where shown, provide floor, wall or roof sleeves for future use. Coordinate with trade contractor under Division 03 of the Work to have such sleeves filled with light weight concrete.

9 LINK SEALS

9.1 General

- .1 Fit each pipe passing through floor slab in contact with ground or basement walls below grade with link seal between sleeve and bare pipe.
- .2 Submit manufacturer's literature and schedule showing location, service, inside diameter of wall opening, sleeve length and pipe outside diameter.
- .3 Link seal:
 - .1 Manufactured from modular synthetic rubber links with stainless steel hardware.
 - .2 Loosely assembled with bolts to form continuous rubber belt around pipe, with pressure plate under each bolt head and nut.
 - .3 Constructed to provide electrical insulation between pipe and sleeve.

Standard of Acceptance

- Power Plant Supply – fig. Thunderline Linkseal
- Advance Products & Systems – fig. Innerlynx
- Metraflex - fig. MetraSeal

9.2 Installation

- .1 Determine inside diameter of each wall opening or sleeve before ordering seal.
- .2 Position seal in sleeve around pipe and tighten bolts to expand rubber links until watertight seal is obtained.

10 FIRE STOPPING AND SMOKE SEALS

10.1 General

- .1 Provide fire stopping and smoke seals where ducts, pipes or conduits penetrate fire separations.
- .2 Fire stop materials to be impervious to water when installed in a horizontal separation, including waterproof service sleeves.

- .3 Firestop material manufacturer or their designated service representative to provide the following services:
 - .1 selection of listed fire stopping assemblies for each applicable service penetration and fire separation assembly/rating,
 - .2 provide training of contractor's staff for proper installation of fire stopping assembly; create and maintain a log of those personnel who obtain training,
 - .3 inspect the completed installation of all penetrations and submit a written report to the Consultant, including photo record of randomly selected instances of each fire stopping method. Where deficiencies are discovered, note the deficiencies in the report and provide remedial instructions to the contractor to correct the deficiency. After deficiencies are corrected, re-inspect the deficiencies to conform their correction, update and resubmit the report to the Consultant.
- .4 Submit a complete fire stopping and smoke seal shop drawing schedule to the Consultant for review. Include details, cut sheets, system description and location for each proposed fire stopping and smoke sealing application.

LEED Requirements

- .1 LEED v4.1 NC EQ Credit: low-emitting materials, category – sealants.
- .2 Submit manufacturer product data sheets and MSDS sheets which identify compliance with this VOC content limit.

10.3 Products

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

Standard of Acceptance

- Hilti Firestop Systems
 - 3M
 - Nelson Firestop Products
 - Eastern Wire + Conduit (Royal Quickstop)
- .2 Other manufacturers having products with explicitly similar characteristics, listings or classifications and approvals are acceptable.

10.4 Installation

- .1 Install firestopping and smoke seals in accordance with the manufacturer's recommendations and in accordance with its listing.
- .2 Firestopping and smoke seals to be installed only by personnel trained by the manufacturer on the installation of such systems.
- .3 Seal space between penetrating service and sleeve or opening in in fire rated floors and walls with a firestop and smoke sealing system.
- .4 Select thickness and arrangement of back-up materials to suit size of service, length of sleeve and anticipated movement.
- .5 At time of application of materials, surfaces to be clean, dry and free from dust, oil, grease, loose or flaking paint and foreign materials.
- .6 Select firestopping system to allow insulation and vapour barrier to pass un-broken through assembly.
- .7 Do not apply fire stopping materials to fire or smoke dampers.

11 WALL AND FLOOR PLATES

11.1 General

- .1 Provide finishing plates fitted to ducts, pipes, and electrical services provided under Division 20 of the Work which pass through walls, floors and ceilings in finished areas.

11.2 Products

- .1 Escutcheons for small diameter piping and small diameter electrical conduit:
 - .1 manufactured chrome plated two-piece split type with hinge and set-screw.
- .2 Finishing plates for ducts, larger pipes, larger electrical conduits and electrical cables:
 - .1 finishing plate (ring) fabricated from minimum 0.9 mm (20 ga) thick T304 stainless steel with No. 4 brushed finish, with minimum 25 mm (1 in) high collar ring,
 - .2 mounting holes drilled at not less than three (3) symmetrically location positions around the ring to allow mechanical fastening,
 - .3 plate diameter to be sufficiently sized to overlap the wall, floor or ceiling opening by not less than 25 mm (1 in) all around the opening.

11.3 Installation

- .1 Escutcheons:
 - .1 secure escutcheons to pipe and electrical conduit with mechanical fastener.
- .2 Finishing plates:
 - .1 set finishing plates flat against the finished surfaces, and secure to the surface with stainless steel pan-head mechanical fasteners. Provide insert anchor plugs in the finished surface as necessary to secure the fasteners.

12 PIPE SUPPORTS, EQUIPMENT SUPPORTS, AND TRENCH COVERS

12.1 General

- .1 Design and fabricate supplementary supporting steel for piping, ductwork and equipment supports, and trench and pit covers, from steel plate and sections. For clarity, the contractor under these Division 20 to 25 of the Work is responsible for design, fabrication and installation of such materials.
- .2 Concrete housekeeping bases for mechanical and electrical equipment which are in direct contact with floor slab, are to be provided by this Division 20.
- .3 Concrete for equipment supported on vibration isolated inertia bases is to be provided by this Division 20.
- .4 Work to be done by firms specializing in these fields.
- .5 Submit shop drawings for steel and concrete work, prepared by Professional Engineers licensed in the jurisdiction of the Work

12.2 Applicable Codes and Standards

- .1 Legislation:

Vancouver Building By-Law, 2019

- .2 BC Building Code, 2018

- .2 Installation codes and standards:

- .1 CAN/CSA-S16.1 Limit States Design of Steel Structures.
- .2 CSA W59 Welded Steel Construction (Metal Arc Welding).
- .3 Product standards:
 - .1 ASTM A36 Standard Specification for Carbon Structural Steel
 - .2 ASTM A53/A53M Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .3 ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - .4 ASTM A 307 Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .5 CAN/CSA G40.20/G40.21 General Requirements for Rolled or Welded Structural Quality Steel.

12.3 Supplementary Supports and Support Brackets

- .1 Provide supplement supports and brackets for the support of equipment, piping and ductwork.
- .2 Fabricate supports from structural grade steel with anchor bolts and fastenings, so that horizontal supporting beam deflections do not exceed 1/360 for the span, and not exceed an absolute deflection of 5 mm (0.20 in), with a safety factor of 1:4 to the ultimate strength of the material
- .3 Design the supports in consultation with the building structural Consultant, to transfer live loads and dead loads to the building structural elements,
- .4 Construct the supports as frames bracketed from walls, and/or supported from building structure above, and/or floor below.

12.4 Slide Pads for Equipment Support

- .1 General:
 - .1 slide pads for equipment supports for equipment subject to thermal expansion,
 - .2 designed for continuous-weld and/or tack-welding of backing plate to the equipment support,
 - .3 assembled in pairs per load point.

Standard of Acceptance

- ° Piping Technologies & Products Inc.
- .2 Composite 25% glass-filled PTFE bearing plate bonded to carbon steel backing plate:
 - .1 PTFE thickness: 0.1 mm (3/32 in.)
 - .2 backing plate: 3 mm (1/8 in.) thick carbon steel plate,
 - .3 compressive strength: 19.3 MPa (2800 psi)
 - .4 temperature rating: -45 to +260°C (-50 to +500°F)
 - .5 coefficient of friction: 0.15
- .3 Graphite bearing plate bonded to carbon steel backing plate:
 - .1 graphite thickness: 13mm & 6mm (1/2 in & 1/4 in.)
 - .2 backing plate: 6 mm (1/4 in.) thick carbon steel plate,
 - .3 compressive strength: 19.3 MPa (2800 psi)
 - .4 temperature rating: -45 to +537°C (-50 to +1000°F)

.5 coefficient of friction: 0.15.

12.5 Trench Covers, and Pit Covers

.1 Fabricated with:

- .1 75 mm x 75 mm x 9.5 mm (3 in x 3 in x $\frac{3}{8}$ in) welded angle frame with anchor bars,
- .2 25 mm x 9.5 mm (1 in x $\frac{3}{8}$ in) trim bar to fit concrete pit, and with matching checker-plate cover,
- .3 hot dip galvanized after fabrication

12.6 Installation - General

- .1 Locate supporting steel to permit removal of parts for service or repair, and to allow clear access to valves, fittings, and equipment,
- .2 Set equipment on supporting frames and brackets and install hangers, anchor bolts, vibration mountings and snubbers.
- .3 Set equipment base plates on housekeeping pads on minimum 13 mm ($\frac{1}{2}$ in) epoxy grout and fill hollow portion of base with concrete.
- .4 Install anchor bolts, vibration mountings and snubbers between equipment and housekeeping pad, or inertia pad and housekeeping pad.
- .5 Provide anchorage, dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.
- .6 Make field connections with bolts to CAN/CSA-S16.1, or by welding.
- .7 Supply items for casting into concrete or building into masonry to appropriate trades together with setting templates.
- .8 Touch-up field welds, bolts and burnt or scratched surfaces after completion of erection with primer.
- .9 Where trench covers are cut in field or damaged, touch up with zinc rich paint.

13 HOUSEKEEPING PADS AND CURBS

13.1 General

- .1 Housekeeping pads and containment curbs are to be provided under Division 03 of the Work with details of construction by the project structural engineer.
- .2 Be responsible for coordinating with the trade contractor under Division 03 of the Work for construction of the housekeeping pads and curbs, including but not limited to laying out of these pads and curbs, location dimensions relative to the building structure, and identifying pad/curb heights based on supported equipment type
- .3 Provide equipment anchors for embedment in concrete floors, pads and curbs, and place and secure in required position.
- .4 Inspect the pads and curbs during construction and verify pads and curbs are level and true.

13.2 Housekeeping Pads for Seismically-Restrained Equipment

- .1 Refer to Specification section 20 05 49 for additional requirements for housekeeping pads which support equipment requiring seismic restraint.

13.3 Products

- .1 Concrete: [20 MPa (3000 psi),

- .2 Reinforcing bars: carbon steel Grade 400R to CSA G30.18 *Carbon Steel Bars for Concrete Reinforcement*,
- .3 Housekeeping pad manufactured anchors:
 - .1 for installation prior to pouring of the housekeeping pad and post-installation of the structural floor,
 - .2 tapered ductile iron body, with openings sized for two runs of 10M (#3) reinforcing bar, and body NC threaded receiver for connection to undercut or expanding wedge anchors,
 - .3 two pieces of Ø10mm (#3) reinforcing bar, of sufficient length to tie into housekeeping pad reinforcement,
 - .4 undercut or expanding wedge anchor for connection to the structural floor slab.

Standard of Acceptance

- Mason Industries - fig. HPA

- .4 Adhesive anchors for post-concrete installation:
 - .1 seismically qualified for installation in cracked concrete in accordance with ACI 355.2 by testing for seismic tension and shear loads in cracked concrete in accordance with ICC-EC AC308.
 - .2 to have an ICC-ES seismic evaluation report, and be suitable for installation in cracked and uncracked normal- and light-weight concrete.
 - .3 anchors to be selected for concurrent shear and tension loads with a safety factor not less than 2.0 times estimated load.
 - .4 injectable, two-component hybrid adhesive, matching threaded rod and accessories.

Standard of Acceptance

- Hilti - fig. HIT-HY 200]

13.4 Installation - Concrete Housekeeping Pads

- .1 Construct housekeeping pads using plywood form-work and site-poured concrete with reinforcing bars and run pads continuously beneath the equipment.
- .2 [Housekeeping pad reinforcement and floor anchors for seismically-restrained equipment: conform to Specification section 20 05 49.]
- .3 Finish exposed concrete surfaces to make them flat, level, and smooth.
- .4 Finish exposed edges with a 20 mm (3/4 in.) chamfer.

13.5 Housekeeping Pad Dimensions

- .1 Seismic applications: outside dimensions of pads to conform to Specification section 20 05 49.
- .2 Plan dimensions of housekeeping pads for large equipment that has a non-continuous base, including chillers and fuel storage tanks:
 - .1 curb width for equipment requiring seismic restraint:
 - (a) extending a minimum of 200 mm (8 in.) outwards from the outside edge of the equipment base frame channel or anchor bracket whichever is greater, and
 - (b) extending 100 mm (4 in.) inwards from the inside face of the equipment base frame channel.]
- .3 Housekeeping pad height for air handling equipment equipped with condensate drains: minimum 150 mm (6 in.) unless higher dimensions are shown.
- .4 Housekeeping pad height for all other equipment: in accordance with the following table based on equipment type, location and vibration isolation condition:

Equipment Type	Floor Type	Vibration Isolation	Thickness of Housekeeping Pad mm (in)
Stationary, not motorized	All	All	100 (4)
Fans	All	Yes	150 (6)
Motorized, up to 7.5kW (10 HP)	All	Yes or No	150 (6)
Motorized, 11 to 19kW (15 to 25 HP)	Slab on Grade	No	250 (10)
	Slab on Grade	Yes	150 (6)
	Suspended Slab	Yes	150 (6)
Motorized, 22kW (30 HP) and over	Slab on Grade	No	300 (12)
	Slab on Grade	Yes	150 (6)
	Suspended Slab	Yes	150 (6)

13.6 Installation - Concrete Containment Curbs

- .1 Concrete containment curbs are not to be used for support of equipment except for equipment weighing less than 9 kg (20 lbs.).
- .2 Construct concrete housekeeping curbs to the same requirements as for housekeeping pads except/and as follows.
- .3 Containment curb reinforcement:
 - .1 reinforce the housekeeping curbs with two runs of size 10M reinforcement bar along the length of the curb with 10M on 300 mm (12 in.) on centres one way across the curb,
 - .2 locate the reinforcement bars parallel to the long dimension of the curb at 40 mm (1-1/2 in.) from the outside face of the curb,
 - .3 tie-wire reinforcing bars together at crossings,
 - .4 place reinforcing bars with bottom layer positioned at 50 mm (2 in.) up from structural floor.]
- .4 Curb anchors:
 - .1 as specified for housekeeping pads, with one anchor provide within 200 mm (8 in.) of the end of the curb and at intermediate spacing not exceeding 1500 mm (5 ft).

13.7 Concrete Curb Dimensions

- .1 Dimensions for containment curbs: 150 mm wide x 150 mm high (6 in. x 6 in.) and length as shown, unless otherwise shown.

14 INSTALLATION OF EQUIPMENT SUBJECT TO THERMAL EXPANSION

- .1 The following specific installation requirements apply 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 deaerators 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 mechanically-fasten one fixed support point which is closest to the inlet exhaust piping connections,
 - .2 for supports located on the same transverse or longitudinal axis as the fixed support point, provide slide guides with lateral limit-stops (lateral to the direction of thermal movement) with a lateral clearance gap not exceeding:
 - (a) 6 mm (1/4 in.) lateral movement for outdoor equipment and/or equipment subject to seismic restraint,
 - (b) 12 mm (1/2 in.) total movement otherwise.
 - .3 for other support points, provide guides with two-axis horizontal limit-stops to allow free movement under thermal conditions,
 - .4 when installed outdoors, or where subject to seismic restraint, or both, provide vertical movement limit stops to limit free movement due to wind loading or seismic forces to not more than 6 mm (1/4 in.).
- .3 Provide support slide pads beneath each support leg other than the fixed support;
- .1 use PTFE slide pads for equipment with an operating temperature less than 260°C (500°F),
 - .2 use graphite slide pads for equipment with an operating temperature greater than 260°C (500°F).

END OF SECTION

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.
 - 21 05 23 General-Duty Valves for Water-Based Fire-Suppression Piping

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

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	•			•		•

Manufacturer	Gate, Globe, Angle, Check	Silent Check	DRV	Butterfly	Plug	Ball
American Valve						•
APCO		•				
Apollo				•		•
Bonney Forge	•					
Beric	•					
Bray				•		•
Canadian Worchester Controls						•
Challenger				•		
Couplox				•		
Crane	•			•		•
Crane Centreline				•		
Crane Flowseal				•		
Dahl Bros	•					•
Demco				•		
DeZurik				!		
Durabla		•				
Grinnell				•		
Gruvlok				•		•
Hattersley Milliken (Crane)					•	
Jenkins	•			•		•
Keystone				•		
Kitz	•			•		•
MA Stewart (MAS)	•					•
Milwaukee Valve				•		•
Mueller		•		•	•	
Neo Valves	•					•
Nibco	•	•		•		•
Nordstrom					•	
Powell	•					
Preso			•			
S.A. Armstrong	•		•			
Shurjoint				•		•
Sure Seal				•		
Tour & Anderson			•			
Toyo Valve (Red & White)	•					•
Triad				•		
Trueline	•					•
Valmatic		•				

Manufacturer	Gate, Globe, Angle, Check	Silent Check	DRV	Butterfly	Plug	Ball
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)				•		•
Pump Balancing		• [1] [3]		•		•

Notes:

[1] Gear operator with position limit memory stops.

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

[3] Sized one (1) NPS line size smaller than pipe line size (not pump discharge size).

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 mains 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:

Issued For Permit and Tender Tender

- .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.

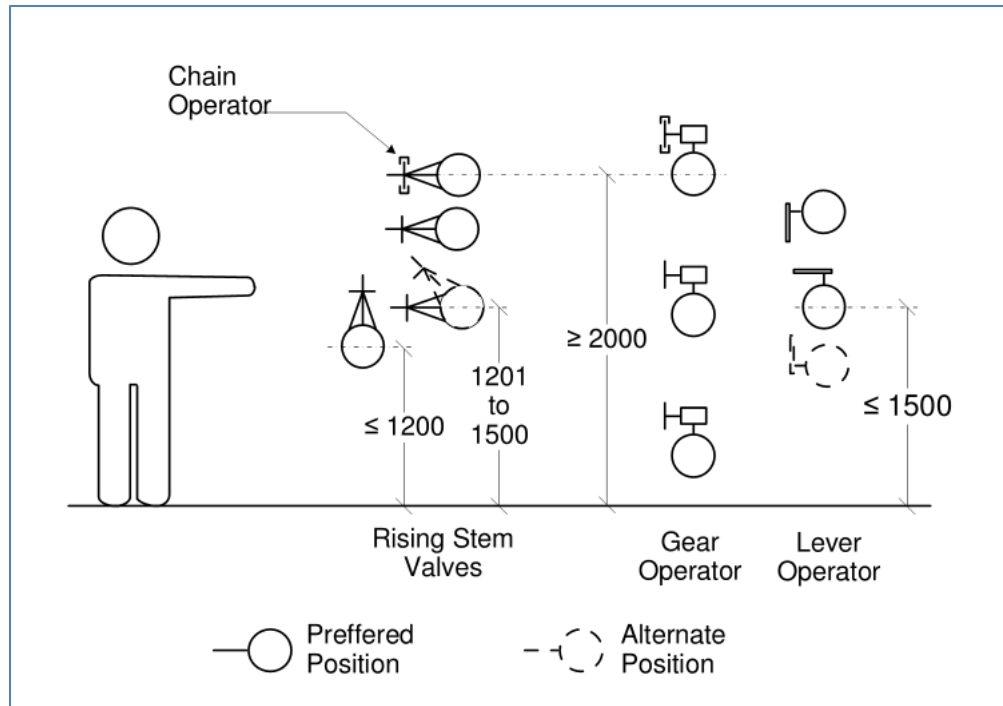


Figure 1: Valve Spindle Arrangement

- .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

COMMON HANGER AND SUPPORT REQUIREMENTS FOR PIPING

20 05 29

1 GENERAL

1.1 Scope

- .1 Provide hangers and supports for piping, including insulation protection devices.
- .2 The requirements of this specification section apply to all piping systems, except where required otherwise by specific piping specification sections including:
 - .1 20 05 16 Flex Connections, Expansion Joints, Anchors and Guides
 - .2 21 05 01 Common Work Results for Fire Suppression
- .3 Provide engineering services associated with the design, analysis, and selection of custom piping supports, including pipe riser supports.

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 16 Flex Connections, Expansion Joints, Anchors and Guides
 - .2 20 05 49 Seismic Restraints for Mechanical Services

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section:
 - .1 **Ambient piping:** piping with a fluid temperature greater than 16°C (61°F) and up to and including 40°C (104°F).
 - .2 **Cold piping:** piping with a fluid temperature greater than 4°C (39°C) and up to and including 16°C (61°F).
 - .3 **Dual temperature piping:** piping which operates non-simultaneously as both cold piping and hot piping depending on the season.
 - .4 **Hot piping:** piping with a fluid temperature greater than 60°C (140°F).
 - .5 **Low temperature piping:** piping with a fluid temperature greater than 40°C (104°F) and up to and including 60°C (140°F)

1.4 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 CAN/UL 203 Standard for Pipe Hanger Equipment for Fire Protection Service
- .2 Refer to each applicable piping specification section for supplemental requirements for pipe supports.

1.5 Analysis, Design, and Inspection Services

- .1 Where custom fabricated pipe and equipment supports are proposed to be used, provide the services of a professional engineer, licensed in the province or territory of the Work and who specializes in the design of piping and equipment supports (the "Specialty Engineer"), for the design of piping and equipment support systems and to provide inspection services of the completed installation.

- .2 Provide services of a Specialty Engineer for the design and selection of constant-load and variable-load hanger supports. Where a manufacturer of such equipment provides this design service, this is deemed to meet this requirement.
- .3 Specialty Engineer design services to include;
 - .1 provide the design of the piping support system, including anchors, guides, expansion joints, and shall include seismic restraints where applicable,
 - .2 analysis of dead loads, thermal expansion loads, wind load, static seismic loads (where applicable) and capacity of materials utilized for connections to equipment and structure.
 - .3 provide design drawings showing locations of supports, restraints and details of construction and attachment of supports and restraints,
 - .4 seismic design to conform to Specification section 20 05 49 where applicable.
- .4 Specialty Engineer inspection services to include:
 - .1 at periods during installation and at completion of the installation of the piping supports and anchor devices, the Specialty Engineer shall inspect the installation, identify and report deficiencies (if any) which are observed, and re-inspect the installation after deficiencies have been corrected,
 - .2 Specialty Engineer to submit periodic inspection reports and a final inspection report after all work is completed and deficiencies have been corrected, confirming the installation conforms to the design requirements. Prepare and submit any required declarations or similar document to this effect where required by local legislation. Include in the final report site photographs of the complete installation prior to covering with insulation, with specific photos at pipe anchors, guides, and expansion joints.
- .5 Provide shop drawings of custom supports, which shall be sealed by the Specialty Engineer.
- .6 Provide signed declarations for commitment for general review and final review letters of conformity as required by applicable legislation at the place of the Work.

1.6 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 published tension load rating data in accordance with Table 2 of MSS SP-58.
 - .2 design of custom trapeze hangers shall meet the design criteria as specified in Part 2 of this section.
- .2 Provide complete custom engineered design services in accordance with the requirements of MSS SP-58 for support of vertical piping for the following portions of the Work:
 - .1 vertical piping located in vertical services spaces (shafts) where any of the following criteria apply;
 - (a) piping is NPS 8 and larger,
 - (b) the vertical pipe length exceeds 25 m (82 ft),
 - (c) pipe expansion joints are shown, or
 - (d) vibration isolated supports, variable spring supports or constant load supports are shown.
 - .2 where horizontal piping is supported on;
 - (a) trapeze hangers or supported on/suspended from horizontal structural elements, or
 - (b) pipe racks.

- .3 Where the mechanical system are required to have seismic restraints, this section is to be read in conjunction with the requirements of Specification section 20 05 49.
- .4 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 custom 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 all loads used for designing of supports are concurrent static and dynamic loads including vibration, seismic (where applicable to the project), and where applicable wind and snow loads in outdoor installations,
 - (a) for clarity, the design does not need to consider seismic loads concurrently with wind or snow loads.
 - .3 horizontal pipe vertical deflection at midpoint in the pipe span while in operation not to exceed 2.5 mm (0.10 in.),
 - .4 deflections of horizontal supporting elements does not exceed $1/240^{\text{th}}$ of the span,
 - .5 design load for carbon steel materials: not to exceed 28% of minimum tensile strength nor exceed 50% of minimum yield strength in combined tension/compression and bending,
 - .6 design load for stainless steel and low alloy steel materials: not to exceed 20% of minimum tensile strength and 45% of minimum yield strength in tension/compression and bending.
 - .7 rod hanger loads are not to exceed 90% of the table 2 values in MSS SP-58.
 - .8 maximum single point suspended tension load in concrete not to exceed [20.5 kN (4600 lbs.)],
 - .9 operating pipe stress not to exceed the maximum allowable stress in accordance with the requirements of the piping code specified for the piping system.
- .5 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 imposed load calculations.

1.7 Submittals

- .1 Submit manufacturer product data sheets for 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 fabricated trapeze hangers and completely engineered support systems, including
 - .1 construction detail drawings for each loading condition,
 - .2 span deflection calculations,
 - .3 building attachment load calculations and type.

- .4 shop drawings to be sealed by a professional engineer licensed in the project location jurisdiction.
- .5 Where custom designed supports are proposed, shop drawings are to be sealed by a professional engineer licensed in the place of the Work.

1.8 Quality Control

- .1 Where custom engineered supports are used, provide the services of a specialist professional engineer licensed in the location of the Work, to design the support systems and to conduct an inspection of the completed installation that it is in general conformance with the sealed shop drawing requirements, and submit an inspection report to the Owner and the Consultant.

2 PRODUCTS

2.1 General

- .1 Fabricate pipe hangers, supports, sway braces and associated components from stock or production parts, manufactured and fabricated in conformance with MSS SP-58, and the requirements of the piping code specified for each piping system.
- .2 Pipe hangers and supports for fire protection systems to be listed to CAN/UL 203, except where such listing requirement is excluded under applicable NFPA standards.
- .3 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.
- .4 Where specified products define the applicable pipe size NPS range (notwithstanding that the product may be available for larger pipe sizes), the maximum specified pipe size is limited to not exceed the load rating of the specified product under maximum allowable pipe spans as defined in MSS SP-58 for insulated pipe filled with water.
- .5 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.
- .6 Select pipe support products from manufacturers standard product line.

Standard of Acceptance

- Anvil
- Unistrut
- Taylor
- Acrow Richmond
- Portable Pipe Hangers
- Hilti
- nVent Caddy
- Pipe Shields
- Buckaroos

2.2 Upper Attachments – Inserts for New Concrete

- .1 General:
 - .1 upper hanger attachment for casting into new cast-in-place concrete decks, for piping or equipment supports,

- .2 for attachment to formwork prior to concrete pour,
 - .3 designed to receive USS coarse thread hanger rods.
 - .4 in the following tables, pipe size limit is based on insulated pipe filled with water at the maximum allowable span in accordance with Schedules A1(a), A2(a), and A3 at the end of this section. Larger pipe sizes may apply where reduced spans are used in accordance with the alternate rod size and support span limits in accordance with Schedules A1(b) and A2(b) as the end of this section.
- .2 Fixed rod position:
- .1 fixed position type,
 - .2 listed to CAN/UL 203 for fire protection piping, for pipe NPS ¾ through NPS 8,
 - .3 materials: malleable iron, or zinc-plated carbon-steel with plastic form, with nailing feature,
 - .4 minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/8	3.25 (730)	2
Ø1/2	5.0 (1130)	3
Ø5/8	5.6 (1260)	4
Ø3/4	11.1 (2500)	8

Standard of Acceptance

- ° Anvil - fig. 152
- ° Hilti - fig. KCM

- .3 Fixed rod position – high capacity:
- .1 fixed position type,
 - .2 stainless steel insert body, with two (2) fibreglass and concrete barrier disc for attachment to concrete rebar,
 - .3 minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/4	14.4 (2500)	8
Ø7/8	19.9 (4480)	12
Ø1	26.2 (5900)	18
Ø1-1/4	42.2 (9500)	20
Ø1-1/2	61.4 (13,800)	30

Standard of Acceptance

- ° Anvil - fig. 286

- .4 Single-direction adjustable rod position:

- .1 listed to CAN/UL 203 for fire protection piping, for pipe NPS ¾ through NPS 8.
- .2 galvanized wedge inserts to MSS SP-58 type 18, with single-direction adjustment of rod position,
- .3 minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/8	3.25 (730)	2
Ø1/2	5.0 (1130)	3
Ø5/8	5.6 (1200)	4
Ø3/4	11.1 (1200)	8

Standard of Acceptance

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

.5 Concrete inserts – channel type;

- .1 single hanger or multiple hangers support,
- .2 2.75 mm (12 Ga) thick channels, hot-dipped galvanized, with concrete embedment tabs, open bottom channel allowing multiple support points and lateral position adjustment,
- .3 with back plates, end caps and closure strips to prevent concrete spillage into channel space,
- .4 minimum point load spacing: 300 mm (12 in.)
- .5 maximum tension load rating for single hanger support:

Channel Length mm (in.)	Tension Load kN (lbf)	Tension Load kN/m (lbf/ft)	Single Pipe Size Limit NPS
200 (8)	4.4 (1000)	---	6
300 (12)	6.6 (1500)	---	8
450 (18)	17.8 (4000)	23.8 (2000)	12

Standard of Acceptance

- ° Unistrut - fig. P-3249 to P-3270 series.

2.3 Upper Attachments – Anchors for Existing Concrete

.1 General:

- .1 upper hanger attachment for anchoring into existing concrete decks, for piping or equipment supports,
- .2 designed to receive USS coarse thread hanger rods.

.2 Drop-in anchors:

- .1 zinc-plated carbon steel drop-in friction anchor design, with matched drill bit and setting tool,
- .2 not to be used for seismic restraints or hanger rods at pipe hangers having seismic restraint,
- .3 rated for uncracked concrete,

- .4 listed to CAN/UL 203 for fire protection piping, for pipe NPS ¾ through NPS 8,
- .5 capacity rating with 4:1 safety factor to ultimate load,
- .6 minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/8	2.82 (635)	2
Ø1/2	4.2 (945)	3
Ø5/8	8.34 (1875)	4
Ø3/4	11.1 (2500)	8

Standard of Acceptance

- ° Hilti - fig. HDI, HDI+, HDI-L+

.3 Wedge anchors:

- .1 anchor-end wedging action on concrete, and not relying on friction between side of bolt and concrete hole wall,
- .2 zinc-plated carbon steel wedge anchor design with load washer and nut,
- .3 wedge anchor capacity as specified herein to be rated for cracked concrete having not less than 20 MPa (2900 psi) strength.
- .4 rated for cracked and uncracked concrete,
- .5 listed for seismic tension and shear loads in accordance with ACI 355.2 and ICC-ES AC193.
- .6 listed to CAN/UL 203 for fire protection piping, for pipe NPS ¾ through NPS 8,
- .7 extra-long bolt length to allow attachment of hanger rod coupling with full thread engagement in the coupling, while providing required load engagement length,
- .8 standard rating: minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/8	4.85 (1090)	2
Ø1/2	7.52 (1690)	3
Ø5/8	12.1 (2715)	4
Ø3/4	15.5 (3495)	8

Standard of Acceptance

- ° Hilti - fig. Kwick Bolt series

- .9 high-capacity rating: minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)
Ø3/8	14.0 (3150)

Rod Nominal Size	Tension Load kN (lbf)
Ø1/2	20.8 (4675)
Ø5/8	29.1 (6535)
Ø3/4	40.6 (9135)
Ø7/8	53.4 (12,000)

Standard of Acceptance

- Hilti - fig. HSL-3 series

2.4 Upper Attachment – Mounting Plates

- .1 Surface mounting plates to underside of concrete decks:
 - .1 for installation post concrete pour with either concrete inserts or drilled anchors,
 - .2 surface mount carbon steel plate, with either clevis hanger with pin (for use with hanging rod-eye) or for attachment of hanger rod and load nut,
 - .3 mounting holes in four corners of plate, sized for fastening bolts to achieve rated capacity,
 - .4 minimum load rating in tension based on connected rod size:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/8	3.25 (730)	2
Ø1/2	6.0 (1350)	3
Ø5/8	9.6 (2160)	4
Ø3/4	14.4 (3230)	8
Ø7/8	19.9 (4480)	12
Ø1	26.2 (5900)	18
Ø1-1/4	42.3 (9500)	20
Ø1-1/2	61.4 (13,800)	30

Standard of Acceptance

- Anvil - fig. 49 clevis plate,
- Anvil - fig. 52 load nut,
- Taylor - fig. 166 clevis plate,
- Taylor - fig. 167 load nut

2.5 Upper Attachments – Steel Structure

- .1 Steel beam clamp (bottom flange), pipe size NPS 8 and smaller:
 - .1 hanger clamp attachment to beam or joist bottom flange, applying concentric loading to the beam/joist web,
 - .2 for hanger rod sizes Ø3/8 to Ø7/8 in.,
 - .3 malleable iron or carbon steel, symmetrically loading beam clamp to MSS SP-58, type 30,

- .4 listed to CAN/UL 203 for fire protection piping,
- .5 minimum load rating in tension: 6.1 kN (1365 lbf)
- .6 with extension piece swivel attachment to receive hanger rod.

Standard of Acceptance

- Anvil - fig. 218 with fig. 157 extension swivel.
- Taylor - fig. 410 with fig. 411 extension swivel.

- .2 Steel beam clamp (bottom flange), pipe size NPS 2½ to 24:
 - .1 hanger clamp attachment to beam or joist bottom flange, applying concentric loading to the beam/joist web,
 - .2 for hanger rod sizes Ø5/8 to Ø1-1/2 in.,
 - .3 forged steel, symmetrically loading heavy duty beam clamp, to MSS SP-58, type 28 or 29.
 - .4 load rating based on standard hanger rod load capacities in accordance with MSS SP-58,
 - .5 with weldless eye nut.
 - Anvil - fig. 228
 - Taylor - fig. 450
- .3 Steel beam (top flange) - for conduit, piping NPS 6 and smaller, and ductwork:
 - .1 hanger clamp attachment to the top flange of beam or joist, applying an eccentric loading to the beam/joist,
 - .2 carbon steel, hook rod with locking jaw, fasteners and lock washers, to MSS SP-58, type 25,
 - .3 for hanger rod sizes Ø3/8 to Ø3/4 in.,
 - .4 minimum load rating in tension:

Rod Nominal Size	Tension Load kN (lbf)	Single Pipe Size Limit NPS
Ø3/8	3.2 (730)	2
Ø1/2 to Ø3/4	4.2 (940)	6

- .5 listed to CAN/UL 203 for fire protection piping (rod size Ø3/8 and Ø1/2 in.)

Standard of Acceptance

- Anvil - fig. 227

- .4 Steel joists (joist bottom chord) – for piping NPS 2 and smaller:
 - .1 steel washer plates for installation of support rod within the interstice space of double-channel steel joists and open-web steel joints, installed on top and bottom surface of the joist and secured with load nut (top washer plate) and locking nut (bottom washer plate).
 - .2 load rating based on standard hanger rod load capacities in accordance with MSS SP-58,
 - .3 carbon steel washer plates with locking nuts,

Standard of Acceptance

- Anvil - fig. 60
- Taylor - fig. 80

2.6 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),
- .4 minimum load rating:
 - (a) medium duty: 6.7 kN (1500 lbs).
 - (b) heavy duty: 13.4 kN (3000 lbs).

Standard of Acceptance

- Anvil - fig. 195 and 199
- Taylor - fig. 801 and 802.

.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,
- .5 minimum load rating: 3.35 kN (750 lbs).

Standard of Acceptance

- Anvil - fig. 194

2.7 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
- Taylor - fig. 63

.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
- Taylor – fig. 64

2.8 Hanger Rod

- .1 Continuous threaded rod:
 - .1 carbon steel, USS course thread,
 - .2 tension load ratings to meet or exceed MSS SP-58.

Standard of Acceptance

- Anvil - fig. 146
- Taylor – fig. 54

- .2 Welded eye rod:
 - .1 carbon steel, USS course thread,
 - .2 tension load ratings to MSS SP-58,
 - .3 tension load ratings to meet or exceed MSS SP-58 for hanger rod.

Standard of Acceptance

- Anvil - fig. 278
- Taylor - fig. 53

- .3 Rod connectors:
 - .1 carbon steel, USS course thread,
 - .2 with mid-point site hole,
 - .3 tension load ratings to meet or exceed MSS SP-58.

Standard of Acceptance

- Anvil - fig. 135i
- Taylor - fig. 62S

2.9 Horizontal Pipe Support - Clevis

- .1 Clevis support:
 - .1 applicable piping materials:
 - (a) carbon steel and stainless steel pipe, schedule 10 to 80,
 - (b) cast iron DWV piping,
 - .2 carbon steel, adjustable clevis, with clevis bolt reinforcing tube, to MSS SP-58 Type 1,
 - .3 adjustable hanger height while under load,
 - .4 listed to CAN/UL 203 for fire protection piping,
 - .5 applicable pipe size:
 - (a) steel pipe: NPS ½ to NPS 16

- (b) ductile or cast iron drainage pipe: NPS 3 to 24

Standard of Acceptance

- Anvil - fig. 260
- Anvil - fig. 590 (for ductile or cast iron drainage pipe)
- Taylor – fig. 24
- Taylor – fig. 27AC (for ductile or cast iron pipe)

- .2 Clevis support with extended yoke for where yoke is located inside of pipe insulation:

- .1 applicable piping materials:

- (a) carbon steel and stainless steel pipe, schedule 10 to 80,
- (b) cast iron DWV piping,

- .2 carbon steel, adjustable clevis, with clevis bolt reinforcing tube, to MSS SP-58 Type 1,

- .3 adjustable hanger height while under load,

- .4 yoke sized for outside dimension of pipe only, with extended yoke to clear pipe insulation,

- .5 applicable pipe size:

- (a) steel pipe: NPS ¾ to NPS 12

Standard of Acceptance

- Anvil - fig. 300
- Taylor – fig. 24L

- .3 Clevis support with integral non-metallic insulation saddle:

- .1 alternate to using standard clevis hanger specified above with separate high density insulation inserts or pipe insulation saddles,

- .2 applicable piping materials:

- (a) insulated carbon steel and stainless steel pipe, schedule 10 to 80,
- (b) insulated cast iron drainage piping.

- .3 carbon steel, adjustable clevis, with clevis bolt reinforcing tube, to MSS SP-58 Type 1,

- .4 adjustable hanger height while under load,

- .5 listed to CAN/UL 203 for fire protection piping,

- .6 with glass-reinforced polypropylene saddle, sized to allow up to 50 mm (2 in.) insulation thickness,

- .7 yoke and clevis sized for outside dimension of pipe and insulation,

- .8 applicable pipe size:

- (a) steel pipe: NPS ½ to NPS 8,
- (b) copper tube: NPS ½ to NPS 8.

- .9 piping system design temperature limits: 4.4 to 100°C (40 to 212°F).

Standard of Acceptance

- Anvil - fig. 260 ISS

- .4 Clevis support for copper pipe and tube:

- .1 for copper tube, NPS ½ to 4,

- .2 zinc-plated carbon steel yoke and clevis, adjustable clevis to MSS SP-58, type 1, copper plated or felt lined finish,
- .3 applicable tube size: NPS ½ to NPS 4,
- .4 sized for outside dimension of pipe/tube, or outside diameter of pipe and insulation as applicable.

Standard of Acceptance

- Anvil - fig. CT-65 or 260F
- Taylor – fig. 52

2.10 Horizontal Pipe Support – Clevis for Fire Protection

- .1 Pipe size range: NPS 2 to NPS 8.
- .2 Light-duty, side-opening clevis support:
 - .1 for fire protection service only,
 - .2 pipe size range: NPS 2 to 8,
 - .3 galvanized carbon steel, adjustable clevis with fixed yoke,
 - .4 listed to ULC/ORD-C203 or UL 203 for fire protection piping,
 - .5 sized for outside dimension of pipe (and insulation if applicable).
 - .6 sized for outside dimension of pipe (and insulation where applicable),
 - .7 nominal pipe size: NPS 2 to NPS 8.

Standard of Acceptance

- Hilti - fig. MH-SLC Speed Lock

2.11 Horizontal Pipe Support – Swivel Ring Hanger

- .1 For non-insulated drain-waste-vent piping, gas piping, and chemical piping.
- .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
- Taylor – fig. 41, 43

2.12 Pipe Straps

- .1 General:
 - .1 for non-insulated drain-waste-vent piping, gas piping, and chemical piping.
 - .2 pipe size: NPS 4 and smaller.
- .2 Zinc plated carbon steel U-loop straps for mechanical fastening to structure.

Standard of Acceptance

- Anvil - fig. 262

- .3 Hot-dipped galvanized carbon steel U-loop with clip-in or bolt-on attachment to modular channel supports.

Standard of Acceptance

- Unistrut

2.13 Horizontal Pipe Support – Pipe Roller (Type 41, 43, 44)

- .1 Suspended support pipe roller – trapeze hanger style:
 - .1 adjustable height, pipe roller support for overhead support, to MSS SP-58 type 41,
 - .2 dual-hanger rod trapeze style,
 - .3 pipe size range: NPS ½ to NPS 16, with or without insulation.

Standard of Acceptance

- Anvil - fig. 171
- Taylor – fig. 95

- .2 Suspended support pipe roller – clevis hanger style:
 - .1 adjustable height, pipe roller support for overhead support, to MSS SP-58 type 43,
 - .2 single rod clevis style,
 - .3 pipe size range: NPS ½ to NPS 8, with or without insulation.

Standard of Acceptance

- Anvil - fig. 181
- Taylor – fig. 93

- .3 Bottom support pipe roller:
 - .1 adjustable height, pipe roller with bottom support rods, to MSS SP-58 type 41,
 - .2 for bottom support of piping,
 - .3 with mounting rods and upper/lower retention nuts at both ends,
 - .4 pipe size range: NPS ½ to NPS 16, with or without insulation.

Standard of Acceptance

- Anvil - fig. 177
- Taylor – fig. 95S

- .4 Bottom support pipe roller with stand:
 - .1 pipe roller with cast iron support stand, to MSS SP-58 type 44,
 - .2 for bottom support of piping,
 - .3 fixed height and adjustable height variants,
 - .4 base drilled for fastening to supporting element,
 - .5 pipe size range: NPS ½ to NPS 18, with or without insulation.

Standard of Acceptance

- Anvil - fig. 271 (fixed), fig. 274 (adjustable)

- Taylor – fig. 279S (fixed), fig. 280S (adjustable)

2.14 Horizontal Pipe Support – Slides

.1 Structural slide bases – 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 operating temperature range: -28 to 200°C (-20 to 400°F),
- .4 pipe insulation thickness clearance: up to 75 mm (3 in.),
- .5 pipe size and load rating in accordance with the following table:

Slide Base Type	Vertical Support Load Rating kN (lbf)	Lateral Restraint Load Rating kN (lbf)	Uplift Restraint Load Rating kN (lbf)	Pipe Size Range NPS	
				Water	Steam, Gas
T	35.0 (8000)	9.0 (2000)	3.6 (800)	½ to 18	½ to 30
H	53.0 (12,000)	13.0 (3000)	5.3 (1200)	6 to 8	½ to 30
	53.0 (12,000)	18.8 (4000)	7.1 (1600)	10 to 20	
	107 (24,000)	26.0 (6000)	10.7 (2400)	24 to 30	

Standard of Acceptance

- Anvil - figs. 257A, 436A, 439A
- Taylor – figs. 257A

.2 Structural slide base assemblies with PTFE pads – welded attachment:

- .1 for piping with design temperatures greater than 121°C (250°F), including steam at pressures greater than 103 kPa (15 psig),
 - (a) may also be used for lower temperatures,
- .2 as specified above for slide bases and as follows,
- .3 PTFE bonded to underside of slide,
- .4 matching lower steel plates with bonded PTFE element (for fastening to structural support beam),

Standard of Acceptance

- Anvil - figs. 257, 436, 439
- Taylor – figs. 257

.3 Restraint variants for slides:

- .1 lug restraints to limit lateral movement due to thermal expansion of between 6 mm to 25 mm (1/4 to 1 in.),
- .2 where seismic restraint is required, lug restraints designed to limit lateral and vertical uplift movement to not more than 6 mm (1/4 in.),
 - (a) exception: if lateral movement of greater than 6 mm (1/4 in.) is shown, then the seismic design load is to be two (2) times the seismic load as shown in Specification section 20 05 49.

- .4 Clamp for T and H slides supporting cold piping:
 - .1 galvanized steel clamp for insulated cold piping, sized for outside dimension of insulated pipe,
 - .2 rolled from structural plate steel with bolting flanges,
 - .3 continuous single clamp for length of slide, or two (2) individual clamps at each end of the slide,
 - .4 bottom half of clamp welded to T or H slides,
 - .5 top half of clamp mechanically fastened to bottom half.

Standard of Acceptance

- Anvil - fig. 212 (2 clamp) 432 (continuous clamp)

2.15 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
- Taylor – fig. 170

- .2 Fabricated trapeze support:
 - .1 custom designed trapeze hangers of either hollow structural sections, double C channels (strongbacks), single C channel or unequal lengths angle channels, to support one or more pipes, conduits or ducts,
 - .2 design of custom trapeze supports to conform to the requirements of MSS SP-58,
 - .3 designed and sealed by a professional engineer licensed in the jurisdiction of the work.
 - .4 design criteria:
 - (a) static design load: deadweight of supported services plus 1.5 kN (250 lbf) point load at the mid-span,
 - (b) dynamic loads: include for seismic loads where system is subject to seismic restraint, and for wind and snow loads where located outdoors, superimposed on static design load,
 - (c) maximum trapeze deflection at any point: 1/250 (0.4%) of trapeze span,
 - (d) design load for carbon steel materials: not to exceed 28% of minimum tensile strength nor exceed 50% of minimum yield strength in tension/compression and bending,
 - (e) design load for stainless steel and low alloy steel materials: not to exceed 20% of minimum tensile strength and 45% of minimum yield strength in tension/compression and bending.
 - .5 for concurrent tension/compression loads and bending loads, the sum of the ratio of the stresses to allowable stress shall not exceed 1.0.

$$\frac{\text{Stress in Tension or Compression}}{\text{Allowable Tension or Compression Stress}} + \frac{\text{Stress in Bending}}{\text{Allowable Bending Stress}} \leq 1.0$$

- .3 Hanger rods:
 - .1 minimum of two support rods per trapeze,
 - .2 rod size selected not to exceed 80% of the allowable maximum rod tensile load rating in accordance with MSS SP-58,

- .4 Pipe restraint:
 - .1 restrain pipes from lateral movement with:
 - (a) bolt-on angle brackets or pipe U-bolts for manufactured hangers, or
 - (b) welded-on angles for fabricated hangers,
 - .2 restraints to permit axial linear movement and axial-rotation, except where otherwise shown to be an anchor.

2.16 Horizontal Pipe Support – Drainage MJ

- .1 For support of horizontal cast iron drainage piping, as an alternative to clevis hangers.
- .2 Designed to support each end of the pipe on both sides of a drainage MJ joint, and at intermediate supports, elbows and tees.
- .3 Carbon steel, plain finish.
- .4 Pipe size: NPS 2 to NPS 6

Standard of Acceptance

- Anvil - fig. 250
- Taylor – fig. 25

2.17 Vertical Pipe Stanchions

- .1 Pipe support stanchion, with welded attachment:
 - .1 fixed height, or telescoping two-piece design with height adjustment, field-welded to pipe elbow or horizontal pipe,
 - .2 carbon steel, structural cylinder shape,
 - .3 designed for static loads of pipe and contents, as well as dynamic loads and anchor loads as shown,
 - .4 nominal pipe size: NPS 2 to NPS 18.

Standard of Acceptance

- Anvil - fig. 62

2.18 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
- Taylor – fig. 82

- .6 suspended pipe riser clamps, 4 or 6 bolt patterns, to ANSI/MSS SP-58, type 42,

Standard of Acceptance

- Anvil - fig. 40, 40SS
- Taylor – fig. 82HCopper pipe and tube:

- .7 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
- Taylor – fig. 85

2.19 Vibration Isolation Supports

- .1 Refer to specification section 20 05 48.

2.20 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 to be within 80% of the calculated in-service load,
- .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

2.21 Constant Load Supports

- .1 General:

- .1 maintains constant support load under variable pipe displacements,
- .2 deviation in supported load due to thermal movement does not exceed 6% of the operating load,
- .3 selected for piping loads and estimated travel under service conditions, with a minimum safety factor of 25 mm (1 in) extra travel or 20% of total travel, whichever is greater.

- .2 Construction:

- .1 carbon steel housing and spring, to MSS SP-58 types 54, 55 and 56
- .2 combination hanger moment arm and balancing spring design,
- .3 horizontal and vertical arrangements,
- .4 load adjustment and load indicator scale,
- .5 factory set for load and travel,

- .6 welding to ASME Section IX
- .7 welded attachment points
- .8 finish: semi-gloss primer coat.

Standard of Acceptance

- Anvil – fig R 80-V, 81-H
- Taylor – fig. RCS

2.22 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

- Taylor – fig. 35

2.23 Insulation Shields

- .1 Insulation shields:
 - .1 galvanized steel protection shield, thickness and length as applicable to pipe size, to MSS SP-58 type 40
 - .2 designed to meet MSS SP-58 maximum support spans with insulation inserts having a compressive strength of 620 kPa (90 psi).
 - .3 pipe size: NPS ½ to 24,
 - .4 insulation thickness: 12 mm to 50 mm (1/2 in. to 2 in.).
 - .5 gauge: minimum 18 ga.
 - .6 sleeve width: minimum 180 degree arc of insulation exterior surface
 - .7 minimum sleeve length:
 - (a) pipe NPS ½ to 4: 300 mm (12 in.)
 - (b) pipe NPS 6: 450 mm (18 in.)
 - (c) pipe NPS 8 to 24: 600 mm (24 in.)

Standard of Acceptance

- Anvil - fig. 167 (up to NPS 24)
- Anvil - fig. 168 (up to NPS 8)
- Taylor – fig. 69H

- .8 sleeve length exemption: sleeve lengths may be reduced where shield is supplied as an integrated part of a high density insulation insert system. – refer to Specification section 20 07 19.
- .2 Heavy-duty insulation shield:
 - .1 for piping NPS 18 and larger installed on roller hangers and trapeze hangers,

- .2 insulation shield as specified above plus a heavy duty support plate as follows,
- .3 support plate fabrication: 6 mm (1/4 in.) thick ASTM A36 galvanized steel rolled plate, inside diameter to fit outer radius of insulation shield,
- .4 size:
 - (a) width: minimum 120 degrees arc of mating insulation shield,
 - (b) length: not more than 100 mm (4 in.) shorter than the primary shield.
- .5 Support plate tack welded to the insulation shield.

2.24 Insulation 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.
- .2 For pipe sizes NPS ¾ to 36.
- .3 Insulation thickness range: 25 to 140 mm (1 to 5.5 in.)

Standard of Acceptance

- Anvil - fig. 160 to 166
- Taylor – fig. 70 to 77

3 EXECUTION

3.1 General

- .1 Where the specific requirements for pipe supports are specified in other sections of Division 20 to 23, the requirements of those sections take precedence over the requirements of this specification section.

3.2 Coordination with Concrete Work

- .1 Supply, deliver and install concrete inserts 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 Support and Hanger Installation – General Requirements

- .1 Support piping directly on or from structural building elements. Do not support pipe directly from other services. Multiple piping services may be supported on a common trapeze support.
- .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. Select hangers to include an electrical insulating material between the hanger and the pipe, or provide electrical insulating 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 lengths,
 - .2 size supporting steel to limit horizontal span deflection to 1/250 (0.4%) between connecting points to the structure,
 - .3 mechanically fasten supplementary steel to structural steel to prevent axial and transverse displacement, and rotation.
- .7 It is permissible to offset hangers and displace the hanging rod so that in the final operating position, the hanging rods are within 4° of vertical.
- .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 load nuts on the underside of attachment to the pipe support, including clevis hangers, roll supports, roll yoke hangers, and trapeze hangers.

3.4 Horizontal Pipe Support Spacing and Hanger Rod Size

- .1 Provide horizontal pipe supports at the spacing as detailed in the Schedule "A" included at the end of this Specification section, unless specified otherwise in other sections of Division 20 to 23.
 - .1 Schedule "A" includes alternate hanger rod size and support spans for reduced rod sizes.
- .2 Use threaded rod of the size based on pipe type and horizontal pipe hanger spacing as stated in the Schedule "A" for single rod hangers. Where the pipe hanger type requires two rods, the rod size may be reduced by one trade size but shall not be less than Ø3/8 in.
- .3 For piping using flexible roll-groove joints, there shall be not less than one hanger between pairs of joints.
- .4 Support plastic and other special piping, including anchors and guides, in accordance with the pipe manufacturer's requirements.

3.5 Horizontal Pipe Hanger and Support Selection

- .1 Select horizontal pipe hanger and support type based on pipe size and fluid service temperature in accordance with Schedules "B(1)" and "B(2)" at the end of this section.
- .2 For fire protection piping;
 - .1 use clevis hangers for all pipe sizes,
 - .2 swivel ring pipe hangers may be used for fire protection piping NPS 4 and smaller.
- .3 Swivel ring pipe hangers may only be used for;
 - .1 drain waste and vent (DWV) piping and tubing, NPS 4 and smaller,
 - .2 medical gas piping and laboratory gas piping, NPS 4 and smaller,
 - .3 compressed air piping and tubing located downstream of a refrigerated dryer, NPS 2 and smaller,
 - .4 chemical treatment piping NPS 2 and smaller.
- .4 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.
- .5 For other piping, select pipe support types in accordance with Schedule B at the end of this section.
- .6 For pipe size NPS 16 to 24, a clevis hanger may be used to support a concentrated load, provided it is used only to locally 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.
- .7 The use of a half-section of a suspended pipe clamp to support a horizontal pipe using two threaded rods is prohibited unless the manufacturer has written installation instructions permitting such use. The use of a pipe riser clamp for this purpose is prohibited.

3.6 Clevis Hangers

- .1 Where clevis hangers are used for cold piping, select clevis to fit the outside dimension of pipe and associated insulation.
- .2 Where clevis hangers are used for heating piping;
 - .1 select clevis to fit the pipe diameter only (clevis located inside of insulation) for small diameter piping in accordance with Schedule "C" at the end of this section,
 - .2 for larger diameter piping, select clevis to fit the outside dimensions of pipe and insulation – refer to Schedule "C" at the end of this section,
 - .3 where the distance from the building support element to the clevis pin is less than the value shown in the standard details at the end of this section, use an alternative method of support;
 - (a) exception: where the pipe is installed tight to the structure, the exposed length between the structural attachment and the top of the clevis shall not exceed 25 mm (1 in.).
- .3 Where clevis hangers are used for stainless steel pipe or tube and for copper tube;
 - .1 use copper or epoxy finished carbon steel 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 select hanger size for outside of the pipe and insulation.
- .4 Adjust clevis hangers to provide the required drainage slope and direction for each pipe.
- .5 Where the project requires seismic bracing of piping systems, add a Schedule 40 pipe over the clevis bolt, sized to provide at least 6 mm (1/4 in.) inside diameter clearance to the clevis bolt. This applies only where a transverse or longitudinal brace is attached to the clevis hanger.

3.7 Roll Hangers and Supports

- .1 For roll hangers, provide load and lock nuts to allow final adjustment of roll hanger to allow pipe drainage.
- .2 For roll supports supported above the structure element, the length of exposed threaded pipe between the roll support and the structural element shall not exceed 10 times the outside diameter of the rod.

3.8 Trapeze Hangers

- .1 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 with top and bottom nuts,

- .2 fabricated retention angles to extend vertically at least one-quarter the outside pipe/insulation diameter, and mechanically fasten to the trapeze,
- .3 where seismic restraint is required, only use U-bolts.
- .2 Adjust trapeze hangers to provide the required drainage slope and direction for each pipe. If the trapeze serves multiple pipes having different drainage slopes or directions, provide shims under each pipe as necessary to provide required slope. Mechanically fasten or tack-weld the shim plates to the trapeze.

3.9 Slide Supports

- .1 For hot piping, weld the T or H slide directly to the pipe.
- .2 For cold piping, weld the T or H slide to the bottom half of a carbon steel clamp assembly.
- .3 Use slides with integral lateral movement limit lugs at pipe supports required to function as a guide. Movement clearance to be between 6 mm and 25 mm (1/4 to 1 in.).
- .4 Where seismic restraint is required, use slides with integral lateral and vertical-up movement limit lugs so that the maximum allowable movement does not exceed 6 mm (1/4 in.).
- .5 For fluid service temperatures of 121°C (250°F) and less, apply grease with a service temperature of not less than 200°C (392°F) over the entire bottom of the T or H slide.
- .6 For fluid service temperatures greater than 121°C (250°F) use a PTFE slide pad bonded to the underside of the slide and a matching PTFE slide pad bonded to the top of the structural steel support.

3.10 Vertical Pipe Supports

- .1 Pipe riser clamps:
 - .1 provide pipe riser clamps for non-insulated pipes NPS 4 and smaller at every second floor level for vertical pipe risers passing through two or more floors, unless other vertical pipe support types are shown,
 - .2 for steel pipe, provide support lugs welded to steel piping so that pipe lugs bear on the top-surface of the riser clamp,
 - .3 for copper tube and pipe, arrange vertical piping so that a pipe joint bears on the top-surface of the riser clamp.
- .2 Fabricated pipe riser supports:
 - .1 support piping NPS 6 and larger, using fabricated riser support brackets complete with reinforcing gusset plates welded or clamped to piping, designed not to exceed the maximum allowable local pipe stress at a load of not less than 200% of the supported load of:
 - (a) for the lowest support point of the riser, the supported pipe plus insulation weight for the lowest support interval plus the total water weight of the entire riser.
 - (b) except at the lowest support point of the riser, the pipe plus insulation weight for each support interval (except at the bottom of the riser).
- .3 Support vertical cold piping and hot piping for riser heights that are 25 m (82 ft) or less in height as follows:
 - .1 provide spring vibration isolators in accordance with specification section 20 05 48, attached to pipe riser supports at intervals of every 2nd storey or 10 m (32 ft), whichever is less,
 - .2 provide a pipe anchor at the base of the riser or the mid-height of the riser.
- .4 Support vertical cold piping and hot piping for riser heights that are greater than 25 m (82 ft) but do not exceed 50 m (165 ft) in height as follows:
 - .1 provide a custom engineered support system utilizing variable spring isolators,
 - .2 provide pipe anchors at the mid-point of the riser, and

- .3 provide at least one spring support per riser section above and below the anchor point.
- .5 Support vertical cold piping and hot piping for riser heights greater than 50 m (165 ft) as follows:
 - .1 provide a custom engineered support system utilizing constant load supports for each pipe section located between expansion joints,
 - .2 variable spring supports may be used at intermediate locations between main constant load supports,
 - .3 provide pipe anchor supports at the base of the riser, and at intermediate locations along riser length at locations as shown,
 - .4 provide in-line expansion joints between each pair of pipe anchors on the same riser in accordance with Specification section 20 05 16,
 - .5 design pipe anchors to withstand pressure thrust created by the expansion joints, unless pressure-balanced expansion joints are used,
- .6 Design riser anchors to support the deadweight of the riser pipe, fluid contents and insulation. Where seismic restraint is required, the anchors may also be designed to resist the seismic horizontal and vertical loads.
- .7 Where custom engineering riser supports are required, they are to be designed to meet the following criteria:
 - .1 the maximum vertical movement of a horizontal branch pipe is not to exceed 20 mm (0.75 in) from its installation temperature to its in-service temperature,
 - .2 the maximum vertical movement of the horizontal mains pipe at the base or top of the riser is not to exceed 40 mm (1.5 in.) from its installation temperature to its in-service temperature, provided that the horizontal piping adjacent to the riser are also supported on variable spring supports for the first three horizontal support points.

3.11 Pipe Saddles and Shields

- .1 Provide pipe saddles and shields for insulated piping in accordance with Schedule "C" at the end of this section.
- .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 of the designation type as shown in Schedule "C" and as specified 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.

3.12 Rooftop Supports

- .1 For manufacturer rooftop pipe supports, conform to Specification section 20 05 06.

3.13 Vibration Isolation Supports

- .1 Provide vibration isolators at pipe supports for horizontal piping in accordance with specification section 23 05 48.
- .2 Provide vibration isolators at vertical pipe (riser) supports in accordance with specification section 20 05 48.
- .3 When installed with clevis hangers, install the vibration isolators below the top surface of the clevis; do not attached the vibration isolator to the structural element.

3.14 Variable Load Supports

- .1 Provide variable load supports on piping connections NPS 10 or larger at motorized equipment as follows:
 - .1 locate the support as close as possible to the equipment connection, and beyond any flexible connector (where required),
 - .2 select the support to have a static displacement to be equal to the static displacement of the equipment vibration isolator, but not less than 20 mm (0.75 in),
 - .3 set the support load so that the total pipe weight imposed on the equipment connection does not exceed the maximum allowable load as defined by the equipment manufacturer.
- .2 Provide variable load supports for vertical pipe supports as shown.
- .3 Provide variable load supports in mechanical rooms where piping transitions from horizontal to vertical where it enters a vertical service shaft. Provide vibration isolation hangers for other locations in accordance with Section 20 05 48 Vibration Isolation.

3.15 Constant Load Supports

- .1 Provide constant load supports for vertical pipe supports as shown and as follows:
 - .1 pipe risers, located at the top of the riser, and intermediate riser locations,
 - .2 first hanger support for main steam piping connections NPS 6 and larger to steam boilers,
 - .3 first hanger support for water piping connections NPS 10 and larger to hot water boilers,
 - .4 first hanger support for water piping connections NPS 12 and larger to refrigeration equipment,
 - .5 first hanger support inside the building for water piping NPS 12 and larger for condenser water piping to a cooling tower.

3.16 Load Nut Retention

- .1 Provide double load-nuts on pipe and equipment hangers and apply 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 hanger.
 - .3 double-nut the clevis bolt nuts.]

3.17 Insulation Shield Retention Requirements

- .1 Modify insulation shields by punching two slots 6 mm x 12 mm (¼ in x ½ in) near each corner of one end of the shield. Provide stainless steel band clamps to secure the insulation shield to the pipe (outside of the insulation). Do not use nylon tie-wraps.

3.18 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.

3.19 Schedules

.1 The following appended schedules form part of this Specification section.

- | | | |
|----|----------------|--|
| .1 | Schedule A1(a) | Horizontal Pipe Support Loads and Support Spans – Schedule 20 to 80 Pipe |
| .2 | Schedule A1(b) | Alternate Hanging Rod Sizes and Support Spans for Schedule 20 to 80 Pipe |
| .3 | Schedule A2(a) | Horizontal Pipe Support Loads and Spans – Schedule 10/10S Stainless Steel Pipe |
| .4 | Schedule A2(b) | Alternate Hanging Rod Sizes and Support Spans for Schedule 10/10S Stainless-steel Pipe |
| .5 | Schedule A3 | Horizontal Pipe Support Loads and Spans – Copper and Stainless Steel Tube |
| .6 | Schedule B | Pipe Support Type Selection Requirements |
| .7 | Schedule C | Insulation Protection Requirements |

3.20 Standard Details

.1 The following standard details are appended to the end of this Specification section.

- | | | |
|----|--------------|---|
| .1 | 20 05 29-010 | Cold Piping and Dual-Temperature Piping – Clevis Hanger Detail |
| .2 | 20 05 29-011 | Cold Piping and Dual-Temperature Piping – Roll Hanger Detail |
| .3 | 20 05 29-012 | Cold Piping and Dual-Temperature Piping – Trapeze Hanger Detail |
| .4 | 20 05 29-013 | Cold Piping and Dual-Temperature Piping – Slide Support Detail |
| .5 | 20 05 29-020 | Hot Piping – Clevis Hanger Detail |
| .6 | 20 05 29-021 | Hot Piping ≤ 100°C, Small Size Piping – Clevis Hanger Details |
| .7 | 20 05 29-022 | Hot Piping – Roll and Trapeze Hanger Detail |
| .8 | 20 05 29-023 | Hot Piping – Slide Support Detail |
| .9 | 20 05 29-030 | Slide Supports – Guides and Seismic Restraint |

Schedule A1(a)

**Horizontal Pipe Support Spacing
for
Carbon Steel, Galvanized Steel, Stainless-steel Piping
Schedule 20 to 80 Inclusive**

Notes for Schedule A1(a) and A1(b):

[1] Hanging rod size for single support. Where two supports are used, the rod size may be reduced by one size but not less than Ø3/8 in..

[2] Subject to load capacity of hanger components other than the hanging rod.

[3] Where piping is hydrostatically tested with water, temporary pipe supports are required to limit pipe span to the "liquids" values.

[4] For trapeze hangers only.

Pipe Size NPS	Rod Diameter Single Support [Note 1] Inches	Maximum Support Spacing, Liquids [Note 2] m (ft)	Maximum Support Spacing Steam, Gases [Note 2, 3] m (ft)
½	Ø 3/8	1.8 (6)	1.8 (6)
¾ to 1¼	Ø 3/8	2.1 (7)	2.1 (7)
1½	Ø 3/8	2.7 (9)	2.7 (9)
2	Ø 3/8	3.0 (10)	4.0 (13)
2½	Ø ½	3.3 (11)	4.3 (14)
3	Ø ½	3.3 (12)	4.6 (15)
4	Ø 5/8	4.2 (14)	5.2 (17)
6	Ø ¾	5.1 (17)	6.4 (21)
8	Ø ¾	5.7 (19)	7.3 (24)
10	Ø 7/8	6.7 (22)	7.9 (26)
12	Ø 7/8	7.0 (23)	9.1 (30)
14	Ø 1	7.5 (25)	9.8 (32)
16	Ø 1	8.0 (27)	10.7 (35)
18	Ø 1 [Note 4]	8.4 (28)	11.3 (37)
20	Ø 1-1/4 [Note 4]	9.0 (30)	11.9 (39.0)
24	Ø 1-1/2 [Note 4]	9.6 (32)	12.8 (42.0)
30	Ø 1-1/2 [Note 4]	10.0 (33)	13.4 (44.0)

Schedule A1(b)

**Alternate Rod Sizes and Pipe Spans
For Pipe Sizes NPS 10 to 16
Carbon Steel, Galvanized Steel, Stainless-steel Piping
Schedule 20 to 80 Inclusive**

The following table provides alternate combinations of rod hanger size and associated support spacing for select pipe sizes.

Pipe Size NPS	Rod Diameter Single Support [Note 1] Inches	Maximum Support Spacing, Liquids [Note 2] m (ft)	Maximum Support Spacing Steam, Gases [Note 2, 3] m (ft)
10	Ø 3/4	4.0 (13)	6.7 (22)
12	Ø 3/4	3.0 (10)	5.8 (19)
14	Ø 3/4	2.7 (9)	5.2 (17)
	Ø 7/8	5.8 (19)	9.1 (30)
16	Ø 3/4	2.1 (7)	4.6 (15)
	Ø 7/8	4.9 (16)	7.9 (26)

Schedule A2(a)

**Horizontal Pipe Support Spacing
For
Stainless-steel Pipe
Schedule 10/10S**

Notes for Schedule A2(a) and A2(b):

[1] Rod size for single support. Where two supports are used, the rod size may be reduced by one size but not less than Ø3/8 in..

[2] Subject to load capacity of hanger components other than the hanging rod.

[3] Where piping is hydrostatically tested with water, temporary pipe supports are required to limit pipe span to the "liquids" values.

[4] For trapeze hangers only.

Pipe Size NPS	Rod Diameter Single Support [Note 1]	Maximum Spacing, Liquids [Note 2] m (ft)	Maximum Spacing Steam, Gases [Note 2, 3] m (ft)
½	Ø 3/8	1.83 (6)	2.45 (8)
¾	Ø 3/8	2.1 (7)	2.75 (9)
1	Ø 3/8	2.45 (8)	2.75 (9)
1¼	Ø 3/8	2.75 (9)	2.75(9)
1½	Ø 3/8	2.75 (9)	3.65 (12)
2	Ø 3/8	3.10 (10)	4.0 (13)
2½	Ø 1/2	3.35 (11)	4.3 (14)
3	Ø 1/2	3.65 (12)	4.6 (15)
4	Ø 5/8	4.25 (14)	5.2 (17)
6	Ø 3/4	4.9 (16)	6.4 (21)
8	Ø 3/4	5.5 (18)	7.3 (24)
10	Ø 7/8	5.8 (19)	7.9 (26)
12	Ø 7/8	6.1 (20)	9.2 (30)
14	Ø 1	7.0 (23)	9.7 (32)
16	Ø 1	7.3 (24)	10.7 (35)
18	Ø 1 [Note 4]	7.3 (24)	11.3 (37)
20	Ø 1-1/4 [Note 4]	7.6 (25)	11.9 (39)
24	Ø 1-1/2 [Note 4]	7.3 (25)	11.9 (42)
30	Ø 1-1/2 [Note 4]	8.5 (28)	12.8 (44)

Schedule A2(b)

**Alternate Rod Sizes and Pipe Spans
For Pipe Sizes NPS 10 to 16
Stainless-steel Pipe
Schedule 10/10S**

The following table provides alternate combinations of rod hanger size and associated support spacing for select pipe sizes.

Pipe Size NPS	Rod Diameter Single Support [Note 1] Inches	Maximum Spacing, Liquids [Note 2] m (ft)	Maximum Spacing Steam, Gases [Note 2, 3] m (ft)
10	Ø 3/4	4.9 (16)	4.9 (16)
12	Ø 3/4	3.7 (12)	3.7 (12)
14	Ø 3/4	2.7 (9)	2.7 (9)
	Ø 7/8	5.2 (17)	6.1 (20)
16	Ø 3/4	2.4 (8)	2.4 (8)
	Ø 7/8	4.3 (14)	5.2 (17)

Schedule A3

**Horizontal Pipe Support Spacing
For
Copper Tube and Stainless-steel Tube**

Notes for Schedule A3:

[1] Rod size for single support. Where two supports are used, the rod size may be reduced by one size but not less than M10 (3/8 in.).

[2] Subject to load capacity of hanger components other than the hanging rod.

Pipe Size NPS	Rod Diameter Single Support [Note 1] Inches	Maximum Spacing, Liquids and Gases [Note 2] m (ft)
1/2	Ø 3/8	1.5 m (5 ft)
3/4 to 1 1/4	Ø 3/8	1.8 m (6 ft)
1 1/2	Ø 3/8	2.4 m (8 ft)
2	Ø 3/8	2.4 m (8 ft)
2 1/2	Ø 1/2	3.0 m (10 ft)
3	Ø 1/2	3.0 m (10 ft)
4	Ø 5/8	3.0 m (10 ft)
6	Ø 3/4	4.3 (14)
8	Ø 3/4	4.9 (16)

Schedule B**Pipe Support Type Selection Requirements**

The following tables B(1) and B(2) lists hanger types which are to be used based on pipe size and service temperature. Refer to Schedule C for additional requirements concerning insulation protection.

Pipe Support Type Legend

CL	Clevis hanger
CL(EY)	Clevis hanger with extended yoke for installation under pipe insulation
CL(IS)	Clevis hanger with integral insulation saddle
CL(LD)	Clevis hanger, light duty
SW	Swivel hanger
RS	Roll support
RH	Roll hanger with clevis
RB	Roll support with integral base
TS	T slide
HS	H slide
TZ	Trapeze

Application Legend

A	Acceptable
---	Not permitted

**Table B(1):
Pipe Support Type Selection Requirements
For Fluid Service Temperatures up to 100°C (212°F) or Less**

Pipe/Tube Size NPS	CL	CL (EY)	CL (IS)	CL (LD)	SW [Note 1]	RS	RH	RB	TS	HS	TZ
½ - ¾	A	A	A	A	A	---	---	---	---	---	A
1 - 4	A	A	A	A	A	A	A	A	A	---	A
6	A	A	A	---	---	A	A	A	A	A	A
8	A	A	A	---	---	---	A	A	A	A	A
10	A	A	---	---	---	---	A	A	A	A	A
12	A	A	---	---	---	---	A	A	A	A	A
14	A	---	---	---	---	---	A	A	A	A	A
16	A	---	---	---	---	---	---	A	A	A	A
18	---	---	---	---	---	---	---	A	A	A	A
20	---	---	---	---	---	---	---	---	A	A	A
24	---	---	---	---	---	---	---	---	---	A	A
30	---	---	---	---	---	---	---	---	---	A	A

Notes:

[1] For uninsulated ambient piping/tubing only.

Table B(2):

**Pipe Support Type Selection Requirements
Fluid Service Temperatures greater than 100°C (212°F)
Including Steam at All Pressures**

Pipe/Tube Size NPS	CL	CL (EY)	CL (IS)	CL (LD)	SW	RS	RH	RB	TS	HS	TZ
½ - ¾	A	---	---	A	---	---	---	---	---	---	A
1 - 4	A	---	---	A	---	A	A	A	A	---	A
6	A	---	---	---	---	A	A	A	A	A	A
8	A	---	---	---	---	---	A	A	A	A	A
10	---	---	---	---	---	---	A	A	A	A	A
12	---	---	---	---	---	---	A	A	A	A	A
14	---	---	---	---	---	---	A	A	A	A	A
16	---	---	---	---	---	---	---	A	A	A	A
18	---	---	---	---	---	---	---	A	A	A	A
20	---	---	---	---	---	---	---	---	A	A	A
24	---	---	---	---	---	---	---	---	---	A	A
30	---	---	---	---	---	---	---	---	---	A	A

Schedule C**Insulation Protection Requirements
For Pipe Hanger/Support****Notes for Schedule C:**

[1] For the column Hanger Support Position, "Insulation" means hanger or support element is outside of the pipe and insulation. "Pipe" means hanger or support element is in direct contact with the pipe and is encased in the pipe insulation.

[2] "Pipe" position only applies to clevis hangers. For all other pipe supports, use the "Insulation" hanger/support position.

[3] Include heavy-duty support plate welded to shield.

[4] Restrictions apply to minimum length of hanger rod for heating piping at this temperature range. Refer to standard details.

[5] Refer to specification section 20 07 19 Piping Insulation for type P-21, P-22 and P-23 high-density insert specifications.

[6] Where ambient piping is required to be insulated under section 20 07 19, insulation is to be protected in accordance with the requirements for Low Temperature Piping.

[7] Insulation for Dual Temperature Piping is to be protected in accordance with the requirements for Cold Piping.

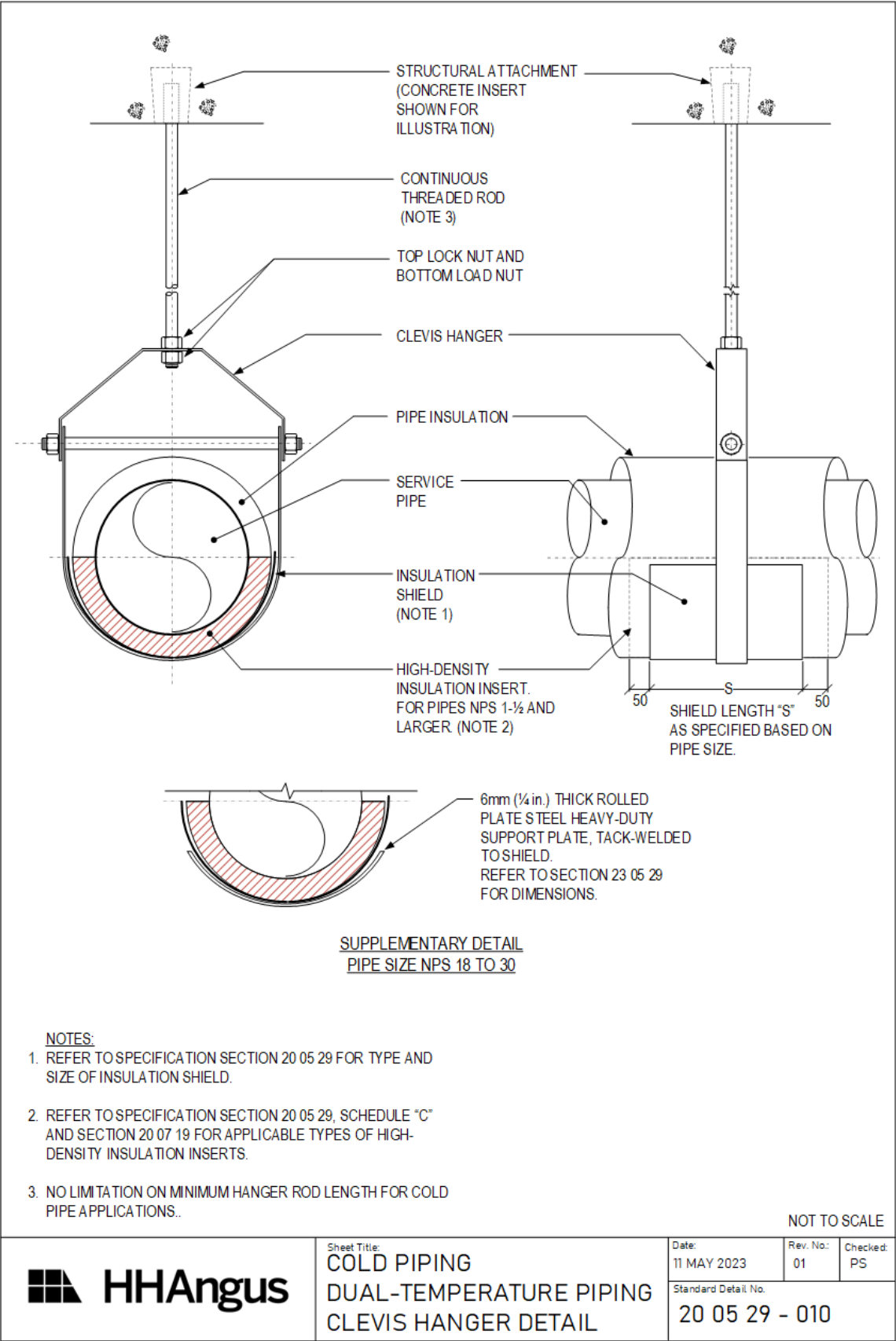
Application Legend for Insulation Saddle and Shields

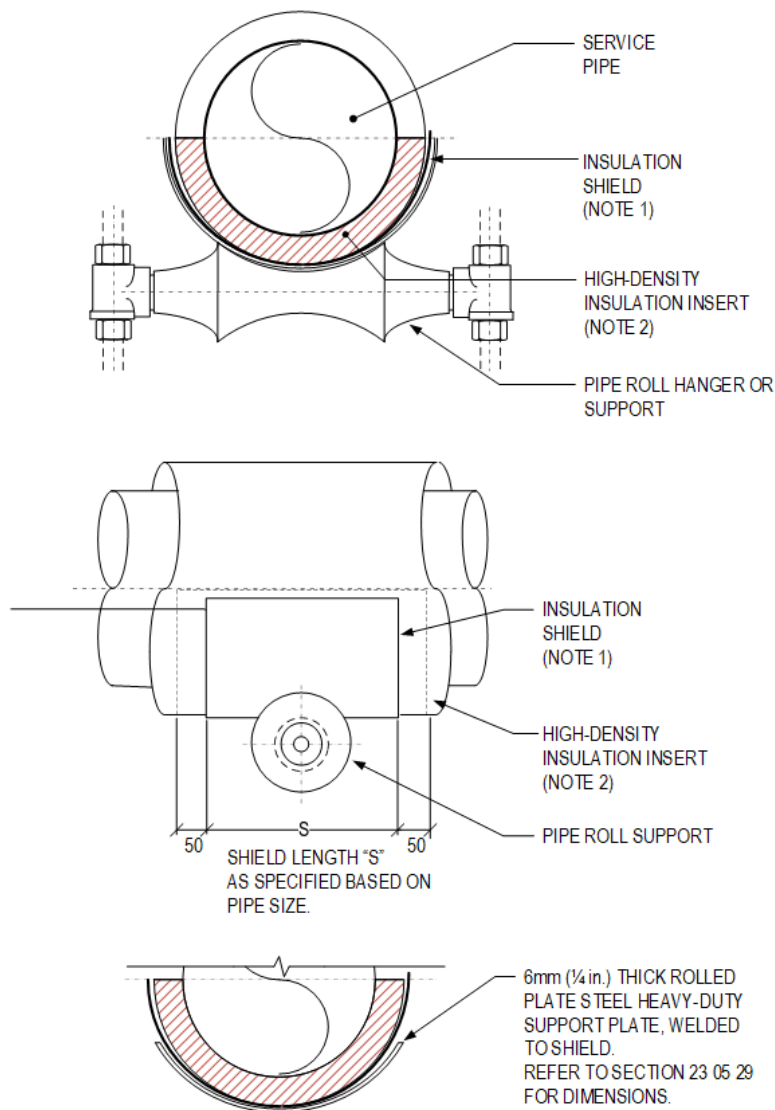
REQ	Required
ALT	Acceptable Alternate
	Not Applicable

Service Temperature °C (F)	Pipe Size NPS	Hanger/ Support Position [Note 1, 2]	Pipe Saddle	Insulation Shield	
				Shield	High-Density Insert Type [Note 5]
Hot Piping > 121 to ≤ 205 (> 250 to ≤ 400) Including steam >103 kPa (15 psi)	≥ 6	Insulation	REQ		
	>1-1/4 and ≤ 4	Insulation	ALT		
				ALT	P-23
	≤ 1-1/4	Insulation		REQ	
Hot Piping > 100 to ≤ 121 (> 212 to ≤ 250) Including steam ≤ 103 kPa (15 psi)	≥ 6	Insulation	REQ		
	>1-1/4 and ≤ 4	Insulation	ALT		
				ALT	P-21, P-22, or P-23
	≤ 1-1/4	Insulation		REQ	

Schedule C (Con't)

Service Temperature °C (F)	Pipe Size NPS	Hanger/ Support Position [Note 1, 2]	Pipe Saddle	Insulation Shield	High- Density Insert Type
Hot Piping 61 to 100 (141 to 212)	≥10 and ≤ 30	Insulation	REQ		
	≥ 6 and ≤ 16	Insulation	ALT		
				REQ	P-21, P-22, or P-23
	≥ 1-1/2 and ≤ 4	Insulation		ALT	P-21, P-22, or P-23
		Pipe [Note 4]	ALT		
	≤ 1-1/4	Insulation		ALT	
		Pipe [Note 4]	ALT		
Low Temperature Water 40 to 60 (104 to 140) [Note 6]	≥18 and ≤ 30	Insulation		REQ [Note 3]	P-21, P-22, or P-23
	≥ 6 and ≤ 16	Insulation		REQ	P-21, P-22, or P-23
	≥ 1-1/2 and ≤ 4	Insulation		ALT	P-21, P-22, or P-23
		Pipe	ALT		
	≤ 1-1/4	Insulation		ALT	
		Pipe	ALT		
Cold Piping 4 to 16 (39 to 61) [Note 7]	≥18 and ≤ 30	Insulation		REQ [Note 3]	P-21 or P-22
	≥ 1-1/2 and ≤ 16	Insulation		REQ	P-21 or P-22
	≤ 1-1/4	Insulation		REQ	
Fire protection piping	≥ 1-1/2	Pipe			
	≤ 1-1/4	Pipe			
MRI Quench Piping	All	Insulation		REQ	P-22





SUPPLEMENTARY DETAIL
PIPE SIZE NPS 18 TO 30

NOTES:

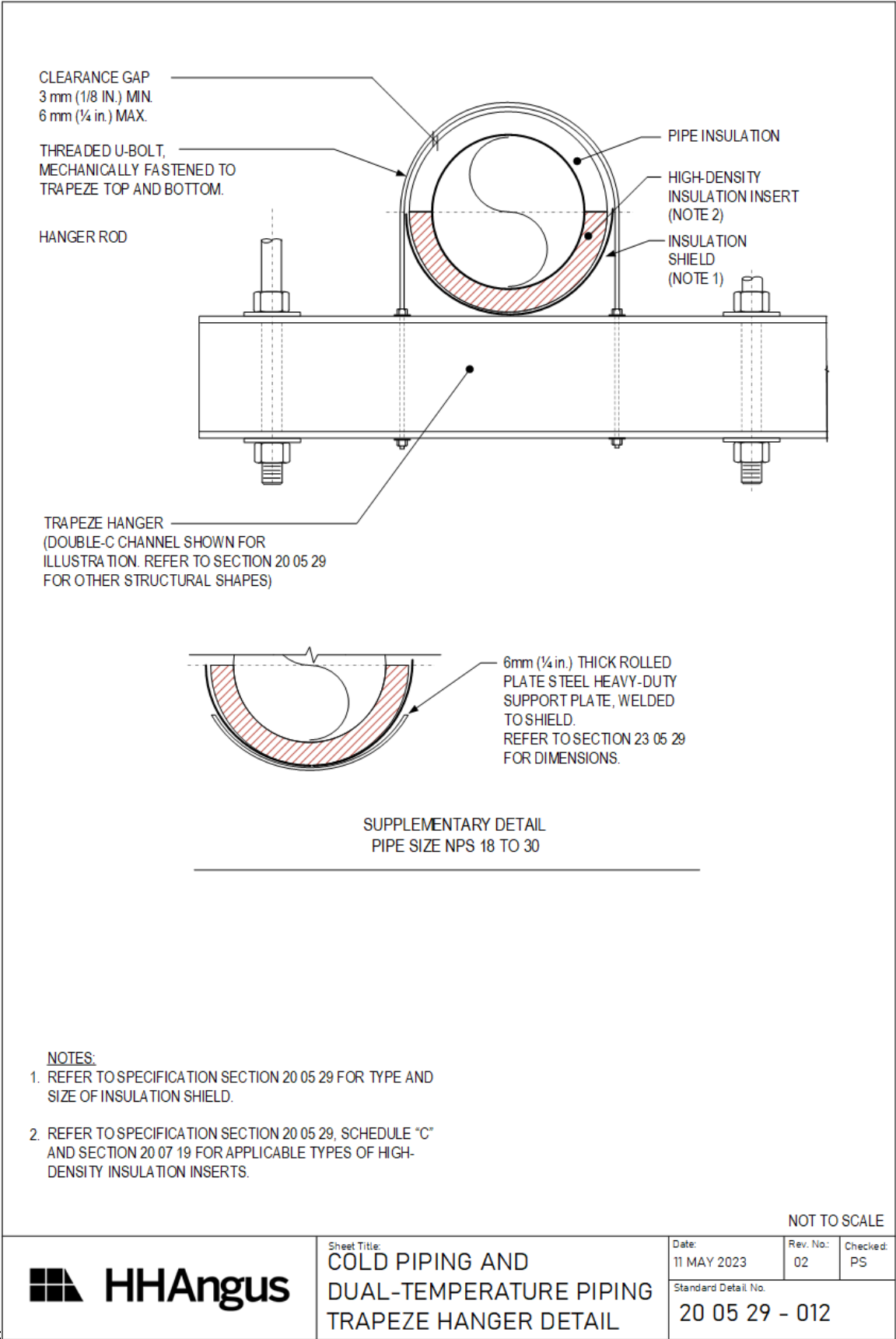
1. REFER TO SPECIFICATION SECTION 20 05 29 FOR TYPE AND SIZE OF INSULATION SHIELD.
2. REFER TO SPECIFICATION SECTION 20 05 29, SCHEDULE "C" AND SECTION 20 07 19 FOR APPLICABLE TYPES OF HIGH-DENSITY INSULATION INSERTS.
3. NO LIMITATION ON MINIMUM HANGER ROD LENGTH.

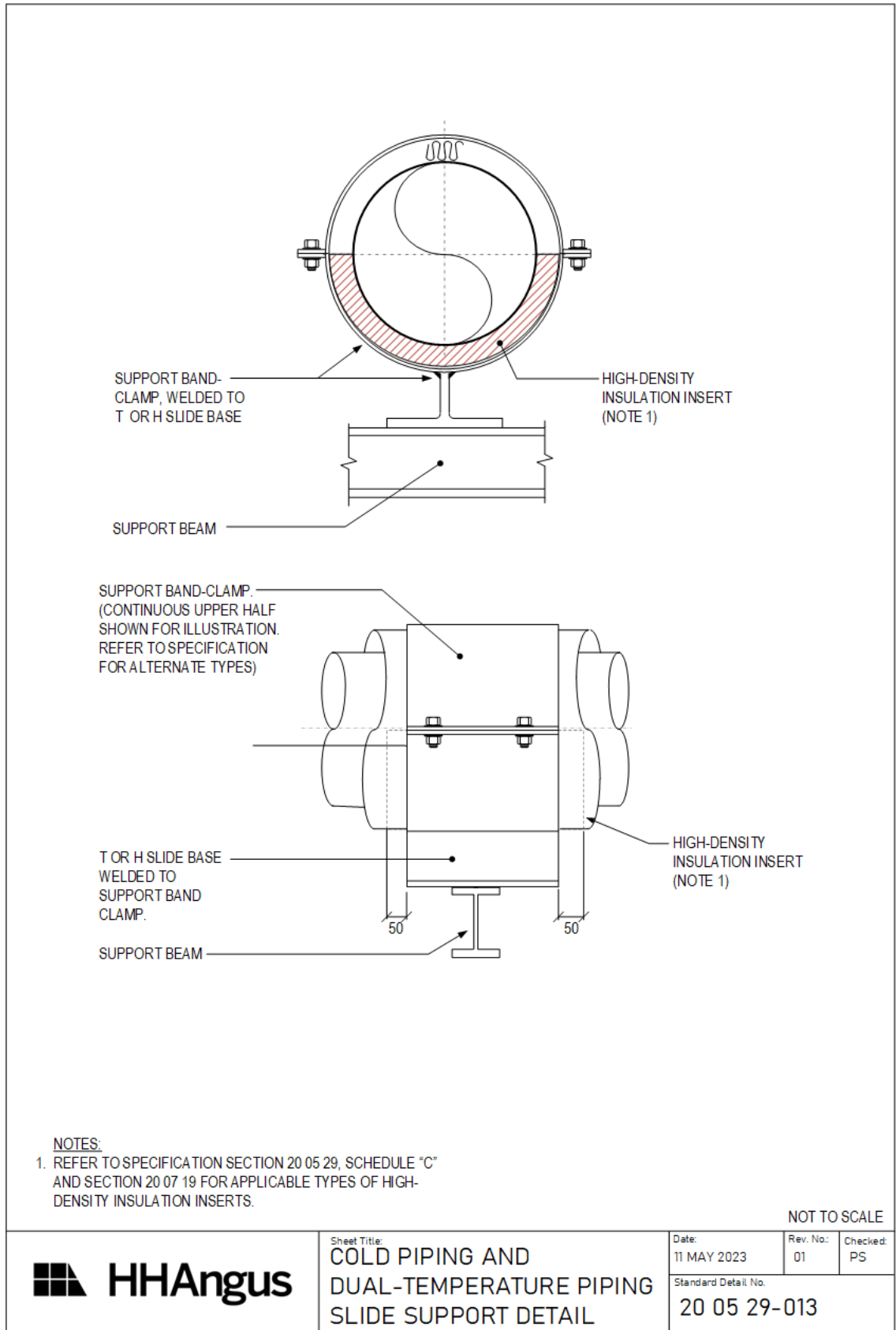
NOT TO SCALE

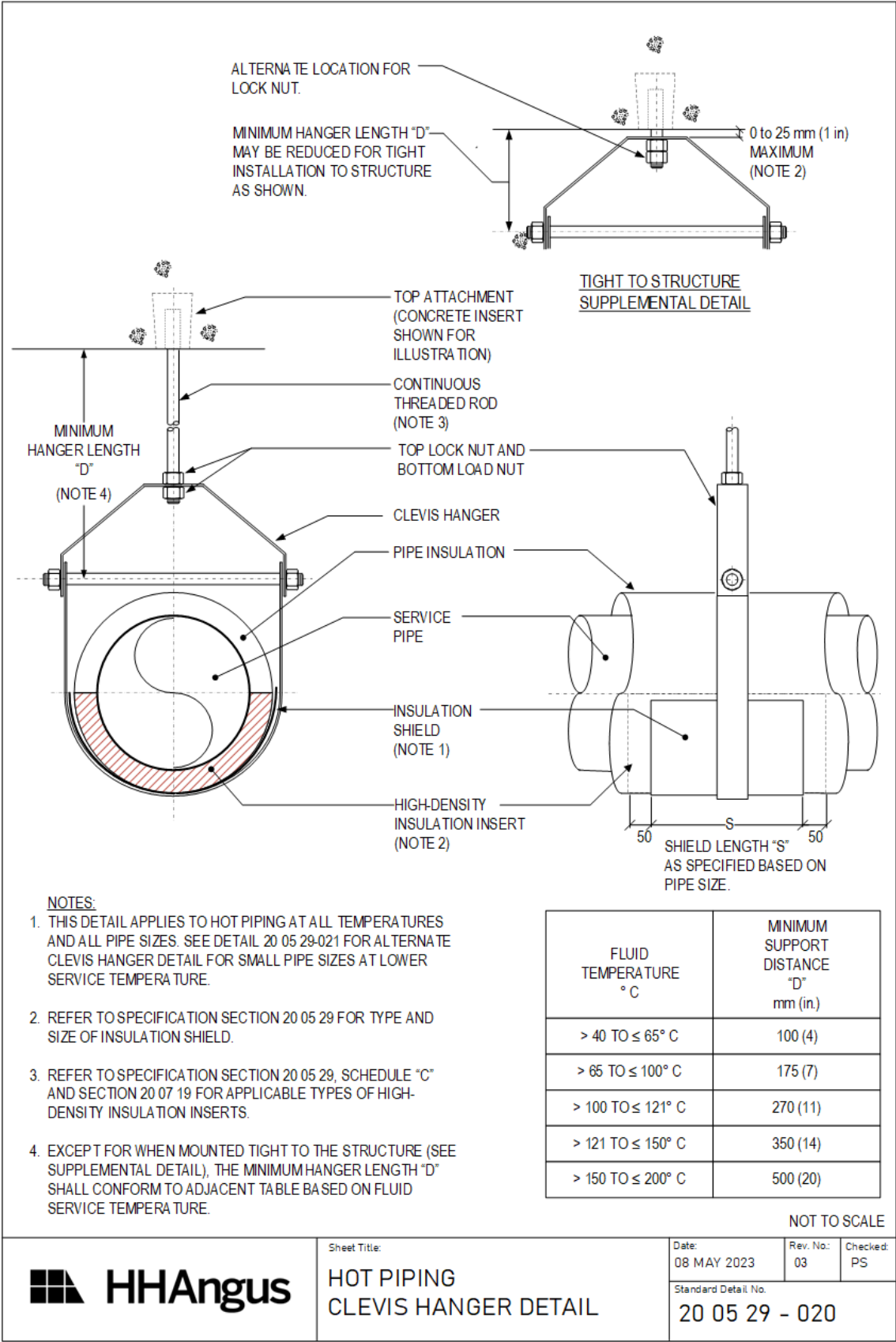


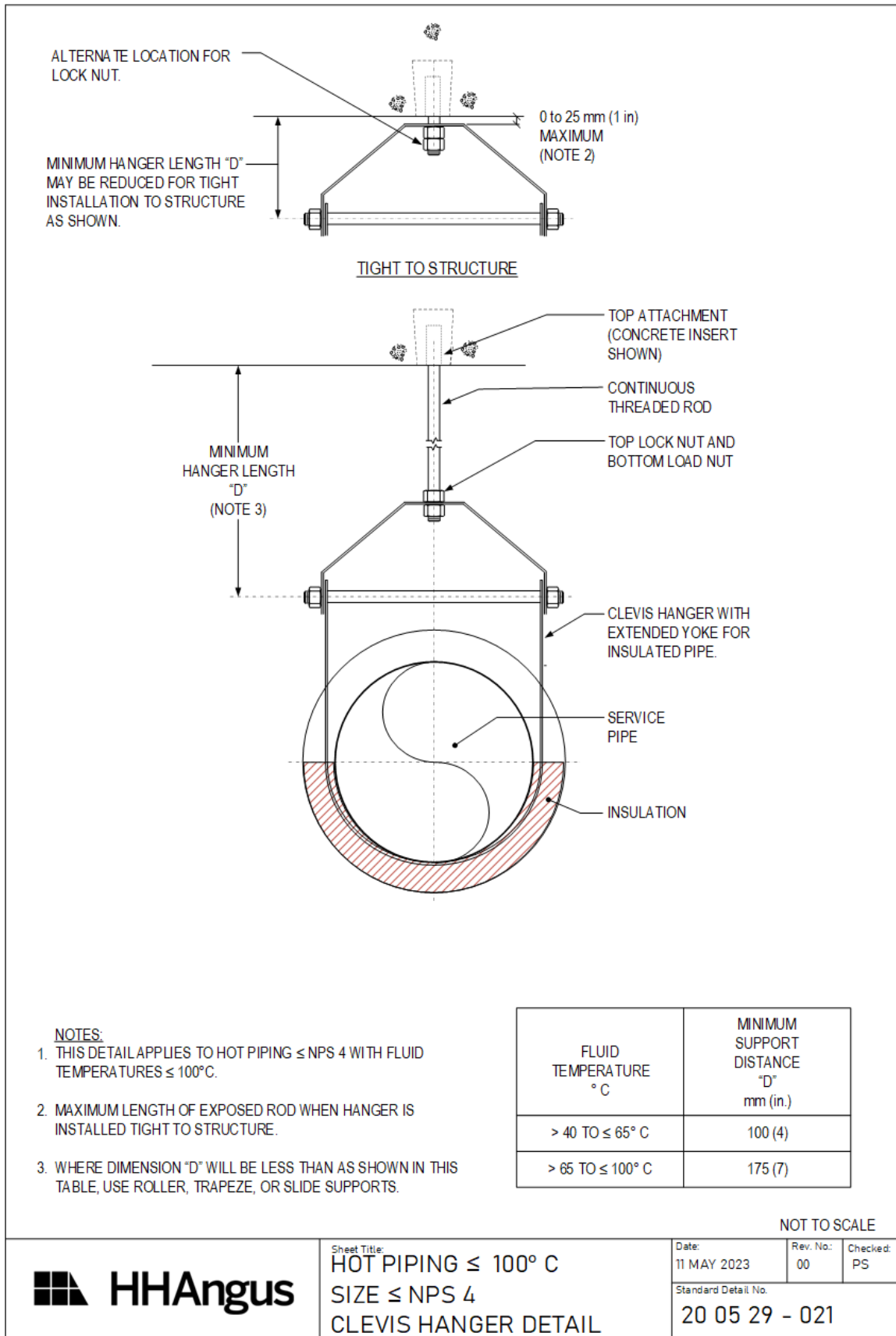
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**COLD PIPING AND
DUAL-TEMPERATURE PIPING
ROLL HANGER DETAIL**

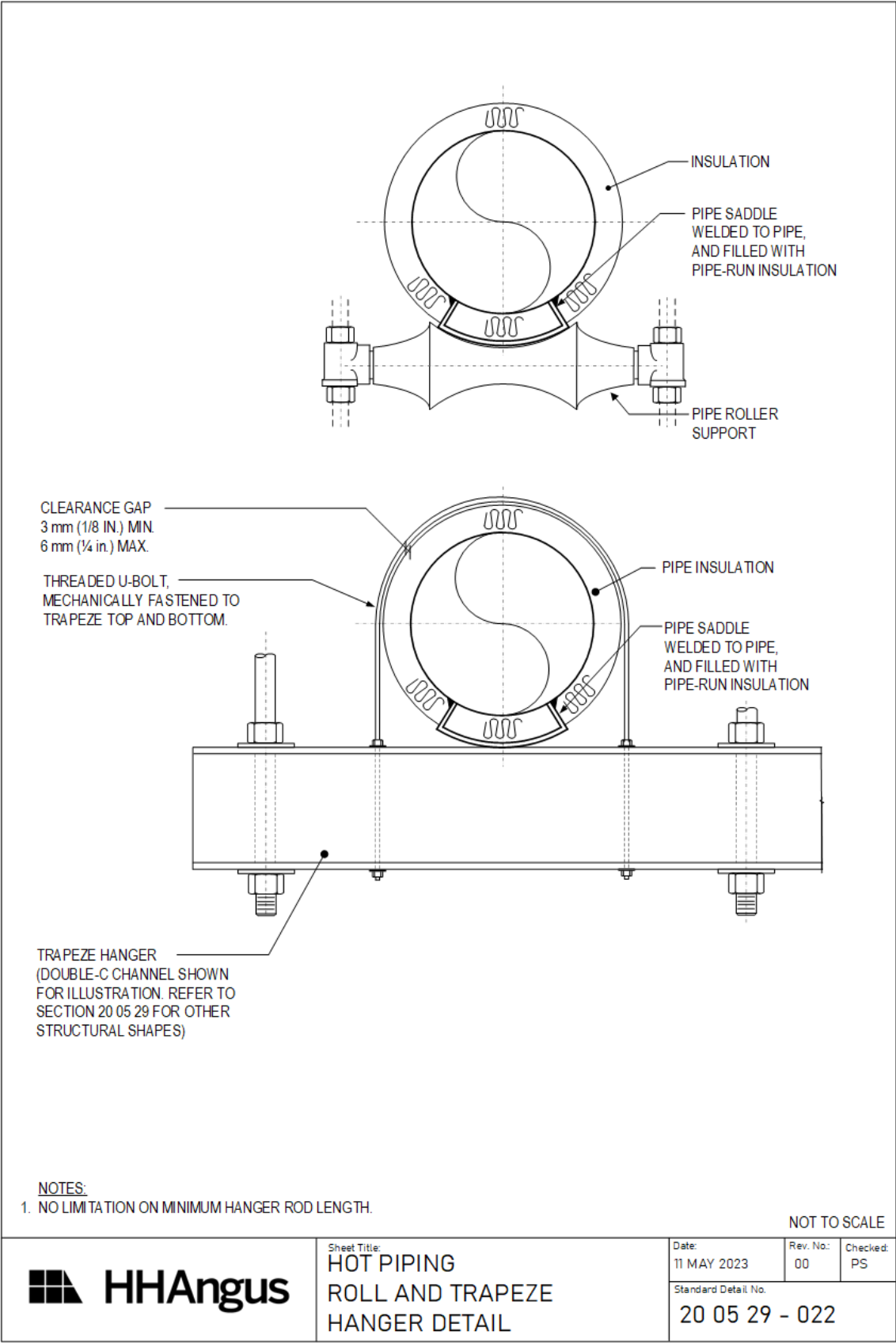
Date: 11 MAY 2023	Rev. No.: 02	Checked: PS
Standard Detail No. 20 05 29 - 011		

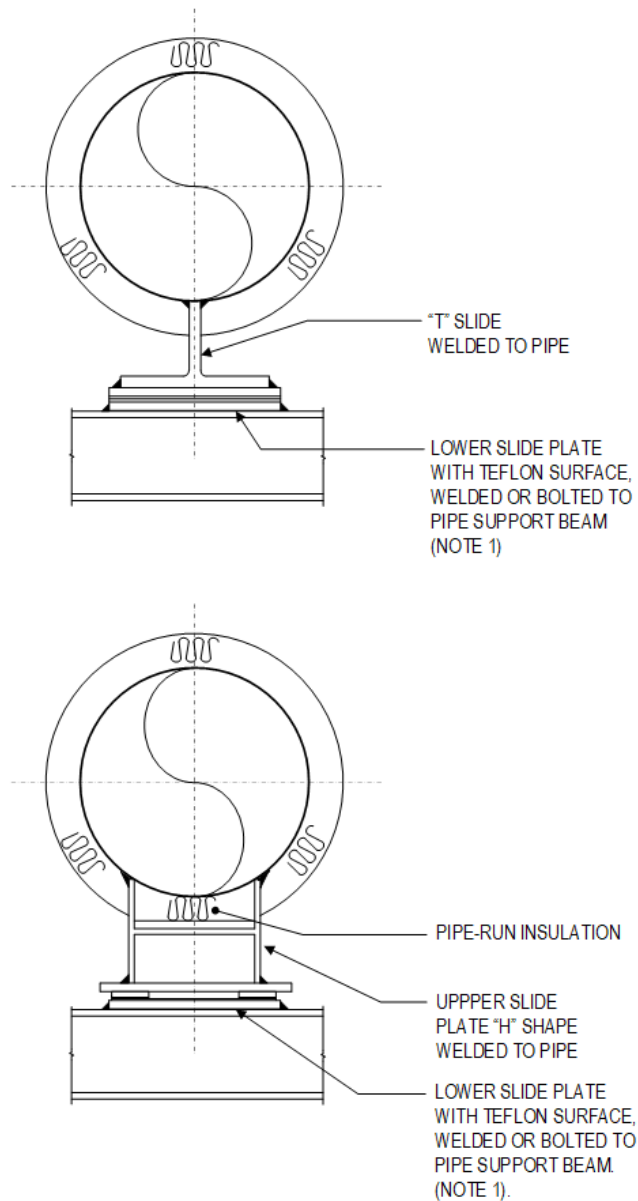












NOTES:

1. TEFLON SLIDE PLATES ONLY REQUIRED FOR HOT PIPING WITH SERVICE TEMPERATURE > 121° C, INCLUDING STEAM AT PRESSURES > 103 kPa.

NOT TO SCALE



Sheet Title:

**HOT PIPING
SLIDE SUPPORT DETAILS**

Date:

11 MAY 2023

Rev. No:

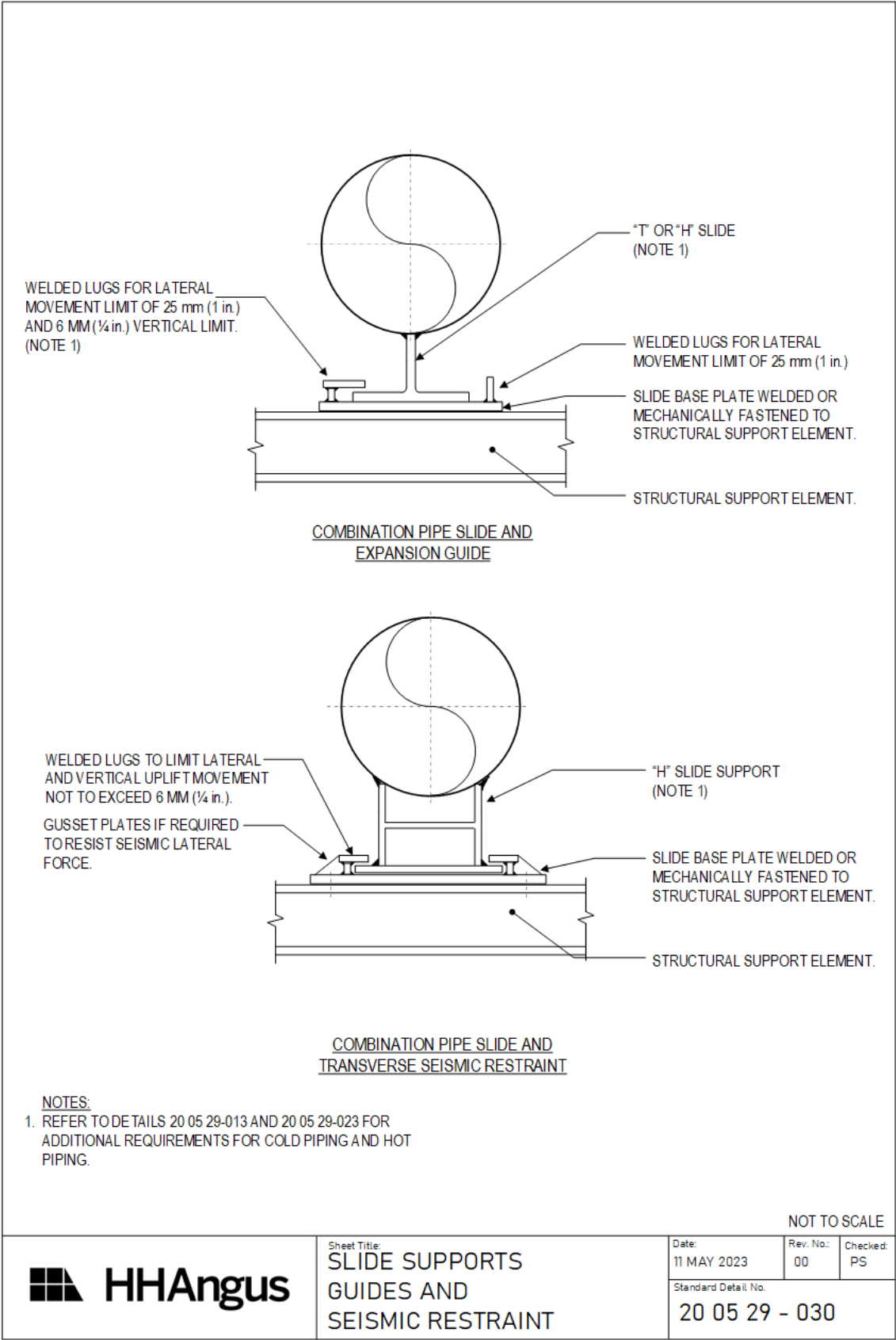
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Checked:

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Standard Detail No.

20 05 29 - 023



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
 - .3 CSA Z7396.1 Medical Gas Pipeline Systems – Part 1: Pipelines for Medical Gases, Medical Vacuum, Medical Support Gases, and Anaesthetic Gas Scavenging 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 ¼ in),
 - .3 letter height:
 - (a) ID and name: 20 mm (¾ 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)

.2 Flexible coil-wrap manufactured markers:

.1 PVC plastic coated markers with integral printing, or plastic cover with field applied self-adhesive markers,

.2 reversing text with integral arrow markers,

.3 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.

.3 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.

.4 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 Buried Piping

- .1 Stretchable polyethylene or metallized ribbon, labeled with name of service, with service name at maximum 800 mm intervals.

2.5 Ductwork Identification

- .1 Punched stencils in PVC or card material, suitable for application of field painting.
- .2 Letter height: 50 mm (2 in).
- .3 Letter paint colour: black.

2.6 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.

2.7 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.

2.8 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

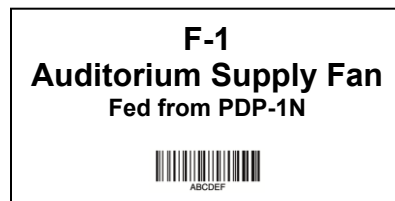
Information Type	Background Colour	Letter Colour	Primary Notification Text
General information	Blue	White	NOTICE

Information Type	Background Colour	Letter Colour	Primary Notification Text
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 self-adhesive type:
 - (a) indoor uninsulated piping,
 - (b) indoor insulated piping with PVC or smooth metal jackets,
 - .2 flexible coil-wrap:
 - (a) outdoor piping,
 - (b) indoor insulated piping with any type of jacket.
 - .3 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):

Domestic Cold Water
Riser C/1
No. 12

Natural Gas
Boiler Plant
No. 2
Normally Closed

- .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):

Chilled Water
Constant Pressure
Differential Valve
CV-3

- .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

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
Vapour from Water	Steam, Steam Vents	White	Black	None
Fire Protection Fluids	Sprinklers, Standpipe, Foam, Gaseous	Red	White	None
Combustible Liquids	Heating oil, Diesel, Lubrication oil, Hydraulic oil	Brown	White	None
Flammable Fluids	Natural Gas, Propane	Yellow	Black	None
	Gasoline	Yellow	Black	  
Compressed Air	Compressed Air, Instrument Air, Laboratory Air	Blue	White	None
Compressed Gases	Nitrogen, Helium, Carbon Dioxide	Grey	White	
Other Gases	Vacuum, Laboratory Vacuum, Plumbing Vents	Grey	White	None

Fluid Service Category	Piping Services	Background Colour	Lettering Colour	GHS Hazard Symbol
Oxidizing Fluids	Chlorine	Yellow	Black	
Toxic and Corrosive Fluids	HVAC chemical treatment, Acid Drain, Acid Vent Isotope Drain, Isotope Vent, Decontamination Drain and Tank	Orange	Black	 

END OF SECTION

CLOSEOUT REQUIREMENTS FOR MECHANICAL WORK

20 77 19

1 GENERAL

1.1 Scope

- .1 Provide documentation deliverables at completion of the Work for the following milestones:
 - .1 Occupancy permit (where applicable) (Form OP1M),
 - .2 Substantial Performance of the Work (Form SP2M),
 - .3 Total Performance of the Work (Form TP1M).

1.2 Definitions

- .1 The following definitions apply to this section.
 - .1 **Occupancy permit** – means either: (i) a permit issued by a regulatory authority to allow the Owner to occupy the building subject to the building permit, or (ii) a building permit close-out procedure where documentation must be submitted to the building authority for that purpose.

1.3 General

- .1 The prerequisites and submittal of supporting documentation for the aforementioned milestone events may be combined as a single submission at one point in time for the following combination of events:
 - .1 Occupancy Permit, and Substantial Performance.
- .2 Where a prerequisite is listed in more than one milestone event, it shall be included in the earliest-occurring milestone event unless expressly specified otherwise.

1.4 Occupancy Permit

- .1 Submit the reviewed final record of the Testing of Integrated Life Safety and Fire Protection Commissioning report two weeks prior to application for occupancy permit, where such a report is required.
- .2 Complete the Occupancy Permit Checklist and submit with required documentation to support the Owner's application for occupancy.

1.5 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 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.

1.6 Total Performance

- .1 Complete the Total Performance Checklist and submit with required documentation when applying for Total Performance of the Work.

Form OP1M: OCCUPANCY PERMIT CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and documentation included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- ☐ Building department inspection reports.
- ☐ AHJ pressure piping inspection reports (if applicable).
- ☐ AHJ fuel system inspection reports (if applicable).
- ☐ AHJ electrical systems inspection reports.
- ☐ Sprinkler installation certification report to NFPA 13.
- ☐ Standpipe installation certification report to NFPA 14.
- ☐ Fire pump installation and test certificate to NFPA 20.
- ☐ Integrated Fire Protection and Life Safety test report to ULC-S1001.
- ☐ Equipment start-up reports (Interim).

Consultant Review	
Status:	☐ Reviewed ☐ Incomplete or deficient - resubmit
Signed:	
Date:	

Form SP2M: 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.
- ☐ Occupancy permit has been issued by the AHJ (where applicable).
- ☐ Systems have been started-up, tested, and demonstrated to Owner or Consultant. Equipment start-up reports (final) have been submitted.
- ☐ First submission TAB reports have been submitted to Consultant.
- ☐ Acoustic survey report submitted to Consultant (if specified).
- ☐ Vibration survey report submitted to Consultant (if specified).
- ☐ Controls / BMS operation report submitted to Consultant (if specified).
- ☐ Equipment, pipeline, and valve identification completed.
- ☐ Final cleaning and waste removal completed.
- ☐ The portions of the building being turned over to the Owner can be secured by Owner.
- ☐ Spare parts and replacement parts turned over to Owner, transmittal attached.
- ☐ Warranty certificates issued to Owner.
- ☐ Delivery to Owner of draft Operating and Maintenance documents.
- ☐ Copies of up-to-date as-built drawings submitted.
- ☐ Final start-up, testing and balancing reports completed and submitted to Owner, including any items requiring corrections identified by Consultant.
- ☐ Demonstration and training are completed, or Contractor and Owner has agreed to a schedule to provide such training to be completed within one month after the date of Substantial Performance of the Work.
- ☐ All commissioning activities except for those activities that are identified or otherwise agreed by the Owner to be deferred commission activities which may be completed after the date of Substantial Performance of the Work.

Consultant Review	
Status:	☐ Reviewed ☐ Incomplete or deficient - resubmit
Signed:	
Date:	

Form TP1M: 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 final Operating and Maintenance documents have been delivered to Owner.
- ☐ All final up-to-date as-built drawings have been delivered to Owner.
- ☐ Any follow-up testing and balancing reports, including alternate season testing reports, have been submitted to Owner.
- ☐ All demonstration and training are completed.
- ☐ All commissioning activities are completed, including deferred alternate season commissioning activities.
- ☐ All known deficiencies have been corrected, including latent deficiencies reported by the Owner.
- ☐ All inspections and tests required to be performed by Contractor or manufacturer's prior to expiry of the warranty period have been completed, and documentation for those inspections and tests are included in this application.

Consultant Review	
Status:	☐ Reviewed ☐ Incomplete or deficient - resubmit
Signed:	
Date:	

End of Section

COMMON WORK RESULTS FOR PLUMBING PIPING 22 05 01

1 GENERAL

1.1 Scope

- .1 Provide piping systems for plumbing, drain and vent systems for:
 - .1 potable (domestic) water systems,
 - .2 non-potable water piping systems,
 - .3 drainage system including:
 - (a) sanitary drainage and vent systems,
 - (b) storm water drainage systems,
 - (c) pumped sewage systems.
 - .4 other plumbing systems including:
 - (a) irrigation systems,
 - (b) grey water systems,
 - (c) specific duty piping systems otherwise specified in Division 22.

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 73.13 Mechanical Services for General Facility Equipment
 - .2 22 05 19 Utility Water Meters

1.3 Applicable Codes and Standards

- .1 Legislation:
Ontario Building Code • Plumbing Code
 - .2 Municipal bylaws regarding potable water, water services, and sewage systems.
- .2 Installation standards and codes:
 - .1 AWWA C651 Disinfecting Water Mains.
- .3 Product standards:
 - .1 CSA B272 Pre-Fabricated Self Sealing Roof Vent Flashings

1.4 Qualified Tradesmen

- .1 Work to be performed by qualified and recognized firm with an established reputation in this field, using tradesmen holding certificates of competency.

Design Criteria – Pressure Piping Systems

- .1 The following design conditions apply unless otherwise shown on drawings.
- .2 System design criteria:
 - .1 Domestic Cold Water Service (to building):
 - (a) Design pressure: 900 kPa (130 psig)
 - (b) Design temperature: 25°C (77°F)

- .2 Potable water:
 - (a) Design pressure: 900 kPa (130 psig)
 - (b) Design temperature: 107°C (225°F)
- .3 Non-potable water:
 - (a) Design pressure: 900 kPa (130 psig)
 - (b) Design temperature: 107°C (225°F)

2 PRODUCTS

2.1 Flashings

- .1 Through-roof penetration flashing, and other waterproofed areas:
 - .1 manufactured from composite material in accordance with CSA B272,
 - .2 minimum dimensions of 500 mm x 500 mm (20 in x 20 in),
 - .3 with sleeve extending at least 150 mm (6 in) above roof.

3 INSTALLATION

3.1 Piping

- .1 Piping system routing is shown diagrammatically. Locate mains, risers and runouts concealed behind furrings or above ceilings except in mechanical equipment rooms and access spaces where piping is to be exposed.
- .2 Determine areas without ceilings from Architectural Drawings and Room Finish Schedules, and in these areas keep piping as high as possible.
- .3 Anchor, guide and support vertical and horizontal runs of piping to resist dead load and absorb thrust.

3.2 Domestic Cold Water System Distribution

- .1 Extend existing domestic cold water system with
 - .1 distribution pipe and fittings,
 - .2 valves,
 - .3 premises backflow isolation,
 - .4 zone or equipment backflow protection.

Minimum water pressure at street level: approximately 500 kPa (70 psi).

- .3 Provide valved connections from supply system, to fixtures and other equipment requiring cold water.

3.3 Domestic Hot Water System Distribution

Extend existing domestic hot water system with

- .1 distribution pipe and fittings
- .2 valves
- .3 zone or equipment backflow protection.
- .2 Provide cold water connections to hot water tank, with shut-off and expansion tank on supply and valved drain at bottom of tank.

- .3 Provide valved connections from hot water supply system to fixtures and other equipment requiring hot water.

3.4 Domestic Hot Water Recirculation System

- .1 Extend existing domestic hot water recirculation system with
 - .1 distribution pipe and fittings
 - .2 valves
 - .3 pumps
- .2 Connect ends of hot water risers to recirculation mains and extend to recirculation pump.
- .3 Provide minimum flow balancing valves at each connection between the domestic hot water loop and the hot water recirculation loop.

3.5 Domestic Water Sub-Meters

- .1 Where shown on drawings, install building domestic water sub-meters supplied by the contractor under Division 25.

3.6 Drainage

- .1 Provide roof drains and storm drainage piping system.
- .2 Provide waste and vent connections to plumbing fixtures and equipment.
- .3 Drainage fittings;
 - .1 do not use double hubs, straight crosses, double T's, or double TY's in soil or waste pipe below any fixture,
 - .2 do not use branch fittings other than full "Y" or "Y" and an eighth bend, on soil or waste pipe running in horizontal direction,
 - .3 do not use quarter bend placed on its side,
 - .4 do not use inverted joints below fixtures,
 - .5 do not install cleanouts above food preparation or patient treatment areas. In these areas carry rodding connection up to floor cleanout fitted with adjustable gasketed access cover and plug, with cleanout body cast in floor slab above,
 - .6 drainage fittings to match connected piping for quality and wall thickness.

3.7 Flashings

- .1 Provide flashing for piping penetrations through roofs and other waterproofed areas. Leave flashing ready for Roofing or Waterproofing Trades to make watertight connections.

3.8 Vent Termination (VTR)

- .1 Fit vents passing through roof with vent stack sleeve terminating not less than 150 mm (6 in) above roof, above flood level of roof, and 900 mm (3 ft) above or 3500 mm (11.5 ft) horizontally from any air intake, door, or operable window.

3.9 Water and Waste Connections

- .1 Provide hot and cold water, waste and vent connections to building service equipment. Provide connections to Owners equipment and equipment supplied by Divisions of the Work other than Division 20 to 25, as specified herein and in accordance with specification section 20 05 73.13.

- .2 Provide vacuum breakers and backflow preventers on equipment connections, and hose bibs, and on fixture connections without adequate air gaps.
- .3 Where hot and cold water supply pipes connect to combination supply fitting with shut-off valve on discharge, or where combination supply fitting is equipped with manual or thermostatic mixing valve, equip each hot and cold water supply pipe with composition disc swing check fitting.
- .4 Provide shut-off valve on each service line close to the apparatus and brass traps complete with cleanout on waste connection unless waste discharges directly into floor drain or funnel drain.
- .5 Where specific sizes are not shown, valves, and final connections to equipment to be one pipe size larger than equipment tapping size, and trap and drain size to be one pipe size larger than waste connection on apparatus.

3.10 Pressure Testing – Water Pressure Piping Systems

- .1 Pressure test piping before insulation is applied.
- .2 Initial pneumatic leak test:
 - .1 Conduct an initial pneumatic pressure test at a maximum pressure of 70 kPa (10 psig) prior to hydrostatic pressure test, to check for large leaks or incomplete joints.
 - .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.
- .3 Final hydrostatic pressure test:
 - .1 Use the system design pressure for the entire installation, unless different design pressures are indicated for each floor.
 - .2 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.
 - .3 Inspect each pipe joint for leaks.
 - .4 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.

- .5 Where leaks are found, repair leaks and retest piping as specified above.
- (a) for soldered or brazed joints, one attempt at repairing the joint is permitted. If joint continues to fail, cut-out and replace the fitting.

3.11 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.

3.12 Flushing and Disinfecting - Water Service Pipe

- .1 Complete piping pressure tests prior to flushing and disinfecting operations. Notify Consultant at least two days in advance of date when disinfecting operations are proposed, so that the Consultant may witness the tests.
- .2 Isolate the water service pipe inside the building at the point of entry, from the building water distribution system. Flush water service pipes for a minimum of 10 minutes to produce a water velocity of 1.5 m/s (5 fps) and discharge water to drain or other acceptable area.
- .1 Minimum flushing flow rates:

Pipe size	Minimum Flow	
NPS	L/s	USGPM
2	3.3	52
2 1/2	4.7	75
3	7.3	115
4	12.6	200
6	23.4	450
8	49	780
10	76	1200
12	110	1750

Disinfect water service pipes NPS 4 and larger:

- .1 Provide chemicals and equipment to clean, disinfect and flush domestic water service pipes in accordance with AWWA C651.
- .2 Drain down system to remove flushing water.
- .3 Isolate service water pipe from the building distribution system.
- .4 Disinfect water supply pipe by introducing chlorine close to point of connection to the municipal water supply and evenly add to water as water service pipe is refilling, to provide an initial concentration of 50 mg/L.
- .5 Close off drains and maintain chlorinated water in mains pipe for 24 hours.
- .6 At the end of 24 hours, arrange and pay for laboratory testing of water samples taken from newly disinfected main. If the residual chlorine is < 25 mg/L, drain down water and repeat disinfection for an additional 24 hours and lab testing until a residual of minimum 25 mg/L is obtained.

.7 After the lab test indicates a residual of 25 mg/L, flush line to remove chlorine solution.

3.13 Flushing and Cleaning - Building Water Distribution Piping

- .1 Conduct first fill and pressure testing of building distribution piping only after completion of flushing and disinfection of water service pipe.
- .2 Complete piping pressure tests prior to flushing and cleaning operations.
- .3 Flush water distribution piping through available outlets with sufficient flow to produce velocity of 1.5 m/s, within pipe for 10 minutes, or until foreign materials have been removed and flushed water is clear.
- .4 Minimum flushing flowrates:

Pipe size	Minimum Flow	
NPS	L/s	USGPM
2	3.3	52
2 1/2	4.7	75
3	7.3	115
4	12.6	200

- .5 Open and close valves, hydrants and service connections to ensure thorough flushing.[]]

3.14 Testing and Balancing – Water Pressure Piping Systems

- .1 Balance domestic water piping systems where double regulating valves are installed, including hot water recirculation piping and as otherwise shown.

END OF SECTION

GENERAL-DUTY VALVES FOR PLUMBING PIPING

22 05 23.13

1 GENERAL

Scope

- .1 Provide valves for general duty service in plumbing piping systems, including shut-off valves, check valves, manual balancing valves, and automatic flow balancing valves.
- .2 Valves under this specification section are provided for:
 - .1 Domestic (potable) water systems using copper tubing, stainless steel pipe or tube, ductile iron water piping, and galvanized steel piping.
 - .2 Non-potable water piping systems including:
 - (a) Process water systems,
 - (b) Irrigation systems,
 - (c) Grey water systems,
 - (d) Pumped sewage systems.

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 22 05 01 Plumbing - General

1.3 Definitions

- .1 The following definitions apply to this section.
 - .1 **Contaminant-free:** means the material is free of contaminants and impurities to the prescribed limits of NSF/ANSI 61 – section 8 (NSF/ANSI 61/8), but excludes evaluation for lead.
 - .2 **Lead-free:** means the weighted average lead content does not exceed 0.25% when evaluated in accordance with the test methods in NSF/ANSI 61-Annex G or NSF/ANSI 372.

1.4 Submittals

- .1 Conform to the requirements of Specification section 20 05 23 except/and as follows.
- .2 For double regulating valves, in addition to manufacturer data sheets, submit a schedule listing all double regulating valves and include the following information:
 - .1 a valve reference number,
 - .2 valve service (e.g. associated equipment, or distribution piping service by drawing, room, etc.)
 - .3 associated pipeline size, NPS
 - .4 valve body size, NPS
 - .5 specified design flow rate,
 - .6 valve minimum and maximum flow rate limits,
 - .7 valve pressure drop at specified design flow rate,
 - .8 expected valve open position (number of valve turns open, percent valve stroke, etc.).

- .3 For automatic flow balancing valves, in addition to manufacturer data sheets, submit a schedule listing all automatic flow balancing valves and include the following information:
 - .1 a valve reference number,
 - .2 valve service (e.g., where the valve is located, floor, room, etc.),
 - .3 associated pipeline size, NPS
 - .4 valve body size, NPS
 - .5 specified design flow rate,
 - .6 valve fixed flow rate,
 - .7 valve operating differential pressure range.

1.5 Applicable Codes and Standards

- .1 Refer to section 20 05 23 and as specified herein.
- .2 Product standards:
 - .1 CSA B125.3 Plumbing Fittings
 - .2 NSF/ANSI 61 Drinking Water System Components – Health Effects
 - .3 NSF/ANSI 372 Drinking Water System Components – Lead Content (formerly NSF/ANSI 61, Annex G).

2 PRODUCTS

2.1 General

- .1 Where products are specified as being lead-free, they shall be listed to either:
 - .1 CSA B125.3;
 - .2 NSF/ANSI 61-G; or
 - .3 NSF/ANSI 372.
- .2 Where products are specified as being contaminant-free, they shall be listed to either:
 - .1 CSA B125.3;
 - .2 NSF/ANSI 61-G; or
 - .3 NSF/ANSI 61/8

2.2 Ball Valves: Brass Body (type BV-1)

- .1 NPS 4 and under, copper alloy body:
 - .1 To MSS SP-110, 600 CWP, two-piece bronze or DZR brass body, full port, stainless steel or chrome plated bronze ball, PTFE seat rings, solder or NPT threaded ends.
 - .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
 - .3 Required MCPR: 2500 kPa (363 psig) at 93°C (200°F).
 - .4 Certified for lead-free and contaminant-free service.
 - .5 Soldered ends: NPS 2 and under.

Standard of Acceptance

- Kitz - fig. 859
- Apollo - fig. 77FLF-20x

- Nibco - fig. S-685-66-LF
- Watts - fig. LFB6081

.6 Threaded ends: NPS 4 and under.

Standard of Acceptance

- Kitz - fig. 858
- Apollo - fig. 77FLF-10x
- Nibco - fig. T-685-66-LF
- Watts - fig. LFB6080

2.3 Ball Valves: Stainless Steel Body (type BV-2)

.1 NPS 4 and under, threaded ends:

- .1 To MSS SP-110, 600CWP, two piece T316 stainless steel body, full port, stainless steel or chrome plated bronze ball, PTFE seat rings, NPT threaded ends.
- .2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.
- .3 Required MCPR: 2500 kPa (363 psig) at 93°C (200°F).
- .4 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Apollo - fig. 76F-10x series (NPS 2 and under)
- Watts - fig. S-FBV-1 series

.2 NPS 1- ½ to NPS 12, flanged ends:

- .1 To MSS SP-72, two piece CF8M stainless steel body, full port, stainless steel ball, PTFE seat rings, flanged ends.
- .2 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .3 Certified for lead-free and contaminant-free service.
- .4 ASME Class 150:
 - (a) Required MCPR: 1600 kPa (232 psig) at 93°C (200°F).

Standard of Acceptance

- Apollo - fig. 87A-200 series

.5 ASME Class 300:

- (a) Required MCPR: 4000 kPa (580 psig) at 93°C (200°F).

Standard of Acceptance

- Apollo - fig. 87A-900 series

2.4 Globe Valves (type GLV-1)

.1 NPS 2 and under:

- .1 To MSS SP-80, Class 125 bronze body valves, brass or bronze disc, threaded bonnet, threaded or soldered ends.
- .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).

.3 Certified for lead-free and contaminant-free service.

.4 Soldered ends:

Standard of Acceptance

- Kitz - fig. 812
- Apollo - fig. 121S-LF

.5 Threaded ends:

Standard of Acceptance

- Kitz - fig. 811
- Apollo - fig. 121T-LF

2.5 Gate Valves: Bronze Body (type GTV-1)

.1 NPS 2 and under:

.1 To: MSS SP-80, Class 125; or MSS SP-139, 300 CWP, bronze body, solid wedge brass or bronze disc, non-rising stem, screw in or union bonnet.

.2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).

.3 Certified for lead-free and contaminant-free service.

.4 Soldered ends:

Standard of Acceptance

- Kitz - fig. 828
- Apollo - fig. 102SLF
- Crane (GGC) - fig. LF1320
- Nibco - fig. S-111-LF

.5 Threaded ends:

Standard of Acceptance

- Kitz - fig. 827
- Apollo - fig. 102TLF
- Crane (GGC) - fig. LF438
- Nibco - fig. T-113-LF

2.6 Gate Valves: Cast Iron Body (type GTV-2)

.1 NPS 2 to 12:

.1 To: MSS SP-70, Class 125, cast iron body, solid wedge bronze disc and bronze seat rings, adjustable graphite stem packing, bolted bonnet.

.2 Finish: FDA food grade epoxy power coat,

.3 Required MCPR: 1380 kPa (200 psi) at 38°C (100°F).

.4 CRN to CSA B51,

.5 Certified for lead-free and contaminant-free service.

.6 End connections: flat-faced flanged, suitable for ASME Class 125 and Class 150 pipe flanges,

.7 Non-rising stem:

Standard of Acceptance

- Apollo - fig. 610F-LF

.8 Outside screw and yoke:

Standard of Acceptance

- Apollo - fig. 611F-LF

2.7 Gate Valves, Non-Potable Applications (type GTVNP)

.1 For non-potable water systems only. Do not use on potable water systems.

.2 NPS 2½ to NPS 12, cast iron:

.1 To MSS SP-70, Class 125, cast iron body with flat faced flange, bronze or bronze faced solid wedge disc with bronze seat rings, OS & Y, bolted bonnet, flanged ends.

(a) Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).

Standard of Acceptance

- Kitz - fig. 72
- Crane - fig. 465 ½
- Jenkins - fig. 454J
- Nibco - fig. F-617-O

.3 NPS 2½ to NPS 24, stainless steel:

.1 To ASME B16.34, Class 150, ASTM A216 grade WCB cast steel body with raised faced flange, flexible Type 416 stainless steel disc and hard faced seat rings, rising stem, OS & Y, bolted bonnet, flanged ends.

.2 ASME Class 150:

(a) Required MCPR: 1700 kPa (246 psi) at 93°C (200°F).

Standard of Acceptance

- Kitz - fig. 150 SCLS
- Crane - fig. 47 XU-F
- Jenkins - fig. J1009B8F
- Powell - fig. 1503-FC8G

.3 ASME Class 300:

(a) Required MCPR: 4000 kPa (580 psi) at 93°C (200°F).

Standard of Acceptance

- Kitz - fig. 300 SCLS
- Crane - fig. 33 XU-F
- Powell - fig. 3003-FC8G

2.8 Butterfly Valves - Flanged

.1 NPS 2 to NPS 12, ductile iron (type BFV-1):

.1 To MSS-SP-67, ductile iron lug body style, with flange bolt holes drilled and tapped for ANSI 150 flange pattern.

.2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).

- .3 Stainless steel shaft, aluminum bronze or 316 stainless steel or ductile iron/nickel plated disc, and replaceable EPDM resilient seat to provide bubble tight shut-off under system pressure from either side with flange removed from un-pressurized side.
- .4 ISO 5211 mounting pad.
- .5 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .6 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Nibco - fig. LD-2000
- Apollo - fig. LD 141, LD 145
- Kitz - fig. 6122EL
- MA Stewart - fig. L-D-4-A-E-LH
- Watts - fig. DBF-03
- Milwaukee - fig. ML233E, ML333E
- Crane Center Line fig. 200

.2 NPS 2 to NPS 12, stainless steel (Type BFV-2):

- .1 To MSS-SP-68, Class 300, CF8M stainless steel lug body style, with flange bolt holes drilled and tapped for ANSI 300 flange pattern.
- .2 Required MCPR: 4000 kPa (580 psi) at 93°C (200°F).
- .3 T316 or 17-4 stainless steel disc and shaft, TFM-PTFE seat complete with titanium or 316 stainless steel spiral wound back-up ring to provide bubble tight shut-off under system pressure from either side, when installed with single flange.
- .4 ISO 5211 mounting pad.
- .5 Locking handles up to NPS 4, and gear operators for NPS 6 and over.
- .6 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Apollo - fig. 230
- Keystone - fig. K-Lok 37

2.9 Butterfly Valves – Groove Ends

.1 NPS 2 to NPS 12, stainless steel (type BFV-4).

- .1 To MSS SP-67, CF8M stainless steel body, and grooved ends to CSA B242.
- .2 Required MCPR: 2000 kPa (290 psi) at 93°C (200°F).
- .3 Stainless steel shaft, CF8M stainless steel disc, and fluoroelastomer seat to provide bubble tight shut-off under system pressure from either side with flange removed from un-pressurized side.
- .4 ISO 5211 mounting pad.
- .5 Locking handles up to NPS 3, and gear operators for NPS 4 and over.
- .6 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Victaulic - fig. Vic 300 MasterSeal series 461

.2 NPS 2-1/2 to NPS 6, grooved ends for copper tubing (type BFV-5).

- .1 To MSS SP-67, brass or bronze body, grooved ends for copper tubing.
- .2 Required MCPR: 2000 kPa (290 psi) at 93°C (200°F).
- .3 Stainless steel shaft, aluminum bronze disc with fluoroelastomer seat or ductile iron with EPDM encased disc/seal combination.
- .4 ISO 5211 mounting pad.
- .5 Locking handles up to NPS 6.
- .6 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Victaulic - fig. Vic 608N
- Gruvlok - fig. AN6721

2.10 Inline Silent Check Valves

- .1 NPS 2 and under:
 - .1 To MSS SP-80, Class 125, bronze or stainless steel body, inline spring-actuated disc or ball type, and PTFE or EPDM seat.
 - .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).
 - .3 Certified for lead-free and contaminant-free service.
 - .4 Soldered ends:

Standard of Acceptance

- Nibco – fig. S-480-Y-LF
- Apollo – fig. CVB-LF (61LF-600)
- Kitz – fig. 826

- .5 Threaded ends:

Standard of Acceptance

- Nibco - fig. T-480-Y-LF
- Apollo - fig. CVB-LF (61LF-500)
- Kitz - fig. 836

- .2 NPS 2 to NPS 12:
 - .1 To MSS SP-125, cast iron body with flat faced flange or wafer body, inline spring-actuated silent type, replaceable PTFE or BUNA-N seats, bronze faced iron or bronze disc.
 - .2 Required MCPR: 13200 kPa (188 psi) at 65°C (150°F).
 - .3 Certified for lead-free and contaminant-free service.
 - .4 Class 125:
 - (a) Required MCPR: 1380 kPa (200 psi) at 65°C (150°F).

Standard of Acceptance

- Nibco - fig. F-910-W-LF, W-910-LF
- Valmatic - fig. VM-8802-S

- .5 Class 250:
 - (a) Required MCPR: 2700 kPa (392 psi) at 65°C (150°F).

Standard of Acceptance

- Nibco - fig. F-960-W-LF, W-910-LF
- Valmatic - fig. VM-8802-S

.3 NPS 2 and over, grooved ends:

- .1 CF8M stainless steel body with spring-assisted twin stainless steel discs, and fluoroelastomeric seat.
- .2 Required MCPR: 2000 kPa (290 psi) at 93°C (200°F).
- .3 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Victaulic - fig. 816

2.11 Swing Check Valves – Non-slam

- .1 For building sump pumps service only.
- .2 NPS 2 and larger, flanged:
 - .1 To MSS SP-71, Class 125, swing check type with external lever weight and/or spring closure, cast iron body, renewable bronze seat rings, bronze faced iron or bronze disc, bolted cap, flanged ends.
 - .2 Required MCPR: 1200 kPa (174 psi) at 93°C (200°F).

Standard of Acceptance

- Val-Matic - fig. 7800LW / 7800LS
- DeZurik - fig. APCP swing check

2.12 Double Regulating Valves (DRVLF)

- .1 NPS 3 and under, threaded or soldered:
 - .1 Brass body, plug type stem with flow measurement ports and tamper-proof setting.
 - .2 NPT threaded or soldered ends.
 - .3 Required MCPR:
 - (a) Soldered: 2000 kPa (300 psig) at 93°C (200°F).
 - (b) Threaded: 2750 kPa (400 psi) at 93°C (200°F).
 - .4 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Bell and Gossett - fig. CB-*-LF, RF-*-LF
- Nexus - fig. Ultra MBNL
- Victaulic/Tour and Anderson - fig. 78BL

.2 Flow meter for DRVs:

- .1 Differential pressure gauge with calibration charts or digital flow meter type.
- .2 Hoses and fittings to suit manual double regulating valves.

Standard of Acceptance

- Bell and Gossett - Readout Kit

- Nexus - Meter Kit, MKM series

2.13 Automatic Flow Balancing Valve (AFBV)

- .1 NPS ½ to NPS ¾, threaded:
 - .1 Automatic flow balancing valve providing constant flow rate over a wide differential pressure control range.
 - .2 Stainless steel or brass body, with stainless steel cartridge and EPDM seals.
 - .3 Performance:
 - (a) +/- 5% flow rate over 95% of control range.
 - (b) Differential pressure control range: minimum of 14 to 220 kPa (2 to 32 psi) operating range.
 - .4 NPT threaded ends.
 - .5 Minimum MCPR: 2750 kPa (400 psi) at 93°C (200°F).
 - .6 Certified for lead-free and contaminant-free service.

Standard of Acceptance

- Victaulic/Tour and Andersson - fig. 76X
- Griswald Controls - fig. K Valve

2.14 Solenoid Valves for Potable Water

- .1 Construction:
 - .1 2-way bronze, brass or composite engineered plastic body valve with EPDM seals and disc,
 - .2 control function: On/Off,
 - .3 for normally closed or normally open operation as shown,
 - .4 pilot operated electric solenoid with general purpose enclosure and conduit hub,
 - .5 minimum allowable working pressure: 1035 kPa (150 psig),
 - .6 minimum operating differential pressure: 820 kPa (120 psi)
 - .7 minimum design temperature: 82°C (180°F)
 - .8 manual override operator for normally-closed valves,
 - .9 pipe ends: ASME B1.20.1 NPT threaded ends, or push/twist lock connector for copper tube,
 - .10 certified for lead-free and contaminant-free service.
 - .11 listed to CSA C22.2 No. 139,
 - .12 power supply: 24 VAC, 24 VDC or 120 VAC.
 - .13 valve size limits based on service temperature:

Valve Size	Maximum Water Temperature
NPS 1	50°C (122°F)
NPS ¾ and smaller	82°C (180°F)

Standard of Acceptance

- ASCO - fig 212

3 EXECUTION

3.1 Installation

- .1 Refer to section 20 05 23 and as required herein.
- .2 Use certified lead-free and contaminant-free valves on potable cold, hot and recirculating water systems. Valves not certified as lead-free may only be used on non-potable water systems, pumped drainage systems and other similar systems.

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 22 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 Manual Valve Selection Based on Service and Pipe Material

- .1 Select manual valve types based on the requirements of Table 1.

Table 1: Manual Valve Selection		
Piping System	Pipe and Tube Material	Manual Valve Type
Domestic Cold Water Domestic Hot Water Domestic Recirculating Water Domestic Tempered Water	Copper	BV-1 GLV-1 GTV-1, GTV-2 BFV-1, BFV-2, BFV-5
	Stainless Steel	BV-2 BFV-2, BFV-4
	Ductile Iron	BFV-1, BFV-2, GTV-2
Domestic Cold Water (Industrial Occupancies only)	Galvanized steel	BV-1 GTV-2 BFV-1, BFV-3
Non-potable water	Copper	BV-1 GLV-1 GTV-1 BFV-1, BFV-2, BFV-5
	Stainless Steel	BV-2 BFV-2, BFV-4
	Galvanized Steel	BV-1, BV-2 GLV-1 GTV-1, GTV-2, GTVNP BFV-1, BFV-2, BFV-3, BFV-4

Table 1: Manual Valve Selection		
Piping System	Pipe and Tube Material	Manual Valve Type
Pumped Sanitary Drainage Pumped Storm Drainage	Copper	BV-1, BV-2
	Galvanized Steel	BV-1, BV-2

3.4 Check Valves

- .1 Select check valves based on the requirements of Table 2.

Table 2: Check Valve Type Selection	
General use	Inline silent check
Domestic water heaters	Inline silent check
Temperature mixing valves	Inline silent check
Elevator sump pump discharge Clear waste sump pump discharge	Inline silent check or non-slam swing check
Sanitary sump pump discharge Storm sump pump discharge	Non-slam swing check valve

3.5 Double Regulating Valves Installation

Size and select valves for flows as shown, based on at 6 kPa (2 ft) pressure drop across the valve in the fully open position, and in accordance with manufactures recommendation. Table 3 identifies the nominal valve size selection:

Table 3: Double Regulating Valve Nominal Sizing				
Valve Size NPS	Nominal Flow			
	Min.	Max.	Min.	Max.
	L/s	L/s	gpm	gpm
½	0.038	0.177	0.6	2.8
¾	0.126	0.379	2.0	6.0

1	0.246	0.631	3.9	10.0
1-¼	0.316	0.947	5.0	15.0
1-½	0.416	1.262	6.6	20.0
2	0.795	2.272	12.6	36.0
2-½	2.398	6.310	38.0	100.0
3	1.956	8.203	31.0	130.0
4	4.291	12.620	68.0	200.0
5	5.679	20.192	90.0	320.0
6	11.48	28.395	182.0	450.0
8	23.16	51.742	367.0	820.0
10	34.07	82.030	540.0	1300.0
12	60.58	94.650	960.0	1500.0

- .2 Install double regulating valves with five pipe diameters of straight pipe on inlet side, two pipe diameters on outlet side and 10 pipe diameters from any pump.
- .3 Install double regulating valves with ports facing horizontal or facing up. Do not install with ports facing down to prevent debris from falling and accumulating inside the ports.

3.6 Automatic Flow Balancing Valves Installation

- .1 Select automatic flow balancing valves to suit the flow rates as shown at a pressure differential of 35 kPa (5 psig). Where the indicated flow rate falls between two catalogued values, select the lower flow rated valve.

End of Section

DOMESTIC WATER PIPING - COPPER

22 11 16.13

1 GENERAL

1.1 Scope

- .1 Provide copper tube and fittings for potable domestic water piping systems for aboveground installations.

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 22 05 01 Plumbing Piping Systems – General Requirements
 - .3 22 05 23.13 General-duty Valves for Plumbing Piping
 - .4 20 05 29 Common Hanger and Support Requirements for Piping

1.3 Definitions

- .1 The following definitions apply to this specification section:
 - .1 **Exposed areas:** include inside service rooms and above lay-in tile ceilings, but excludes: vertical and horizontal service shafts; above any other ceiling construction; and inside walls and partitions.

1.4 Applicable Codes and Standards

- .1 Installation standards:
 - .1 Copper Development Association (CDA) Copper Tube Handbook
- .2 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 B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
 - .4 ASME B16.24 Cast Copper Alloy Pipe Flanges and Flanged Fittings; Class 150, 300, 400, 600, 900, 1500, & 2500.
 - .5 ASME B16.50 Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
 - .6 ASTM A193 Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature
 - .7 ASTM A194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
 - .8 ASTM B32 Standard Specification for Solder Metal
 - .9 ASTM B88 Standard Specification for Seamless Copper Water Tube
 - .10 ASTM B813 Standards Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
 - .11 ASTM B828 Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
 - .12 AWS A5.8 Brazing Filler Metal.

- | | |
|----------------|--|
| .13 AWS A5.31 | Specification for Fluxes for Brazing and Braze Welding |
| .14 AWS C3.4 | Specification for Torch Brazing |
| .15 CSA B242 | Groove and Shouldered Type Mechanical Couplings |
| .16 MSS SP-106 | Cast Copper Alloy Flanges and Flanged Fittings, Class 125, 150 and 300 |

2 PRODUCTS

2.1 Copper Tube

- .1 Hard drawn, type L.
- .2 Listed to ASTM B88 and to have certification markings made by testing agency accredited by Standards Council of Canada.

2.2 Fittings

- .1 Brass or bronze flanges and flanged fittings: to ASME B16.24.
- .2 Brass or bronze threaded fittings: to ASME B16.15.
- .3 Solder/brazed fittings: cast bronze to ASME B16.18, or wrought copper and bronze to ASME B16.22.
- .4 Threaded fittings including unions to ASME B16.15, Class 250.
- .5 Roll groove full flow standard radius cast bronze fittings for sizes NPS 2 1/2 and larger: to CSA B242

2.3 Joints

- .1 Solder: 95:5 tin-antimony solder to ASTM B-32.
- .2 Silver brazing alloy to AWS A5.8 classification BCUP-5.

Standard of Acceptance

- Handy Harman "SIL-FOS"
- All-State Welding Alloys "SILFLO 15"

- .3 Flanges:
 - .1 Threaded end connection: flat face, cast copper alloy to ASME B16.24, class 150 and 300, NPT threaded,
 - .2 Brazed end connection: flat face, cast copper alloy to MSS SP-106, class 150 or 300.
 - .3 Dielectric flanges: to specification section 22 05 01.
 - .4 Studs and bolts: stainless steel to ASTM A193.
 - .5 Nuts: stainless steel type 316, to ASTM A194.
- .4 Flange gaskets:
 - .1 Full flat-faced style to ANSI B16.21.
 - .2 Suitable for use in potable water service and listed to NSF/ANSI 61.
 - .3 Ethylene propylene diene monomer (EPDM);
 - (a) required working pressure: 1700 kPa (250 psi) at up to 95°C (203°F)
 - .4 Compressed mineral fibers bonded with nitrile (NBR);
 - (a) required working pressure: 2750 kPa (400 psi) at up to 95°C (203°F)

Standard of Acceptance

- American-Biltrite (EPDM) – fig. AB-576
- Durlon (NBR) – fig. 7910

.5 Roll grooved piping:

- .1 Roll groove positive clamp gasketed couplings or roll groove flange adapters for copper piping to CSA B242.

Standard of Acceptance

- Victaulic - fig. 607
- Gruvlock
- Couplox
- Shurjoint

3 EXECUTION

3.1 Installation

- .1 Refer to section 22 05 01 for piping design criteria and general requirements for piping installation.
- .2 Install tubing close to building structure to minimize furring and conserve headroom. Group tubing and run parallel to walls and ceilings.
- .3 Cut tube square, ream tube ends and clean tubing and tube ends before joint assembly.
- .4 Before making solder or brazed joints, remove working parts of valves, clean inside of solder fittings and outside of mating pipe with emery paper and coat with applicable flux.

3.2 Pipe Supports

- .1 Support piping and tubing in accordance with specification section 20 05 29 except as specified herein.
- .2 Support horizontal copper tubing at intervals in accordance with Table 1:

Table 1: Horizontal Pipe Support Spacing for Copper Tube		
Pipe Size NPS	Rod Diameter	Maximum Spacing
½	M10 (3/8 in)	1.5 m (5 ft)
¾ 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)

- .1 Support vertical pipe and tube risers;
- .1 at the base (bottom) of the riser by a support that is independent of any adjacent horizontal pipe supports,

- .2 at every other floor level with pipe riser clamps, but not to exceed a vertical spacing of more than 7.5 m (24.5 ft).

3.3 Class Rated Fittings

- .1 Select ASME Class rated fittings and flanges in accordance with the following Table 2 for design pressure limits at coincident design temperature limits unless otherwise shown on drawings.

Table 2: Pressure and Temperature Limits for Class Rated Fittings		
Class	Maximum Design Pressure	Maximum Coincident Design Temperature
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)
300	3100 kPa (450 psi)	≤ 121°C (250°F)

3.4 Joints and Fittings

- .1 Joints in tubing:
- .1 NPS ½ to NPS 2:
 - (a) soldered.
 - .2 NPS 2-1/2 and larger:
 - (a) brazed, flanged or roll-grooved joints.
- .2 Make solder joints in accordance with the recommendations of the CDA handbook.
- .3 Make braze joints in accordance with specification section 20 05 24.
- .4 Use manufactured fittings. Use of fabricated pulled-tee's is subject to approval by the local municipal authority for plumbing, and only brazed butt weld joints shall be used.
- .5 For flange joints, select gasket materials in accordance with the following Table 3 so that gasket pressure and temperature both exceed the piping system design pressure and design temperature.

Table 3: Flange Gasket Selection				
Gasket Temperature Limit	Gasket Pressure Limit	Gasket Material	Gasket Thickness	Figure
95°C (203°F)	1720 kPa (250 psig)	EPDM	1.5 m (1/6 in)	A-B AB-576
	2750 kPa (400 psig)	NBR	1.5 m (1/6 in)	Durlon 7910

3.5 Groove Joint Piping

- .1 Make pipe ends clean and free of indentations, projections and roll marks, between the end of the pipe and the groove.
- .2 Verify gasket style and material grade with supplier for use with intended service.
- .3 Provide for manufacturers' service representative to conduct on-site training prior to piping rough-in and installation.
- .4 Arrange and pay for a factory-trained representative to periodically visit the place of the Work and review the installation for compliance with the manufacturer's installation instructions.
 - .1 Correct any identified deficiencies.
 - .2 Correct any product that has been examined and which has not met the visual inspection criteria for proper installation
 - .3 Arrange and pay for re-examination by the manufacturer's representative after deficiencies have been corrected and/or materials replaced to verify the corrected installation prior to filling the system for testing or placing into service.

3.6 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, or
 - (b) grooved end where equipment has compatible factory-prepared grooved ends.
- .2 Where connection is made to equipment with a threaded fitting, provide a union between the isolation valve and the equipment connection.
- .3 For threaded flanges, provide a sweat x NPT adaptor; do not thread tubing directly.
- .4 Provide a dielectric union or dielectric flange in accordance with specification section 22 05 01 when connecting potable water piping to equipment with carbon steel connections. Dielectric fittings are not required when connecting to equipment with stainless steel connections.

3.7 Valves

- .1 Provide valves in accordance with specification section 22 05 23.13.
 - .1 Isolate equipment, fixtures and branches with gate, ball or butterfly valves.
 - .2 Use globe, DRVs, ball or butterfly valves for throttling service.

3.8 Pressure Testing, Flushing and Balancing

- .1 Pressure test, flush and balance water systems to specification section 22 05 01.

END OF SECTION

Master revised: 7 March 2023

SANITARY WASTE AND VENT PIPING – CAST IRON AND COPPER

22 13 16.13

1 GENERAL

1.1 Scope

- .1 Provide cast iron pipe and fittings and/or copper tube and fittings for sanitary soil and waste drain and vent piping, for aboveground and buried services.
- .2 Provide PVC-DWV piping for urinal fixture drains and a portion of the fixture vent piping.
 - .1 For clarity, the use of PVC DWV piping under this specification section is restricted to this purpose.

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 25 Excavation and Backfilling
 - .2 20 05 29 Common Hanger and Support Requirements for Piping

1.3 Applicable Codes and Standards

- .1 Installation standards and codes:
 - .1 Cast Iron Soil Pipe Institute (CISPI) Technical Manual
- .2 Product standards:
 - .1 ASME B16.23 Cast Copper Alloy Solder Joint Drainage Fittings: DWV
 - .2 ASME B16.29 Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings-DWV
 - .3 ASTM B32 Standard Specification for Solder Metal
 - .4 ASTM B306 Standard Specification for Copper Drainage Tube (DWV)
 - .5 ASTM C564 Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
 - .6 ASTM C1540 Standard Specification for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
 - .7 ASTM B828 Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
 - .8 CSA B70 Cast Iron Soil Pipe, Fittings, and Means of Joining
 - .9 CSA-B125 Plumbing Fittings.
 - .10 CSA B158.1 Cast Brass Solder Joint Drainage, Waste, and Vent Fittings
 - .11 CSA B602 Mechanical Couplings for Drain, Waste, and Vent Pipe and Sewer Pipe.

2 PRODUCTS

2.1 Copper DWV Pipe and Fittings

- .1 Application: inside of buildings only. Do not use for buried drain or vent.
- .2 Pipe:
 - .1 copper DWV tube to ASTM B306
 - .2 certification markings made by testing agency accredited by Standards Council of Canada.

.3 Fittings:

- .1 copper or copper alloy to ASME B16.23, or ASME B16.29.

.4 Solder

- .1 tin-antimony 95/5 to ASTM B32 alloy Sb5.

2.2 Cast Iron DWV Pipe and Fittings

- .1 Application: inside of buildings and buried drain and vent.

.2 Pipe and fittings:

- .1 cast to CSA B70,
- .2 with heavy bituminous coating for buried service.
- .3 riser fittings with integral riser support ring for hub-less piping installed in vertical risers.

.3 Joints above ground:

Plain end made up using mechanical sleeve joints to CSA B602 and ASTM C1540 with neoprene or butyl rubber compression gaskets to ASTM C564, with stainless steel sleeve and not less than four stainless steel drive clamps with stainless steel worms.

- .2 Hub and spigot made up neoprene gasket to ASTM C564 and lubricating compound.

PVC DWV Pipe and Fittings**.1 Application:**

- .1 Restricted to fixture drain piping and partial vent pipe for urinals.

.2 Pipe and fittings:

- .1 PVC pipe and fittings to CSA-B181.2,
- .2 flame spread rating ("FSR") of not more than 25 when tested to ULC-S102.2,
- .3 smoke developed rating ("SDR") of not more than 50 when tested to ULC-S102.2.
- .4 materials marked for CSA B181.2 and ULC-S102.2.

Standard of Acceptance

- IPEX -"System XFR 15-50"

.3 Joint cement:

- .1 one-step CSA listed cement for pipe sizes NPS 1½ to NPS 6.
- .2 IPS primer Type P-70 and Heavy Bodied IPS Cement Type 711 for pipe sizes larger than NPS 6.
- .3 Volatile Organic Content: maximum 510 g/L.]]

3 EXECUTION**3.1 Installation General**

- .1 Install soil, waste and vent piping in accordance with the requirements of the plumbing code applicable at the project location. Except as otherwise shown, venting of fixtures may use any method permitted in the plumbing code.

- .2 Install suspended piping to grade, parallel and close to walls and ceilings to conserve headroom and space.
- .3 Install piping close to building structure to minimize furring. Group piping and run parallel to walls and ceilings.

3.2 Cast Iron Piping

- .1 Install cast iron drainage piping in accordance with Cast Iron Soil Pipe and Fittings (CISPF) Technical Manual.
- .2 Lay buried piping in bedding prepared in accordance with specification section 20 05 25. Support piping on 150 mm (6 in.) thick bedding material, shaped to accommodate hubs and fittings, to line and grade as shown. Backfill with cover material to 300 mm above top of pipe or to underside of floor slab whichever is less.
- .3 Assemble and tighten mechanical sleeve joints to coupling manufacturers recommended torque value with torque wrench.
- .4 Install cast iron hub-and-spigot joints with neoprene compression gasket and lubrication in accordance with manufacturer requirements.
- .5 Provide thrust restraints consisting of pipe clamps and restraint rods installed across tees, elbows, and blind plugs (cleanouts), for cast iron drainage piping NPS 5 and larger.
- .6 Provide sway braces on all horizontal piping where the hanger length is greater than 450 mm (18 in) measured from the top of the pipe to the structure connection point, as follows:
 - .1 transverse brace at 12 m (40 ft) intervals,
 - .2 longitudinal brace at 24 m (80 ft) intervals,
 - .3 a transverse brace of one pipe section may act as a longitudinal brace for a second pipe section connected perpendicular to the first section, provided the brace is located within 600 mm (24 in) of the connection.
 - .4 for clarity, these braces are required even where seismic restraint is not required.

3.3 Copper Tubing

- .1 Cut copper tube square, ream tube ends and clean tubing and tube ends before joint assembly.
- .2 Before assembling solder joints, clean inside of solder fittings and outside of mating pipe with emery paper and coat with flux.
- .3 Solder joints in copper pipe with blow torch or oxy-acetylene flame.

3.4 Pipe Supports

- .1 Support piping in accordance with specification section 20 05 29 except as specified herein.
- .2 Support horizontal copper DWV tubing in accordance with Table 1A:

Table 1A: Horizontal Pipe Support Spacing for Copper Tube		
Pipe Size NPS	Rod Diameter	Maximum Spacing
½	M10 (3/8 in)	1.5 m (5 ft)
¾ 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)

- .3 Support horizontal cast iron DWV piping in accordance with Table 1B and as follows;
- .1 one pipe support for each end of the pipe, located at or within 150 mm (6 in) of each hub or mechanical joint,
 - .2 for mechanical joints, if the pipe length between adjacent fittings is 300 mm (12 in) or less, reduce the support spacing to a maximum of 1000 mm (39 in),
 - .3 where multiple joints occur within a 1000 mm (39 in) developed pipe length;
 - (a) support may be reduced to every other hub or mechanical joint, or
 - (b) where the pipe run is made of multiple fittings connected end-to-end, provide a 1.6 mm (16 ga) galvanized steel half sleeve underneath the pipe and fittings, and support the sleeve with a support at each end of the sleeve.

Table 1B: Horizontal Pipe Support Spacing for Cast Iron DWV Piping			
Pipe Size NPS	Maximum Spacing	Clevis Hanger: Minimum Rod Diameter	MJ Hanger: Minimum Rod Diameter
1-1/2	3 m (9.8 ft)	---	M10 (3/8 in)
2	3 m (9.8 ft)	---	M10 (3/8 in)
3 to 4	3 m (9.8 ft)	M10 (3/8 in)	M10 (3/8 in)
6	3 m (9.8 ft)	M12 (1/2 in.)	M12 (1/2 in.)
8 to 12	3 m (9.8 ft)	M16 (5/8 in)	---
15	3 m (9.8 ft)	M20 (3/4 in)	---

- .4 Support vertical pipe and tube risers at the base (bottom) of the riser and as follows:
- .1 for cast iron drain and vent piping,
 - (a) support piping at every floor level with a pipe clamp, arranged so that the pipe clamp is above the pipe section center of gravity,

- (b) support the pipe below a hub, or support the pipe with a riser fitting for hub-less joints.
 - (c) support the base of a riser at a fitting hub, or for mechanical joints support the riser pipe at a riser fitting,
 - (d) for pipe sizes NPS 5 and larger, provide sway braces at the base support to limit movement in both horizontal directions.
- .2 for other piping, support piping at every other floor level with pipe riser clamps,
 - .3 for all piping and tubing, do not exceed a vertical spacing of more than 7.5 m (24.5 ft),
 - .4 in addition, for cast iron drainage piping provide lateral guides;
 - (a) at the base and top of the pipe riser,
 - (b) and at every 9 m (30 ft) except where the pipe riser clamp is restrained to prevent lateral movement.

3.5 Special Requirements for Urinals

- .1 Use cast iron DWV piping or PVC DWV piping for the following sections of the drainage piping and venting systems for all urinals (do not use copper tube or pipe):
 - .1 for the fixture drain between the urinal trap outlet and the connection to another part of the drainage system, other than drainage piping that only serves urinals,
 - .2 for the portion of the vent pipe that vents one or more urinals between the connection to the fixture drain and up to a height not less than the flood level rim of the urinal,
 - .3 for horizontal drains serving only multiple urinals, from the fixture drain and the connection to another part of the drainage system conveying soil or waste from plumbing fixtures other than urinals.

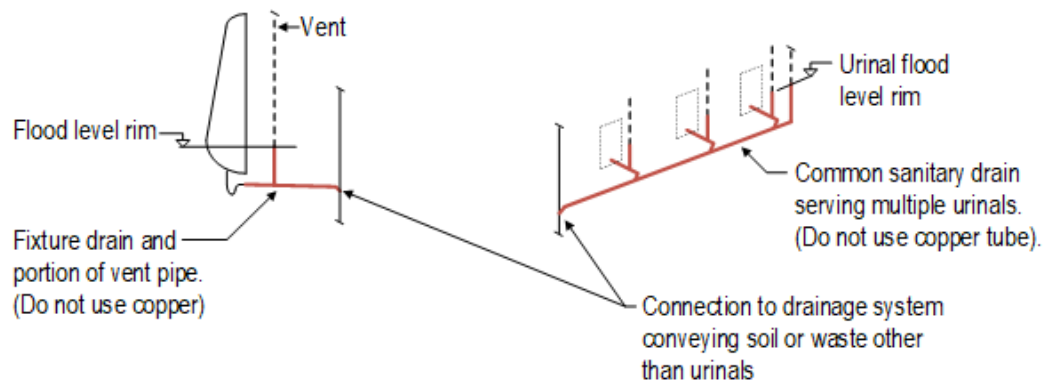


Figure 1: Prohibited use of copper tube

3.6 Testing

- .1 Test drainage piping in accordance with the requirements of the plumbing code applicable at the project location.
- .2 Test before piping is concealed.
- .3 Cut-out and replace leaking soldered fittings, remake joints in cast iron piping, and retest.

END OF SECTION

Master revised: 18 March 2024

SANITARY WASTE AND VENT PIPING - PVC

22 13 16.16

Scope

- .1 Provide PVC pipe and fittings for sanitary soil and waste drain and vent piping ("DWV"), for drainage services with a maximum continuous operating temperature of 60°C (140°F) or less.
- .2 Limitations for use:
 - .1 do not use PVC DWV piping in the following locations:
 - (a) for drain and vent piping located in vertical services spaces,
 - (b) for drain piping receiving waste water at temperatures above 60°C (140°F).
 - (c) for drain and vent piping located in an HVAC ventilation plenum, except where otherwise specified, and
 - (d) as otherwise shown.

1.2 Definitions

- .1 The following definitions apply to this section and referenced sections:
 - .1 **Vertical service space:** means a shaft that is oriented essentially vertically, extends through two or more floors, and that is provided in a building to facilitate the installation of building services.

1.3 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 25 Excavation and Backfilling
 - .2 20 05 63 Safety Bollards and Machine Guards
 - .3 22 13 16.13 Sanitary Waste and Vent Piping – Cast Iron and Copper
 - .4 20 05 29 Common Hanger and Support Requirements for Piping

1.4 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA B181.2 PVC Drain Waste and Vent Pipe and Fittings from CSA B 1800 Plastic Non-Pressure Pipe Compendium
 - .2 ULC-S102.2 Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials
 - .3 ULC-S115 Fire Tests of Fire Stop Systems

1.5 Submittals

- .1 Shop drawings:
 - .1 submit shop drawings showing for firestop systems as applicable to each piping penetration of a fire separation, and include:
 - (a) firestop materials data sheets,
 - (b) ULC listing details of construction for each applicable firestop assembly,
 - (c) Firestop manufacturer installation instructions for each applicable firestop assembly type.
 - (d) Instructions on where each firestop assembly type is to be used.

LEED requirements

- .1 CaGBC LEED Canada v4 requirements:
 - .1 EQ Credit Adhesives and Sealants:
 - (a) PVC pipe adhesive with maximum VOC of 510 g/L in accordance with California South Coast Air Quality Management District, rule #1168, amendment date of January 7, 2005.

2 PRODUCTS

2.1 PVC DWV Pipe and Fittings

- .1 PVC pipe, fittings, and jointing system to be a coordinated package supplied by pipe manufacturer with written installation instructions.

Pipe and fittings ("PVC Type 2"):

- .1 listed to CSA B181.2,
- .2 flame spread rating ("FSR") of not more than 25 when tested to ULC-S102.2,
- .3 smoke developed rating ("SDR") of not more than 50 when tested to ULC-S102.2.
- .4 materials marked for CSA B181.2 and ULC-S102.2.

Standard of Acceptance

- IPEX - fig. XFR DWV

- .3 Joint cement:

- .1 volatile Organic Content: maximum 510 g/L.
- .2 pipe sizes NPS 1-1/2 to NPS 6:
 - (a) one-step (primer optional)

Standard of Acceptance

- IPEX - fig. System 15/System XFR One-Step PVC Cement

- .3 pipe sizes NPS 8 to NPS 12:
 - (a) Two-step primer and cement.

Standard of Acceptance

- IPEX - fig. System 15/System XFR Two-Step PVC Primer and Cement

- .4 pipe sizes NPS 14 and larger:
 - (a) pipe manufacturer specific PVC cement with primer.

Standard of Acceptance

- IPEX - fig. Xirtec19 PVC Cement.

2.2 Firestops

- .1 Firestop system for combustible piping with through-penetrations of horizontal and vertical fire separations, having a fire resistance equal to or greater than the fire resistance rating of the affected fire separation.
- .2 Listed to ULC S115:

- .1 "F" rating of not less than the fire resistance rating of the applicable fire separation,
- .2 "F" rating with a pressure differential of 50 Pa (0.20 in.w.c) for buildings more than 3 storeys in building height,
- .3 "FT" rating of not less than the fire resistance rating of the applicable fire separation or firewall separating a parking garage from the rest of the building, or where passing through a horizontal service space horizontal fire separation.

Standard of Acceptance

- Hilti Canada
- 3M Canada

3 EXECUTION

3.1 Restrictions on Use

- .1 Do not install PVC piping in vertical service spaces.
- .2 Do not install PVC piping in locations where the ambient temperature can be less than 4°C (40°F) including but not limited to:
 - .1 outdoors,
 - .2 outdoor multi-storey parking garages,
 - .3 generator rooms,
 - .4 indoor parking garages,
 - .5 unheated loading docks.
 - .6 loading docks which are partially heated with local radiant heaters,
 - .7 ambulance bays even if fully enclosed,
 - .8 cold storage rooms,
 - .9 cold storage warehouses.

Only use PVC Type 2 piping materials in HVAC air distribution plenums including ceiling spaces and raised floors used as part of a supply or return air distribution system.

Do not use PVC drainage piping serving floor drains and other fixture drains located in mechanical service rooms containing steam boilers, or hot water boilers or other water heating devices operating at water temperature greater than 60°C (140°F). In these areas, use cast iron or copper DWV drain piping in accordance with specification section 22 13 16.13, and run cast iron or copper DWV drain piping until connected to the main building sanitary drain as shown.

3.2 Installation - General

- .1 Contact pipe manufacturer to provide training of contractors personnel for solvent weld training prior to installation of PVC DWV drainage piping materials.
- .2 Install soil, waste and vent piping in accordance with the requirements of the plumbing code applicable at the project location. Except as otherwise shown, venting of fixtures may use any method permitted in the plumbing code.
- .3 Install suspended piping to grade, parallel and close to walls and ceilings to conserve headroom and space. Install piping close to building structure to minimize furring. Group piping and run parallel to walls and ceilings.
- .4 Cut pipe squarely, remove burrs and loose material and chamfer pipe ends.
- .5 PVC joints for pipe size NPS 1-1/2 to NPS 6:

- .1 apply joint cement to male end of pipe and to fitting socket.
- .6 .2 While the surfaces are still wet, insert the pipe into the fitting using sufficient force to ensure that the pipe bottoms into the fitting socket. Give the pipe one quarter turn during insertion. PVC joints for pipe sizes NPS 8 and larger:
 - .1 apply primer to fitting socket and to male end of pipe.
 - .2 immediately after priming, apply cement to fitting socket and to male end of pipe,
 - .3 while the surfaces are still wet, insert the pipe into the fitting using sufficient force to ensure that the pipe bottoms into the fitting socket. Give the pipe one quarter turn during insertion,
 - .4 hold the pipe and fitting together in position for 10 seconds to eliminate push out,
 - .5 wipe away excess cement.
- .7 Follow manufacturer published cure time schedules prior to testing the piping system.
- .8 In buildings with vehicles, material handling carts, forklifts or other similar equipment vehicles, protect PVC pipe located within 3 m (10 ft) of floor level with one of the following methods.
 - .1 Use cast iron or copper tube starting from 300 mm (12 in.) below top of floor surface and extending up to 3 m (10 ft) above floor level, or
 - .2 provide at least two (2) protection bollards in accordance with specification section 20 05 63, to separate PVC piping from contact with such equipment.

3.3 Pipe Supports

- .1 Support piping in accordance with specification section 20 05 29 except as specified herein.
- .2 Support horizontal piping in accordance with the manufacturer installation requirements, but with supports
 - .1 spacing not to exceed 1200 mm (47 in),
 - .2 provided at the ends of branches,
 - .3 provided at each change of direction or elevation, and
 - .4 provided as close to a fixture trap as possible for fixture drains more than 1000 mm (39 in) long.
- .3 Support vertical piping;
 - .1 at its base,
 - .2 at every other floor level with pipe riser clamps, but not to exceed a vertical spacing of more than 7.5 m (24.5 ft) between supports,
 - .3 arrange vertical piping so that a joint coupling bears on the top of the pipe riser clamp.

3.4 Buried Installation

- .1 Lay buried piping in bedding prepared in accordance with specification section 20 05 25. Support piping on 150 mm (6 in.) thick bed of clean sand, shaped to accommodate hubs and fittings, to line and grade as shown. Backfill with clean sand to 300 mm above top of pipe or to underside of floor slab whichever is less.
- .2 Support piping through foundation walls on backfill material as specified, and supported on 150 mm (6 in.) thick reinforced concrete pads. Dowel concrete pad into side of foundation walls and extend pad to obtain minimum bearing of 600 mm (2 ft) on undisturbed soil.

3.5 Firestop Collars

- .1 Seal combustible pipe and fitting system which penetrates vertical or horizontal fire separation, with a listed firestop assembly. Install firestop system in accordance with the manufacturer's instructions.

3.6 Testing

- .1 Test drainage piping in accordance with the requirements of the plumbing code applicable at the project location.
- .2 Test before piping is concealed.
- .3 Cut-out and replace leaking soldered fittings, remake joints in cast iron piping, and retest.

END OF SECTION

SANITARY DRAINS 22 13 19.13

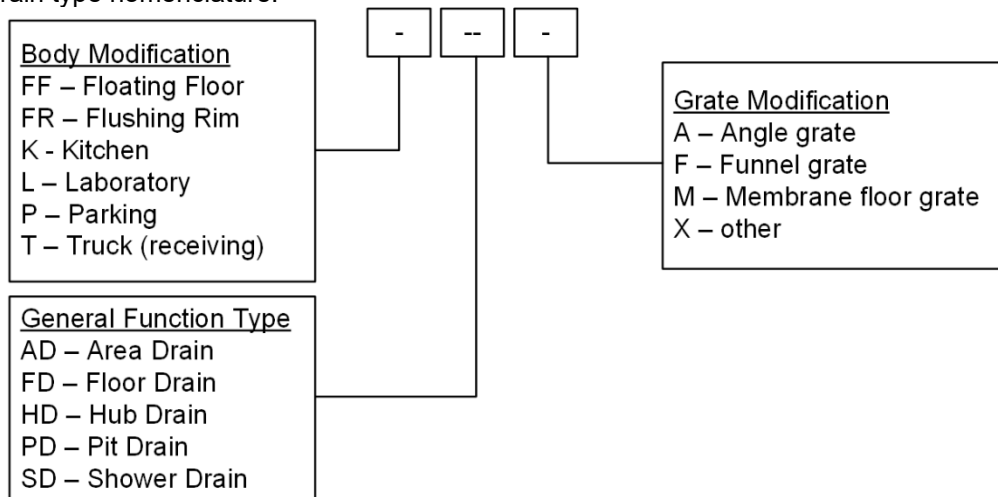
1 GENERAL

1.1 Scope

- .1 Provide sanitary waste piping accessories including floor drains, area drains and cleanouts.

Definitions

- .1 The following definitions apply to this specification section.
- .1 **Grate:** the finished exposed element of the floor or area drain which is suitable for heavy loads including vehicle loads.
 - .2 **Sheet waterproof flooring:** includes vinyl sheet or tiles, linoleum sheet or tiles, and rubber sheet or tiles, which have an installed thickness of 6 mm (1/4 in.) or less.
 - .3 **Strainer:** the finished exposed element of the floor or area drain which is suitable for foot traffic only.
 - .4 **Strainer shank:** the strainer supporting element which connects to the drain body. Grate shank has the same meaning.
 - .5 **Tile (floors):** includes ceramic or porcelain tiles and similar materials that are thicker than 6 mm (1/4 in.) including mortar/adhesive bed.
- .2 Load ratings of Light Duty, Medium Duty, Heavy Duty, Extra Heavy Duty and Special Duty: in accordance with CSA B72 / ASME A112.3.1 / ASME A112.6.3.
- .3 Drain type nomenclature:



1.3 Applicable Codes and Standards

- .1 Product standards:
- .1 ASME A112.3.1 Stainless Steel Drainage Systems for Sanitary DWV, Storm, and Vacuum Applications, Above-ground and Below Ground
 - .2 ASME A112.6.3 Floor and Trench Drains
 - .3 ASME A112.36.2M Cleanouts

.4 CSA B79 Commercial and Residential Drains and Cleanouts

1.4 Submittals

- .1 Submit product data sheets for materials specified herein.

2 PRODUCTS

2.1 Floor Drains (type "FD")

- .1 Floor drains to be listed to CSA B79 and marked in accordance with ASME A112.3.1 (stainless steel floor drains), or ASME A112.6.3 (non-stainless steel floor drains).
- .2 The following requirements apply to all floor drains, combination drains, and hub drains except as otherwise specified.
- .3 Construction:
- .1 application: general purpose floor drains, for floors with or without a sub-floor membrane.
 - .2 loading: Light Duty to CSA B79, for foot traffic,
 - .3 body:
 - (a) coated cast iron with minimum Ø200 mm (8 in.) diameter anchor flange with primary and secondary drainage (seepage) openings,
 - (b) sub-floor membrane clamp,
 - (c) bottom hub outlet pipe connection.
 - (d) NPS ½ NPT trap seal primer connection.
 - (e) No-hub outlet.
 - .4 strainer:
 - (a) adjustable height, nickel bronze or stainless steel strainer secured with stainless steel tamper resistant (Allen key) screws,
 - (b) openings not exceeding 8 mm (5/16 in.) in any direction,
 - (c) round shape for poured monolithic floor finishes,
 - (d) square shape for tiled or similar floor finishes,
 - (e) minimum size: based on location in accordance with the following table.

Drain Pipe Size, NPS	Strainer/Grate Size mm (in.) diameter or square		
	General Purpose, Kitchens	Service Rooms, Wash Down Rooms, Emergency Fixtures	Parking, Loading Docks
2	125 (5)	125 (5)	---
3	175 (7)	200 (8)	---
4	200 (8)	250 (10)	250 (10)
6	250 (10)	250 (10)	250 (10)

- .5 Drain body pipe size as shown on drawings.

Standard of Acceptance

- Watts - fig. FD-100-C-A
- Zurn - fig. Z415 series
- Mifab - fig. F1100-C series
- Jay R. Smith - fig. 2005-C series

Cleanouts

- .1 Listed to CSA B79 and marked in accordance with ASME A112.36.2M.
- .2 In floors:
 - .1 line size for NPS 2, NPS 3 and NPS 4, and NPS 4 in larger lines.
 - .2 body: cast iron body with sub-floor membrane clamp, and with gas-tight plug.
 - .3 head - unfinished floor areas including service rooms:
 - (a) coated cast iron frame heavy duty scoriated cast iron round.
 - .4 head - finished floor areas:
 - (a) round, coated cast iron frame and polished nickel bronze adjustable head cover[.]], recessed for tile infill in tiled areas,
 - (c) recessed for carpet infill in carpeted areas,
 - (d) deeply recessed for terrazzo infill in terrazzo finished areas.]

Standard of Acceptance

- Watts - fig. C-100 series
- Zurn - fig. Z-1400 series
- Mifab - fig. C1100 series
- Jay R. Smith - fig. 4000 series

- .3 In exposed areas, ceiling spaces and accessible pipe chases,
 - .1 cast iron caulking ferrule with neoprene jacket and plug secured to body with cap screws.

3 EXECUTION

3.1 Installation - General

- .1 Install sanitary drainage specialties in accordance with the applicable provincial plumbing code, and the requirements of the local authority having jurisdiction.
- .2 Install sanitary drainage specialties in accordance with the manufacturers installation instructions and as described herein.

3.2 Floor Drains and Area Drains

- .1 For floors constructed with a sub-floor membrane;
 - .1 install bodies flush to top of structural slab, and provide temporary coverings to protect top surface of anchor flange, receiver threads and body openings during concrete pour,
 - .2 after the sub-floor membrane is installed, install the membrane clamp and strainer and set the strainer top to be at the finished floor level or slightly lower,
- .2 For floors constructed as a single concrete pour without a sub-floor membrane, set the body and the strainer to suit the final floor elevation prior to concrete pour. Provide temporary covering of the strainer top surface.

- .3 For all types of floors, place clear pea gravel around the top of the anchor flange to protect the primary and secondary weeping drainage openings from being plugged with concrete or other flooring material.
- .4 Where shown on drawings for a combination floor drain, install a hub of specified type by attaching to the floor drain strainer.

3.3 Cleanouts

- .1 Install cleanouts at the base of soil and waste stacks, at changes in direction of sanitary drainage piping, at intermediate locations on long runs of piping, and as shown.
- .2 Extend cleanouts flush to wall or up to finished floor above except as follows:
 - .1 clean-outs may be terminated in accessible ceiling spaces except where drawings indicate the clean-out is to be extended up through the floor.
- .3 Install cleanouts located in floors clear of obstructions.

END OF SECTION

Master revised: 12 February 2018

PLUMBING FIXTURES

22 42 00

GENERAL

1.1 Scope

- .1 Provide plumbing fixtures and trim, and temperature mixing valves for fixtures.
- .2 This specification section does not apply to temperature mixing valves located remote from individual plumbing fixtures, or for process equipment; refer to specification section 22 39 13 *Domestic Water Temperature Mixing Valves*.
- .3 This specification section does not apply to temperature mixing valves for emergency shower and eye-wash stations; refer to specification section 22 45 13 *Emergency Plumbing Fixtures*.

1.2 Definitions

- .1 The following definitions apply to this section.
 - .1 **Barrier-free:** has the same meaning as the applicable building code of the place of the Work, or in its absence, means, when applied to plumbing fixtures and emergency plumbing fixtures, the fixture can be approached, entered, and used by persons with physical or sensory disabilities.

1.3 Applicable Codes and Standards

Installation codes and standards:

- .1 CSA Z317.1 Special Requirements for Plumbing Installations in Health Care Facilities.
- .2 CSA Z318.3 Commissioning of Plumbing Systems in Health Care Facilities
- .2 Product standards:
 - .1 ASME A112.6.1 Supports for Off-the-Floor Plumbing Fixtures for Public Use
 - .2 ASSE 1016/ASME A112.1016/CSA B125.16
Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations
 - .3 ASSE 1066 Performance Requirements for Individual Pressure Balancing Valves for Individual Fixture Fittings
 - .4 ASSE 1070 Performance Requirements for Water Temperature Limiting Devices
 - .5 CSA-B45 Series Plumbing Fixtures.
 - .6 CSA-B125 Plumbing Fittings.
 - .7 NSF/ANSI 61 Drinking Water System Components – Health Effects, including Annex G
 - .8 NSF/ANSI 372 Drinking Water System Components – Lead Content
 - .9 UL 1951 Electrical Plumbing Accessories

1.4 Fixture Count and Location

- .1 Determine the number and location of plumbing fixtures from Architectural drawings in the first instance, followed by the mechanical drawings.
- .2 In the event of a conflict as to location of plumbing fixtures between the architectural drawings and the mechanical drawings, the location as shown on the architectural drawings govern.

1.5 Submittals

- .1 Submit product data sheets for materials specified herein. Organize the submission in accordance with the following requirements:
 - .1 make one consolidated submission for all products specified,
 - .2 indicate the fixture type designation for each product on each submittal page,
 - .3 where a fixture type consists of multiple product components, organize the information in a cohesive presentation by fixture type designation,
 - .4 where a data sheet includes multiple figures/options, clearly mark the applicable model number and/or option that is being proposed as meeting the specification requirement.

2 PRODUCTS

2.1 General Requirements - Fixture Quality

- .1 Fixtures and trim of the same type to be the product of one manufacturer.
- .2 Finished surfaces to be clear, smooth and bright, and guaranteed not to craze, discolour or scale.
- .3 Visible parts of faucets, escutcheons, wastes, strainers, traps, shower heads, supplies and stops to be chrome plated.

Do not include aerators in water supply faucets in healthcare facilities.

- .5 Floor mounted water closets fitted with china bolt caps; plastic bolt caps are not acceptable.
- .6 Where fixtures and trim are identified by manufacturers' catalogue designation these references are to establish quality standards not otherwise specified. For the purposes of this section of the specification, fixtures or trim from manufacturers listed below are equally acceptable when conforming to the same level of quality.

Standard of Acceptance

- Eljer
- American Standard
- Crane
- Kohler
- Symmons Valve
- Waltec
- Delta Commercial
- Emco
- Beneke
- Centoco
- Kindred
- Waltec
- Architectural Metals
- Zurn

2.2 Water Closet Type "WC-1" – Barrier Free

- .1 White, vitreous china, floor mounted, 2-piece tank type, round bowl, tank lined with bolt down cover, chrome-plated rigid supply with stop, lid with vandal-proof lockdown.

Standard of Acceptance

- Zurn Z5555-K-VL

- .2 White, open front toilet seat, with cover and stainless steel check hinge.

Standard of Acceptance

- Zurn Z5957SS

- .3 Two chrome plated, solid brass angle stops with loose key, two 305mm (12 in) flexible chrome plated copper lavatory risers complete with two chrome plated steel deep bell flanges.

Standard of Acceptance

- Zurn Z8802-XL-LR-PC-D

2.3 Lavatory Type "L-1" (Small Washroom Barrier-Free Use)

- .1 Vitreous china wall hung basin, modified with sealed overflow, faucet holes for 200 mm (8 in) centreset, white in colour supplied with modified concealed arm carrier.

Standard of Acceptance

- American Standard "Lucerne" 051-0668 modified

- .2 200 mm (8 in) centreset below deck mounted faucet, gooseneck rigid swivel, moderator outlet, 100 mm (4 in) chrome plated blade handles, tamperproof with sanitary hood.

Standard of Acceptance

- Cambridge Brass 27T2824M

- .3 NPS 1¼ cast brass chrome plated tailpiece with open grid strainer, offset P.O. plug modified to 150 mm (3 in) offset

Standard of Acceptance

- Cambridge Brass 33T290 modified

- .4 Chrome plated NPS 3/8 rigid or flexible supplies with lockshield stops

Standard of Acceptance

- Cambridge Brass 47T512

- .5 Chrome plated cast brass swivel "P" trap with cleanout, slip joint inlet, female outlet, NPS 1¼ M.I.P. adapter and chrome plated escutcheon

Standard of Acceptance

- Eljer 804-1100

2.4 Stainless Steel Sink Type "S-1"(single compartment)

- .1 200 mm (8 in) below-deck concealed mechanical mixing kitchen faucet with single-lever ADA/OBC compliant handle, 200 mm (8 in) wall-form swing spout, pressure-compensating non-aerated laminar flow moderator outlet, and vandal-resistant tamperproof hardware.

Standard of Acceptance

- Cambridge Brass 27T2126

- .2 Rough brass NPS ½ lockshield stop on each supply.

2.5 Shower Fixture – Barrier Free (SH-1)

- .1 Pressure balancing mixing valve and adjustable stop screw, spray head, vacuum breaker, wall/hand shower with 1753 mm (69 in) long flexible metal hose, wall connection with flange, 915 mm (36 in) slide bar for hand shower mounting.
- .1 listed to ASSE 1016
- .2 for barrier-free showers, in addition to the shower head slide bar, provide a separate wall hook.

Standard of Acceptance

- Chicago Faucets SH-PB1-13-044
- Delta Faucet T13H332-25C c/w R10700-UNWS

2.6 Thermostatic Mixing Valves – Lavatories, Under-Sink Mount (“TMV”)

- .1 General:
- .1 application: temperature mixing valve at an individual lavatories or sinks, for under-basin mounting.
- .2 type: thermal actuated mixing valve,
- .3 listed to ASSE 1070,
- .4 listed to NSF 61+G or NSF 372.
- .2 Performance:

Primary Parameter	Secondary Parameter	Value
Cold water inlet temperature	Range	4 - 20°C (39 - 68°F)
Hot water inlet temperature	Range	49 - 82°C (120 - 180°F)
Maximum Approach Temperature	Hot Inlet to Mixed Temperature	+ 3.8°C (5°F) ΔT
Controlled Temperature Range	High temperature unit	27 to 49°C (80 to 120°F)
Temperature stability, at flow rate range	0 – 0.3 L/s (0 – 5 gpm)	± 1.7°C (±3°F)
	0.3 to 2.5 L/s (5 to 40 gpm)	± 2.8°C (± 5°F)
Maximum Flow Rate	at 100 kPa (15 psi)	0.03 L/s (0.5 gpm)
Minimum Flow Rate	---	0.016 L/s (0.25 gpm)
Maximum Differential Pressure	Between hot and cold supplies	20% of cold water pressure
Minimum design pressure	---	860 kPa at 93°C (125 psi at 200°F)

- .3 Construction:

- .1 brass or bronze body, with corrosion resistant internals,

- .2 four port design - cold inlet and outlet, hot inlet, tempered outlet,
- .3 filed-convertible to be suitable for installation as a;
 - (a) dual-outlet for two-handle or single handle faucet, or
 - (b) single-outlet for tempered water to an automatic lavatory faucet,
- .4 thermal actuated movement, with adjustable temperature selection, and maximum temperature limiter,
- .5 tamper resistant setting handle,
- .6 pipe ends: NPS 3/8 compression fittings,
- .7 integral inlet debris screens.

Standard of Acceptance

- Watts (Powers) - fig. LFUSG-B
- Lawler - fig. TMM-1070T

2.7 Sealant Between Fixture and Wall Finish:

- .1 One-part acetoxysilicone sealant
- .2 White or clear colour.
- .3 Formulated with fungicide

Standard of Acceptance

- Tremco - fig. Tremsil 200
- Dow Corning
- GE

3 EXECUTION

3.1 Fixture Installation - General

- .1 Support fixtures level and square and connect with supplies, drains, traps and vents.
- .2 Where a faucet has separate hot and cold water handles, position the hot water handle on the left side of the faucet.
- .3 Where fixtures are located on exterior walls, run the water supplies up through the floor. For other fixture locations, run water supplies in the wall cavity.
- .4 Provide resilient, watertight and gas-tight seals for every joint in a floor flange or between a floor-outlet fixture and the drain.

3.2 Fixture Supports

- .1 Provide plates, brackets, wall carriers, cleats, and supports to secure fixtures in place.
- .2 Fasten wall brackets with bolts attached to double steel supporting plates.
- .3 Bolt fixture to wall through cored holes under lavatory wall flange, using chrome plated carriage bolts with integral washers, and expansion shields.
- .4 Install extra-heavy-duty chair carriers for fixtures not directly supported from floor.
- .5 Conceal vertical supports and baseplates in wall construction.
- .6 Apply sealant bead between wall mounted fixture and finished wall and finish with a smooth concave profile.

- .7 Set floor mounted water closet bowls in mastic, and seal the floor flange with a resilient, watertight and gas-tight flange seal.

3.3 Plumbing Fixture Installation Heights and Clearances

- .1 Install plumbing fixtures at heights as shown on architectural drawings and specifications. Where such information is not provided therein, install fixtures at heights as described in the following table.

- .1 Mounting heights are in reference to the top of the finished floor level unless otherwise stated.

Fixture Type	Mounting Height Reference (above finished floor)	Mounting Height Mm (inch)	
		Barrier-Free	All Other
Water Closet	Top of seat	≥ 430 and ≤ 485 (≥ 17 and ≤ 18)	≥ 430 and ≤ 460 (≥ 17 and ≤ 18)
Urinal	Front rim	400 to ≤ 430 (16 to ≤ 16.5) [Note 1]	575 to ≤ 600 (22.5 to ≤ 23.5)
Lavatory	Rim	850 to ≤ 865 (33.5 to ≤ 34)	[850 to ≤ 865 (33.5 to ≤ 34)] [885 to ≤ 910 (35 to ≤ 36)]
Shower	Valve control handle	1150 to ≤ 1200 (45 to ≤ 47)	1150 to ≤ 1200 (45 to ≤ 47)
	Hand-held shower head: Two positions	1200 and 2300 (45 and 90) [Note 2]	1200 and 2300 (45 and 90) [Note 2, 3]
Bathtub	Faucet centerline (above tub rim)	425 to ≤ 450 (16.5 to ≤ 17.5)	425 to ≤ 450 (16.5 to ≤ 17.5)
	Hand-held shower head; Two positions	1200 and 2300 (45 and 90) [Note 2]	1200 and 2300 (45 and 90) [Note 2, 3]

Notes:

[1] Where there are two or more urinals in a washroom, one urinal is to be mounted at this height.

[2] An adjustable hand-held shower head mounted on a vertical shower bar, that can be set at these positions.

[3] If specified.

- .2 Mount manually-operated flushing control for water closets;
- .1 between 500 and 900 mm above the finished floor, and
- .2 for barrier-free water closets, located on the transfer side of the water closet.
- .3 Mount manually-operated flushing control for urinals;
- .1 between 900 and 1100 mm above the finished floor level for barrier-free urinals, and
- .2 at a height to suit the urinal fixture and flush-control valve for all other urinals.
- .4 For barrier-free lavatories not equipped with a fixture-skirt barrier, arrange piping beneath the lavatory so that the hatched area shown in figure 1 is clear of any obstruction.

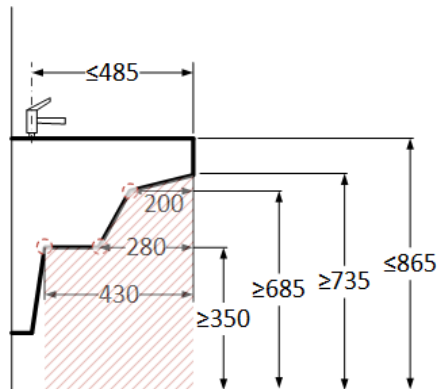


Figure 1: Barrier-Free Lavatory Clearances

3.4 Hand-Held Showers

- .1 Install hand-held shower head hook on independent mounting rail located centered on the shower enclosure wall.
- .1 Do not install shower hooks on grab-bars provided under other Divisions of the Work.

3.5 Thermostatic Mixing Valve Installation

Install a fixture Thermostatic Mixing Valve at individual faucets where specified as an accessory for the fixture type, or as otherwise shown.

- .2 Provide field installed bass-bodied, in-line spring-loaded check valves on the hot and cold water supplies to each TMV unit, regardless of whether or not the TMV is equipped with integral check valves. For greater certainty, if the TMV unit is supplied with integral check valves they are deemed not to meet this requirement.

3.6 Protection

- .1 Cover plumbing fixtures and trim with plywood, cardboard or heavy paper and kept protected before, during and after installation and until work is completed and accepted.
- .2 Clean fixtures, and trim immediately prior to building completion.

3.7 Start-Up and Testing

- .1 Test, adjust and set high temperature limit stops on fixtures to supply a maximum water temperature, including faucets with integral or remote temperature mixing valves, as follows.

Fixture Type	Occupancy	Temperature Setpoint
Combination tub/shower, Showers	Healthcare, Long-Term Care, Retirement Homes	43°C (109°F)
	Other Occupancies	49°C (120°F)
Faucets	Healthcare, Long-Term Care, Retirement Homes	43°C (109°F)
	Other Occupancies	49°C (120°F)
Group (Sitz Baths)	Healthcare	40°C (105°F)

[[Commissioning Program

- .1 Comply with the project commissioning requirements in accordance with specification section 20 08 15.
- .2 The verification and testing requirements specified in this section may be concurrent with, or conducted separately from, the commissioning program, as coordinated with the Contractor and the commissioning agent.]

3.9 Test and Installation Records

- .1 Provide a report of this testing and include:
 - .1 fixture reference,
 - .2 measured maximum temperature,
 - .3 date of test(s),
 - .4 signature of person(s) conducting test.
- .2 Submit a copy of each report to the Consultant and Owner for review and acceptance.
- .3 The above tests are subject to a demonstration test audit of up to 10% of the total fixture count to verify compliance. If audit tests are not satisfactory to the Consultant, additional testing and verification will be conducted by the Contractor until such time as a demonstration audit provides satisfactory results to the Consultant.

END OF SECTION

Master revised: March 3, 2022

CUSTOM CENTRAL-STATION AIR-HANDLING UNITS

23 73 23

1 GENERAL

1.1 Scope

- .1 Provide New UV lights to existing AHU on the roof. Make necessary modifications to the existing system to allow for the installation of the new UV lights.
- .2 UV lights shall be installed on the AHU serving the following areas:
 - Congregate dining areas
 - Lounges
 - Shared rehabilitation spaces

1.2 Submittals

- .1 Submit a complete shop-drawing package which includes all submittal requires specified herein. Incomplete submissions, including partial submissions, will not be reviewed and will be returned marked for resubmission.
 - .1 shop drawings to be sealed by a professional engineer licensed in the jurisdiction of the Work.

2 PRODUCTS

2.1 General

- .1 Engage with the AHU manufacturer of the existing AHUs to ensure proper selection of UV lights for the existing units.

Standard of Acceptance

- Haakon
- Engineered Air
- Ventrol (Nortek)
- York Custom (Johnson Controls)
- Ingenia Technologies Inc.
- Scott Springfield Manufacturing Inc
- Mafna

2.2 Ultraviolet Lights

- .1 The UVGI surface irradiation system shall consist of heavy duty, factory assembled and tested light fixtures that emit short wave UVC light. Units shall be constructed and tested for HVAC environments, be suitable for operating temperatures between 0°C (32°F) and 65.5°C (150°F), and suitable for airflow velocities up to 5.08 m/s (1000 FPM).
- .2 Unit housings shall be made of 304 stainless steel, with electrical connectors on both ends. Reflectors or approved equivalent shall be constructed of high spectral finished aluminum alloy with a minimum 85% reflectance of 254-nm UVC energy.
- .3 Emitter tube shall be of the high output, hot cathode, T5 (15mm) diameter, and medium bi-pin type or single ended four pin connectors. They shall produce 95% of their energy at 254 nm and be capable of producing the specified output at airflow velocities to 5.08 m/s (1000 fpm) at temperatures of 0°C – 65.5°C (35° – 150°F). UVC Emitters shall produce no ozone or other secondary contamination.
- .4 Power source shall be 120 VAC 60hz.

- .5 Emitters and fixtures shall be installed downstream of the cooling coil at right angles to the coil fins, such that UVC energy bathes all surfaces of the coil and drain pan.
- .6 Access door to UVC emitters shall be provided with an interlock switch which will cut power to the emitters when the door is opened. The window in this door shall be tested for use with UV lights.

2.3 Maintenance Access Sections

- .1 Unit sections to provide access to internal components.
- .2 Unit section length: minimum 660 mm (26 in.) unless otherwise shown.
- .3 Section provided with access doors.

3 EXECUTION

3.1 Installation

- .1 Installation procedure of the new UV lights shall be coordinated with the AHU manufacturer.

3.2 Field Wiring

- .1 Provide wiring for CSAHUS in accordance with Specification section 20 05 13 except/and as specified herein.
- .2 Provide field wiring between sections of multi-section units and for knock-down units for motors, lights, service receptacles and controls.
- .3 Provide wire and conduit between the 120 V junction box provided under Division 26, and the:
 - .1 service light switch/duplex outlet, and
 - .2 to the humidifier control panel.
- .4 Obtain electrical inspection permits and approval of the final assembly.

3.3 Cleaning

- .1 Before starting fans, hand-clean interior surfaces of unit floor, walls and ceiling, and internal components. Vacuum both sides of coil faces. Wipe-down surfaces with clean clothes dampened with water and detergent solution. Where oil or grease is found, remove with solvents suitable for the contaminant and underlying unit material.
- .2 Immediately prior to hand-over to the Owner, reclean the interior of the CSAHUs as specified above. Clean the exterior of the units with water/detergent or solvent solution as recommended by CSAHU manufacturer.
- .3 Do not wet acoustic media or media protection films.

3.4 Start-Up and Testing

- .1 Start-up and test CSAHUs to demonstrate specified performance requirements.
- .2 Verify operation of individual components and new UV lights.
- .3 Where fans are provided with an integral airflow rate sensor, such as a piezo-ring flow station, calibrate the flow sensor as follows:
 - .1 conduct airflow traverse readings across a cooling coil or heating coil at 25%, 50%, 75% and 100% design airflow rates,
 - .2 record the fan airflow sensor readings concurrently with the traverse readings,
 - .3 use the traverse readings to determine a correction factor at each part airflow rate, and enter the correction factor into the BAS control sequence,

- .4 repeat the flow tests and revise the calibration factor until traverse readings and fan airflow sensor readings are within +/- 5% of each other.

- (a) for clarity, this calibration of the fan airflow rate sensor does not permit and is not intended to be used for online validation of fan airflow performance or for energy monitoring purposes.

3.5 Test and Installation Records

- .1 Provide the following test records to the Owner and a copy to Consultant.
 - .2 Report confirming operation of the new UV lights.
- .2 Submit reports prior to the earlier of application for occupancy permit, application for substantial performance of the Work, or when the Work is ready for take-over by the Owner.

END OF SECTION