# All Trades Specification

FOR

# FSJ CT SCANNER REPLACEMENT

**8407 112 Ave**

Fort St John, BC V1J 0J5

Issued for Construction

October 5th, 2020

HHA #2191374

1127 Leslie Street
Don Mills, Ontario
M3C 2J6
T. (1) 416.443.8200
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www.hhangus.com

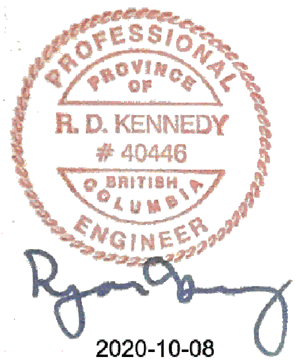
# SEALS PAGE
# 00 01 07

## 1 GENERAL

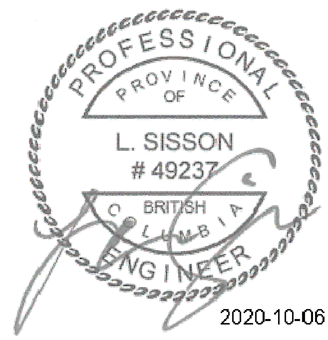
.1 The following professional seals/signatures are provided and apply to the specifications bound herein and amendments made thereto, for the project:

CT Scanner Replacement

and apply only to those documents written by the respective Engineers, and as further designated by the Symbols M and E.




Electrical
Engineer
"E"




Mechanical
Engineer
"M"

**END OF SECTION**

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**Division 27**

# INSTRUCTIONS TO BIDDERS
# 00 21 13

## 1 BIDS

### 1.1 Submission Date

.1 Bids in accordance with the Drawings and Specifications included with these Bid Documents for: Fort St. John Hospital – CT Scanner Replacement

must be received by:
June 4th, 2020

prior to 2 o'clock p.m. PST

### 1.2 Submission requirements

.1 Bids are to be electronically submitted, clearly identifying the name of the Bidder, and clearly marked:

**BID FOR:** Fort St. John Hospital – CT Scanner Replacement
**ATTN:** Claudia Sorgini/Rita Patel @ Claudia.sorgini@hhangus.com/rita.patel@hhangus.com

.2 Bids are to be submitted on the Bid Form provided, filled out and signed by an authorised signing officer from the Bidder's organization and duly witnessed. Bid forms are to be completed without delineation, alteration or erasures and there is to be no re-capitulation of the work to be done. Should there be any discrepancy between the original and any of the copies, the original will prevail.

.3 Bids to be for a Stipulated Sum without escalation clauses or other qualifications.

.4 The Bid Price to include Provincial Sales taxes, Goods and Services Tax, Excise Taxes and Government Duties on materials and services required for completion of the work of the Contract, at the rates and under the conditions that are in force at the time of Bid submission.

.5 The Bidder may show priced alternatives, substitutions and/or qualifications of the Bid which are not requested in the Bid Documents, separately from the Bid form, either as a further appendix or in an accompanying letter. The Bidder agrees that the Owner may accept the Bid without modification by the aforesaid priced alternatives, substitutions and/or qualifications, or that the Owner may accept all or any of these priced items within a mutually agreed time after executing the Contract.

.6 Oral, telephonic, facsimile, e-mail, or telegraphic proposals will not be entertained.

## 2 QUESTIONS DURING BIDDING

### 2.1 Document review

.1 Bidders finding discrepancies, ambiguities, or omissions in the Drawings or Specifications are to immediately notify the Consultant, and the Tender Calling Authority will issue written instructions to Bidders in the form of Addenda.

### 2.2 Addenda

.1 During bidding period Bidders may be advised by Addenda of additions, deletions, or alterations to the Specifications and Drawings. The information contained in the Addenda is to supersede and amend the Drawings, Specifications and Schedules. These revisions to the work are to be allowed for in the Bid and the Addenda are to become part of the Contract Documents.

.2 Bidders to state in the space provided on the Bid Form the numbers of the Addenda received and included for in the preparation of the Bid.

**2.3 Questions arising during the bidding period to be directed to:**

H.H. Angus & Associates Limited
1127 Leslie Street
Don Mills, Ontario
M3C 2J6
Attention: Claudia Sorgini
Telephone: (416) 443-8200
e-mail: Claudia.Sorgini@hhangus.com

.1 Bidders seeking information with regard to organization of documents and clarification and interpretation of information on drawings or in specification may contact Consultant by telephone and questions will be collected, collated, printed and answered by Addenda.

.2 Questions of substance with regard to quantities, quality, or acceptable manufacturers of materials and equipment or questions with regard to interpretation of the documents will not be discussed or answered by telephone and must be e-mailed to Consultant not less than three (3) days before date set for receipt of Bids.

.3 E-mailed questions will be collected, collated, printed and answered by Addenda.

.4 Neither Owner nor Consultant will be responsible for oral instructions.

## 3 MANDATORY SITE VISIT

.1 A mandatory formal briefing meeting and site tour will be held at date and time and location as stipulated in Invitation to Bidders. All Prequalified General and Mechanical/Electrical Subcontractors, wishing to bid must attend the Mandatory Formal Briefing Meeting and Site Tour. The Formal Briefing and Site Tour is on May 14th, 2020 Bidders must RSVP by May 7th, 2020 via email to Claudia Sorgini: Claudia.sorgini@hhangus.com to obtain time and meeting location details. Each person attending the site tour must obtain their own set time for the site tour through this RSVP process. This process is in place due to COVID-19 precautions.

.2 Purpose of meeting is to review full extent of the Project, conduct an inspection of existing premises and to discuss any questions regarding this Project.

.3 One representative(s) from each Bidding Contractor must attend. The minutes of this pre-Bid meeting listing attendees may be issued as an Addendum.

.4 It is mandatory that the general, mechanical and electrical contractors attend the meeting. All other interested Bidders/sub-trades are also invited to attend, but must RSVP as per Instructions in this section. Bids will be accepted only from Bidders that attended the mandatory site tour. Bids from those who did not participate in the site tour will be disqualified.

.5 Bidders must visit and examine the site and the existing building and satisfy themselves as to the conditions of the site, the means of access to same and the nature and quantity of work required.

.6 Also ascertain the extent, nature and location of concealed services which may have to be protected, removed or relocated.

.7 Information shown on the Drawings is furnished in good faith by the Consultant, but in no way relieve Bidders of the responsibility for ascertaining to their own satisfaction, the nature of conditions at the site. No claims for extra costs for failure to determine any/ all existing conditions will be entertained.

.8 Take note of the nature of existing surfaces and include for temporary work necessary to maintain Owner's use of the premises, the roads, and the pathways during the progress of the Contract.

## 4 EXAMINATION OF SITE

.1 Bidders are to visit and examine the site and the existing building, facility and satisfy themselves as to the conditions of the site, the means of access to same and the nature and quantity of work required.

.2 Also ascertain the extent, nature and location of concealed services which may have to be protected, removed or relocated.

.3 Levels and information shown on the Drawings are furnished in good faith by the Consultant, but in no way relieve Bidders of the responsibility for ascertaining to their own satisfaction, the nature of conditions at the site.

.4 Take note of the nature of existing surfaces and include for temporary work necessary to maintain Owner's use of the premises, the roads, and the pathways during the progress of the Contract.

## 5 SUBMISSION OF BIDS

.1 Submission of Bids to constitute proof of the Bidder's inclusion in the proposal for the work to complete the Contract in every respect and provisions for conditions and limitations, particularly with respect to access facilities, working conditions, existing conditions, storage space, codes, laws, ordinances, and regulations, whether mentioned in the Bid Documents or not.

.2 Arrangements have been provided for the Bidder to obtain clarification with regard to discrepancies, ambiguities, or omissions in the Bid

.3 Documents and to visit and review the conditions at the site and therefore the submission of a Bid will be construed as a waiver of any claims for extra compensation on account of un-anticipated work caused by existing conditions or un-expected interpretation of the Bid Documents.

## 6 BID DEPOSITORY

.1 Conform to Rules and Instructions of the Bid Depository. Supplementary data called for in the Supplementary Bid Form must be submitted with the standard Bid in the electronic submission of each General Contractor either by transfer to the standard form or by inclusion of the Supplementary Bid Form with the standard form.

## 7 AWARDS

.1 The Owner reserves the right to open Bids privately, to reject any or all Bids, to waive informalities, and to award the contract to the Bidder providing the greatest value, based on quality, service, and price. These rights are expressly reserved by the Owner without liability on the part of the Owner or Consultant.

.2 The Owner reserves the right to reject Bids received from parties who cannot show a reasonable acquaintance with or preparation for the class of work specified. Evidence to substantiate competence to be furnished by the Bidder if requested.

.3 It is to be understood by Bidders that the Bid is to be valid and subject to acceptance by the Owner without adjustment, for a period of up to and including ninety (90) days from the date of closing of Bids.

## 8 BONDS

.1 Bidders to include with their Bid a Bid Bond made payable to Angus Consulting Management Limited (ACML) for the amount of 15% of the Bid Price as evidence of good faith that, if awarded the Contract, the Bidder will execute and enter into a formal agreement within the time required and will furnish the security required to secure the performance of the terms and conditions of the Contract.

.2 Proof of a 50% Material and Labour Bond as well as a 50% Performance Bond to be included in the submission

.3 Bidders are to include with their Bid an Agreement to Bond in accordance with Article 22.1 of the Supplementary General Conditions. The successful Bidder to furnish the Bond at the time of signing the Contract in accordance with Article GC11 of the General Conditions and Article 22.1 of the Supplementary General Conditions.

## 9 COMPANY PROFILE

.1 Provide company profile with description and details (include square footage) of completed projects with similar scope in Acute Care Hospital Settings over the past 5 years Bidders. Provide 3 separate references.

.2 Provide resumes for the proposed Project Manager and Foreman for General Contractor with completed projects of similar scope in Acute Care Hospital Settings over the past 5 years Bidders. Provide 3 separate references.

## 10 BID DOCUMENTS

.1 Electronic copies of the drawings and specifications will be issued to each Bidder.

.2 Bidder is responsible for checking the Drawings and Specifications received to ensure that the documents are complete in accordance with the List of Bid Documents.

.3 After the Contract is signed the successful Bidder will be given electronic sets of Specifications and Drawings in addition to the signed and sealed Contract Document set.

## 11 SCHEDULING OF WORK

.1 Time is the essence of this Contract. The Bidder is to indicate in the space provided on the Bid Form the time to mobilize before commencing the work after award of Contract and the time to complete the work after commencing.

.2 Bidder to provide a detailed estimated schedule with major milestones along with the Bid Form.

## 12 SUB-CONTRACTORS

.1 Bids have been solicited from General Trades Contractors, and all other Sections of the work to be performed by sub-contractors employed and coordinated by the successful General Trades Bidder.

.2 Bidders to submit on the Bid Form, a complete list of all sub-contractors to whom it is proposed to sublet any part of the work.

.3 The list of sub-contractors set forth is not to be altered or changed except as may be agreed by the Owner and the Consultant prior to the signing of the Contract.

## 13 ASSIGNMENT

.1 The work under this Bid covers the all trades, the whole of which will be executed by a General Contractor selected from the following list of General Trades Bidders:

  .1 After the award of the General Contract, the work under this Bid will become a normal sub-contract within the General Contract.

  .2 The work described in this Bid Document to be executed in full co-operation with the General Contractor and other Contractors and sub-contractors.

  .3 After assignment of the Contract there will be no direct contractual relationship between the Owner and the sub-contractor.

## 14 EVALUATION PROCESS

.1 The objective of the evaluation process is to identify the Proponent that has the highest ranking score based on the Evaluation Criteria in Section 16. The evaluation of the Bids will be conducted by the Consultant in three stages described below:

.2 Stage 1 - Review of Mandatory Requirements

  (a) Provided that the Proposal is a qualified Bid, the Bid shall be reviewed for compliance in accordance with all Mandatory Requirements contained in this RFT. Bids that fail to comply with all Mandatory Requirements in this RFT will be eliminated from the process.

  (b) Mandatory Requirements are listed in the Evaluation Criteria in Section 15.

.3 Step 2 - Evaluation of Rated Requirements: Bid Submission

  .1 Proponents will be evaluated based on the requirements listed in Section 15, Evaluation Criteria.

  .2 Pricing will be scored based on a relative pricing formula. Each bidder will receive a percentage of the total points possible related to the lowest bid price. The percentage will be calculated by dividing the lowest bid price / bid price and multiplying it by the maximum points available.

  .3 Company and Personnel profiles will be scored based on a relative scoring formula. Each bidder will receive a percentage of the total points possible related to quality of submission (at sole discretion of HHA and Owner) while meeting of all of the mandatory tasks.

  .4 Schedule will be scored based on a relative scoring formula. Each bidder will receive a percentage of the total points possible related to shortest duration of schedule while meeting of all of the mandatory tasks outlined in Section 13.2 (excluding alternate season testing). The percentage will be calculated by dividing the shortest schedule (days) / bid schedule (days) and multiplying it by the maximum points available.

.4 Step 3 - Identification of successful Proponent(s)

.1 Identification of Successful Bidder based on the evaluation completed in Stage 1 and Stage 2.

## 15 EVALUATION CRITERIA

| Rated Criteria | Weight |
|---|---|
| **Step 1 : Mandatory Requirement** | |
| a. Mandatory Site Visit | PASS/FAIL |
| b. Insurance Certificates | PASS/FAIL |
| c. Proof of Performance Bond / Material & Labour Bond | PASS/FAIL |
| d. Bid Bond | PASS/FAIL |
| **Step 2: Rated Requirements – Bid Submission** | |
| a. Price Proposal | 70% |
| b. Company and Personnel Profile | 15% |
| c. Schedule | 15% |
| **TOTAL** | **100%** |

## 16 MATERIALS AND EQUIPMENT

.1 Bids to be based upon materials and equipment of manufacture, type and design specified.

.2 Bid Price to be based on using materials or equipment of the manufacturer named in the Specification. If more than one manufacturer's name is listed in Specification for a specific item, the bidder may choose the manufacturer, whose price is used in preparing Bid.

.3 Material and equipment, considered equal to that specified, may be proposed at time of Bidding. The price adjustment, showing addition to or deduction from Bid Price for each item, to be entered as an alternative price in the Bid Form. When requested, submit specifications and details of proposals to Consultant for evaluation.

## 17 ITEMIZED PRICES

.1 Not Applicable

## 18 SEPARATE PRICES

.1 Not Applicable

## 19 UNIT PRICES

.1 Not Applicable

## 20 CASH ALLOWANCES

.1 Bidders to indicate on the Bid Form any Cash Allowances listed thereon. These Cash Allowances are to serve as a basis for payment for certain portions of the work that will be described in greater detail as the project progresses. Work to be performed under the Cash Allowances will be defined through the Contract Change process and payment will be authorized from the Cash Allowance.

**END OF SECTION**

# BID FORM - STIPULATED SUM - SINGLE PRIME CONTRACT
# 00 41 13

TO: Angus Consulting Management Limited (ACML)

c/o: H.H. Angus & Associates Ltd.
1127 Leslie Street
Don Mills, Ontario
M3C 2J6

BIDDER______________________________

ADDRESS______________________________

______________________________

TELEPHONE______________________________

## 1 BID PRICE

.1 Having examined the Contract Documents, Drawings, Specifications and Addenda prepared by H. H. Angus & Associates Limited for

CT Scanner Replacement

as well as the premises and conditions affecting the work, we offer to furnish plant, labour, services, equipment and materials necessary for the work for the price stated herein in lawful money of Canada.

.2 The price includes overhead and profit, insurance, warranties, transportation charges, Provincial Sales Taxes and other related fees and charges.

**1.2 Stipulated Sum (no tax)**______________________________

______________________________

______________________ Dollars ($______________________)

**1.3 Provincial Sales Tax** ______________________________

______________________________

______________________Dollars ($______________________)

**1.4 Goods and Services Tax** ______________________________

______________________________

______________________Dollars ($______________________)

## 2 SCHEDULE

.1 Our Bid is in accordance with the requirements of the Instructions to Bidders.

.2 We will start preparation of shop drawings immediately on receipt of a Letter of Intent, and commence the work in days after award of Contract. We will complete the work [ weeks after commencing in accordance with the schedule of work in the Documents.

.3 The Bid Price includes costs on account of premium time or overtime work required in order to meet the above-mentioned completion date, whether or not such work is done by the Contractor's own work force or by sub-contractors.

## 3 DOCUMENTS

.1 The undersigned submits that he has carefully examined the site of the proposed work, existing conditions, as well as the Drawings listed in the List of Drawings.

.2 Also, he has thoroughly reviewed the Instructions to Bidders, Bid Form, General Conditions, Supplementary Conditions, Specifications listed in the Table of Contents, and the following Addenda and hereby accepts and agrees to the same as forming part and parcel of the proposed Contract.

Addendum No. dated________________________________________

Addendum No. dated________________________________________

Addendum No. dated________________________________________

## 4 BONDS

.1 The following required items are submitted herewith.

Bid Bond
Agreement to Bond

## 5 EXECUTE CONTRACT

.1 If notified of the acceptance of this offer within ninety (90) days of the closing of Bids, we will:

- .1 Execute a Contract with the Owner for same in the form of the Canadian Standard Construction Document - CCDC2-2008.
- .2 Furnish bonds as set out in the Instructions to Bidders
- .3 When requested by the Owner, perform additional work at the percentages set forth in the Supplementary General Conditions Article 18.

## 6 WORK SUBLET

.1 Listed below are the names of sub-contractors and the extent of work sublet:

Work Sublet | Name

Mechanical Contractor: ______________________________

Electrical Contractor: ______________________________

______________________________

.2 We reserve the right to substitute other sub-contractors for any trades in the event of any sub-contractor withdrawing his Bid or becoming bankrupt after the award of Contract. Any such substitution shall be subject to the approval of the Owner, and contingent upon evidence of withdrawal or bankruptcy, satisfactory to the Consultant.

## 7 ALTERNATE MANUFACTURERS, MATERIALS, AND EQUIPMENT

.1 The following are proposed alternates with the price adjustment if the alternate is accepted. Each price adjustment is inclusive of PST, and exclusive of GST.

| Item | Manufacturer | Addition | Deduction |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

## 8 ITEMIZED PRICE

.1 Not Applicable

## 9 SEPARATE PRICE

.1 Not Applicable

## 10 UNIT PRICES

.1 Not Applicable

## 11 CASH ALLOWANCE

.1 The Bid Price includes the following specified Cash Allowances.

| | | |
|---|---|---|
| Unforeseen | Dollars | $ 30,000 |
| | | |
| | | |
| | | |

Date ____________________ SIGNATURE ______________________________

COMPANY ______________________________

Seal ________________________________________

ADDRESS ______________________________

**END OF SECTION**

# GENERAL CONDITIONS
# 00 73 05

## 1 GENERAL

.1 The Stipulated Price Contract of the Canadian Standard Construction Document CCDC 2 - 2008, consisting of The Agreement between Owner and Contractor, Definitions, the General Conditions Articles GC 1.1 to GC 12.3 inclusive, CCDC 40 Rules for Mediation and Arbitration of Construction Disputes, and CCDC 41 CCDC Insurance Requirements are hereby made a part of the Contract as though written out in full herein.

**END OF SECTION**

# SUPPLEMENTARY GENERAL CONDITIONS
# 00 73 13

## 1 GENERAL

1.1 The Standard Construction Document for Stipulated Price Contract CCDC 2-2008 consisting of the Agreement between Owner and Contractor, Definitions, the General Conditions Articles GC 1.1 to GC 12.3 inclusive, CCDC 40 Rules for Mediation and Arbitration of Construction Disputes, and CCDC 41 CCDC Insurance Requirements, together with these Supplementary General Conditions are hereby confirmed as comprising part of the Contract Documents for the Work.

## 2 DEFINITIONS

2.1 Revise Item 19. Subcontractor by changing the item title to Sub-Contractor and Sub-Sub-Contractor and add a new sentence;

*'A Sub-Sub-Contractor is a person or entity having a direct contract with a Sub-Contractor to perform a part or parts of the Work at the Place of the Work'*

2.2 Revise Item 22. Supplier by inserting after the word 'Contractor' the words ' Sub-Contractor or Sub-Sub-Contractor '

2.3 Add the following to `Definitions' of CCDC 2:

27. Wherever the words `indicated', `designated', `shown', `noted', `listed', 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 is `indicated', `designated', `shown,', or `noted', on the Drawings.

28. Wherever the words `approved', `satisfactory', `as directed', `submit', `permitted', `inspected', 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', `satisfactory to', `as directed by', `submitted to', `permitted by', or `inspected by' the Consultant.

29. The terms `*Sub-Contractor'* and `this Contractor' used in the Specification covering the Work of the various trades shall mean the person or firm to whom that particular portion of the Work has been let or sublet.

30. The term `Inspection Engineer', `Inspection & Testing Company' used in the Specification covering the Work under the various trades, shall mean the person or firm, respectively, appointed by the *Consultant* to carry out the Inspection & Testing Work specified.

31. The term "Notice of Change" is a written description of a proposed change to the Work which requests a quotation from the Contractor.

## 3 CONTRACT DOCUMENTS

3.1 Add paragraph GC1.1.7.5 as follows:

1.1.7.5 Where conflict occurs in or between *Specifications and Drawings* or with codes applicable to the *Work*, the maximum condition shall govern and the Tender or Bid Price shall be based on whichever indicates the greater cost. The Contractor to obtain clarification of the conflict prior to the commencement of the *Work*.

3.2 Add paragraph GC1.1.7.6 as follows:

1.1.7.6 In case of conflict between the General Conditions and the Supplementary Conditions, the General Conditions shall be amended but only to the extent necessary to make the provisions of the Supplementary Conditions effective.

3.3 Delete Article GC1.1.8 and substitute as follows:

1.1.8 In addition to the signed sets of *Contract Documents* required for the Owner/Contractor Agreement the *Consultant* will furnish the General Contractor with up to 15 sets of the working *Drawings and Specifications* and up to 10 copies of each scale or full size detail drawing. The General Contractor shall be responsible for cost of any additional prints and *Specifications* that he may require.

## 4 LAW OF THE CONTRACT

4.1 Delete Article GC 1.2.1 and substitute as follows:

1.2.1 The law of the *Place of the Work* shall govern the *Work* and the interpretation of the *Contract*.

## 5 ROLE OF THE CONSULTANT

5.1 Delete Article GC2.2.7 in its entirety and substitute the following:

2.2.7 The *Consultant* will be, in the first instance the interpreter of the requirements of the *Contract Documents*.

5.2 Add the following to Article GC2.2:

2.2.19 The *Consultant* shall not be required to decide on questions arising under agreements or contracts between the Contractor, his *Sub-Contractor's*, their *Sub-Sub-Contractor's*, and *Supplier's*.

## 6 REVIEW AND INSPECTION OF THE WORK

6.1 Add the following to Article GC2.3:

2.3.8 The Contractor shall notify the *Consultant* of locations where installation of fixtures, fittings and equipment would interfere with interior treatment and use of building. In such cases detail *Drawings* or instructions exactly locating these items will be issued. If the Contractor claims that any instructions, by *Drawings* or otherwise, involve extra cost under the *Contract* he should give the *Consultant* prior written notice <u>and obtain</u> the *Owner's* <u>prior written approval</u> in the form of a *Change Order* or *Change Directive*, before proceeding to carry out the *Work*.

## 7 DEFECTIVE WORK

7.1 Delete Article GC2.4.3 in its entirety and substitute as follows:

2.4.3 If in the opinion of the *Consultant* it is not expedient to correct defective *Work* or *Work* not performed as provided in the *Contract Documents*, a *Change Order* will be issued to deduct from the amount otherwise due to the *Contractor*, the difference in value between the *Work* as performed and that called for by the *Contract Documents*.

## 8 DOCUMENT REVIEW

8.1 Delete Article GC3.4.1 in its entirety and substitute as follows;

3.4.1 During the bidding period the Contractor thoroughly reviewed the Instructions to Bidders, Bid Form, General Conditions, Supplementary Conditions, *Specifications and Drawings* listed in the Agreement, Article A-3 *Contract Documents*, and the included Addenda and accepted and agreed to the same as forming part and parcel of the *Contract* for construction of the *Work* in the *Place of the Work*.

3.4.2 The Contractor, by submitting a bid, agrees that he carefully examined the site of the proposed *Work*, the existing conditions, and the *Contract Documents*, and further warrants that the bid price includes for provision of materials, equipment, labour and superintendence to complete the *Work*.

3.4.3 During the Bidding Period, where the Contractor found discrepancies, ambiguities, or omissions in the *Drawings* or *Specifications* the *Consultant* was notified, and written instructions to Bidders in the form of Addenda were issued to resolve these matters.

3.4.4 During construction the Contractor shall report promptly to the *Consultant* any subsequently discovered discrepancies, ambiguities, errors, inconsistencies or omissions in the *Contract Documents*, and shall not proceed with the *Work* affected until *Supplemental Instructions* are furnished by the *Consultant*.

## 9 SUPERVISION

9.1 Delete paragraph GC3.6.1 and GC3.6.2substitute as follows:

3.6.1 The Contractor and each major *Sub-Contractor* shall provide supervision of the *Work* and appoint competent representatives and appropriate assistants who shall be in attendance at the *Place of the Work* while *Work* is being performed. The representatives and assistants shall not be changed without approval from the *Consultant*,and upon submission of valid reasons such approval shall not be unreasonably withheld.

3.6.2 The Contractors representative shall represent the Contractor at the *Place of the Work*. Information and instructions provided by the *Consultant* to the Contractors representative shall be deemed to have been received by the Contractor, except with respect to Article A-6 of the Agreement - RECEIPT OF AND ADDRESSES FOR NOTICES IN WRITING. The Contractors representative shall be responsible for prompt transmission of Information and instruction received from the Consultant shall be promptly transmitted to *Sub-Contractors*, *Sub-Sub-Contractors* and *Suppliers* involved.

## 10 SUB-CONTRACTOR AND SUPPLIERS

10.1 Add the following to Article GC3.7:

3.7.7 The Specification has generally been divided into trade Sections. It is not thereby intended to recognize, set, or define limits to any trade subcontractor or to restrict the Contractor in letting subcontracts. Neither is the Contractor relieved of responsibility for completion of *Contract* whether or not portions of the *Work* are sublet.

## 11 LABOUR AND PRODUCTS

11.1 Delete paragraph GC3.8.1 and GC3.8.3 and substitute the following:

3.8.1 The Contractor shall provide *Products*, and arrange and pay for labour, tools Construction Equipment, water, heat, light, power, transportation, and other facilities and services for the completion of the *Work* in accordance with the *Contract*.

3.8.3 The Contractor shall maintain good order and discipline among the personnel engaged on the *Work* and shall not allow the employment of anyone not skilled in the tasks assigned.

## 12 SHOP DRAWINGS

12.1 Add the following to the first sentence in Article GC3.10.9

......... and provide written explanation for the deviation, with proposed *Contract Price* adjustment.

12.2 Add the following to Article GC3.10:

3.10.13 *Shop Drawings* shall each be noted with the following information:

Project Name and Number
Manufacturer's and Supplier's Name
Catalogue model number
Name of trade supplying item
Number or designation identifying item on *Drawings* and/or in *Specifications*
Drawing and/or Specification reference

## 13 USE OF THE WORK

13.1 Add the following to Article GC3.11:

3.11.3 The *Owner* shall have the right to enter and occupy the building in whole or in part for the purpose of placing fittings and equipment or for other uses before completion of the *Contract*. Such entry and occupation shall not be considered as acceptance of the *Work* or in any way relieve the *Contractor* from his responsibility to complete the *Contract*.

## 14 CASH ALLOWANCES

14.1 Add the following to paragraph GC4.1.1:

Expenditures from Cash Allowances must be authorized in writing by the *Consultant*. Vouchers shall be submitted by the *Contractor* to substantiate expenditures from Cash Allowances.

14.2 Delete the first sentence in paragraph GC4.1.3 substitute the following:

If the Cash Allowance is specified to be included by a particular *Sub-Contractor* then the *Contract Price* and not the Cash Allowance includes the *Sub-Contractor's* overhead and profit.

14.3 Revise the first line of paragraph GC4.1.4 to read as follows:

Where the total costs expended under Cash Allowances exceed the aggregate amount of all Cash Allowances, the *Contractor* shall be....

14.4 Delete the last two sentences in paragraph GC4.1.4

## 15 FINANCING INFORMATION REQUIRED OF THE OWNER

15.1 Delete Article GC5.1 and subsequent references to this Article in their entirety.

## 16 SUBSTANTIAL PERFORMANCE OF THE WORK

16.1 Delete Article GC5.4.3 in its entirety.

## 17 WITHHOLDING OF PAYMENT

17.1 Add new paragraph GC5.8.2 as follows:

5.8.2 In addition to any rights the *Owner* has pursuant to the Construction Lien Act, if a lien is registered or an action commenced against the *Owner*, the *Owner* may withhold from any money otherwise due to the *Contractor*, the full amount claimed in the lien action plus an additional sum sufficient to satisfy all of the *Owner's* expenses relating to such lien actions, including legal costs. These funds held back shall be released to the *Contractor* upon the full discharge of all liens and dismissal of all actions against the *Owner*.

## 18 CHANGE ORDER

18.1 Add new paragraphs GC6.2.3 through GC6.2.6 as follows:

6.2.3 The value of a proposed change in the Work shall be determined in one or more of the following methods:

(a) by unit prices set out in the Contract or subsequently agreed upon,
(b) by labour and material costs submitted in a detailed quotation.

6.2.4 In the case of changes in the *Work* to be paid for under method (a), the form of presentation of costs and methods of measurement shall be agreed to by the *Consultant* and *Contractor* before proceeding with the change. The *Contractor* shall keep accurate records, as agreed upon, of quantities or costs and present an account of the cost of the change in the *Work*, together with vouchers where applicable.

6.2.5 In the case of changes in the *Work* to be paid for under method (b) detailed quotations to show three components: material costs, labour charges, and fees. Material costs are to be less trade discounts. Labour costs to include burden on wages, such as Canada Pension Plan contributions, Employment Insurance premiums, and include costs for; taxes, and insurance, workplace safety meetings, estimating, as-built *Drawings*, supervision, small tools, warranty labour, and clean up.

6.2.6 In the case of changes in the Mechanical and Electrical trades *Work* to be paid for under method (b) detailed quotations to show three components: material costs, labour charges, and fees. Material costs are to be less trade discounts. Discount for items taken from Allpriser Catalogue or Electrical Price Guide to be 20%. Labour charges to be based on National Electrical Contractors Association (NECA) Manual of Labor Units (difficult) and Mechanical Contractors Association of America (MCAA) Labor Estimating Manual. Labour costs to include burden on wages, such as Canada Pension Plan contributions, Employment Insurance premiums, and include costs for; taxes, and insurance, workplace safety meetings, estimating, as-built *Drawings,* supervision, small tools, warranty labour, and clean up. Hourly labour rate applicable for changes not to exceed 1.55 times base rate of current union agreement.

Hourly rate for specialists not covered by union agreements, (controls and instrumentation technicians or engineers) not to exceed 1.75 base rate for unionized plumbers and pipe fitters.

6.2.7 The fees allowed for overhead and profit on proposed changes to the *Work* is to include for the *Contractor's* head and site office expense, project manager, assistants, site office and storage facilities, utilities, site security, telephone and facsimile transmission costs.

The *Contractor,* the *Sub-Contractor,* or the Sub-Subcontractor is allowed an overhead and profit fee of 15% for *Work* to be performed by his own forces. The *Contractor* is allowed an overhead and profit fee of 10% for *Work* performed by a *Sub-Contractor* and a *Sub-Contractor* is allowed an overhead and profit fee of 10% for *Work* performed by a Sub-Subcontractor.

## 19 LAWS, NOTICES, PERMITS AND FEES

19.1 In Article GC10.2 add the following paragraphs:

10.2.2.1 The *Owner* will, if required, submit the *Drawings and Specifications*, complete with the necessary forms, to obtain approval from the Factory Inspection Branch of the Ministry of Labour and the Certificates of Approval from the Ministry of Environment and Energy and will pay all costs in connection therewith.

10.2.3.1 Applications for permits requiring *Owner's* signature shall be submitted before *Work* is commenced.

10.2.6 Inspection Certificates, as follows, shall be submitted before the final certificate will be issued:

Electrical Inspection, Plumbing Inspection, Pressure Vessel, Inspection, Piping and Boiler Inspection

10.2.7 Department of Labour certificates shall be renewed if necessary, to remain in force for the full guarantee period.

## 20 BONDS

20.1 Add the following to Article GC11.2:

11.2.3 The Bidder shall include with his Bid a written agreement to bond from a Bonding Company stating that the Bidder will be covered by a Performance Bond, and a Labour and Materials Payment Bond, each in the amount of 50% of the *Contract Price* if the Bidder is successful in obtaining the *Contract*. This bond coverage will include for cost of *Work* required under warranty, the payment of all legal and *Consultant's* expenses incurred by the *Owner* in determining the extent of *Work* executed, and the cost of any additional *Work* required as a result of the failure of the *Contractor* to complete the *Work*.

11.2.4 The *Contractor* shall furnish these bonds after receiving written notification, in the form of a letter of intent, from the
Owner. Bonds shall not be terminated until Consultant has been notified in writing of this intention and until there is agreement to such termination.

11.2.5 The Contractor is responsible for notifying the surety of any significant changes in the Contract. The bond values are to be fixed upon their issue and not altered unless authorized by the Owner .

## 21 WARRANTY

21.1 Add the following to Article 12.3:

12.3.7 A letter of warranty covering the above-mentioned correction of defects shall be given to Owner at completion of Work , but before issue of final certificate. This warranty shall in no way supplant any other warranty of longer period called for on certain equipment or materials.

**END OF SECTION**

# WORK COVERED BY CONTRACT DOCUMENTS
# 01 11 13

## 1 GENERAL

### 1.1 Arrange for;

.1 Labour, material and equipment to complete work of Contract in conformity with Contract Documents and Construction Schedule.

.2 Utility connections, permits, inspections, tests, and systems verifications. Demolition, relocation, and removal of existing equipment and services to complete Work.

.3 Delivery, receiving, inspection at time of delivery, unloading, and hoisting of materials and equipment.

.4 Clean-up of materials and garbage on daily basis or as directed, and removal of unused equipment/materials from site.

## 2 SUMMARY OF WORK

### 2.1 Project involves;

.1 Replacement of the existing CT Scanner room #5.1.9.1.1, including re-working of the floors and ceiling as well as mechanical, electrical and structural upgrades

.2 The area of renovation also includes the existing Soiled Holding Room #5.1.4.13, Waiting Room #5.1.9.10, Tech. Workstation #5.1.9.2 and Supervisor Office #5.1.9.9. Note that the Image Control Room #5.1.9.1.2, Tech. Workstation #5.1.9.2 and Supervisor Office #5.1.9.9 are all one thermal zone, as there are no walls/doors partitioning these spaces.

.3 Coordinate with CT supplier to remove existing equipment and install new. CT supplier will be responsible for removing existing and delivering and installing new. Contractor is responsible for terminating and making safe all existing connections and terminating new connection as per drawings that have been provided for reference. Site specific drawings will be provided to the successful contractor.

**END OF SECTION**

# PRODUCT SUBSTITUTION PROCEDURES
# 01 25 13

## 1 GENERAL

### 1.1 Scope

.1 This specification describes the required procedures to request substitution of manufacturers or products during construction, for:

.1 substitute manufacturers not listed in the applicable technical specification, and

.2 substitute products by a manufacturer that is listed in the applicable technical specification.

### 1.2 Definitions and Abbreviations

.1 The following definitions apply to this section.

.1 ***Substitute manufacturer***: a proposed manufacturer that is not included in a list of manufacturers in the technical specification applicable to the subject product.

.2 ***Substitute product***: a proposed alternative product to one that is specified, produced by the same manufacturer that is listed in the technical specification.

### 1.3 General Requirements for Substitutions

.1 The Consultant or Owner will not review a substitution request unless it is accompanied by the required submittal information specified herein.

.2 Where use of a substitution involves redesign or changes to other parts of the Work, the contractor shall be responsible for all such construction cost and time impacts. Any time and costs required by the Consultant to affect such redesign will be considered in evaluating the suitability of the proposed products.

.3 Submittals or other requests made by a manufacturer directly to the Consultant or the Owner will not be considered.

.4 Where classification, listing, or other certification to a recognized standard is a part of the project technical specification or as otherwise required by law, substitution submittals shall include reports from the testing certification laboratory indicating certification to those standard(s). Product data sheets that only indicate a testing laboratory mark symbol is not sufficient; at a minimum, a certification listing report that references the required product standard is required.

### 1.4 Timeliness of Substitution Request Submission

.1 Substitution request shall 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.

.2 Except for eligible substitute product review by shop drawing submittal, the Consultant and the Owner shall require up to four (4) weeks to review a submission for each requested substitution. Substitution submissions consisting of multiple products, submitted concurrently or as one submission, will require longer review periods as determined by the Consultant.

.3 Any time required by the Consultant and/or the Owner to review substitution requests shall not be deemed nor attributed to a cause for delay in the construction schedule.

### 1.5 Substitute Manufacturer Procedure

.1 Where it is proposed to use a substitute manufacturer, such substitution is only permitted after review of a substitution request by the Consultant and approval by the Owner.

.2 Substitution requests are subject to the following provisions;

.1 Prior to submission of the first product shop drawing for each Division of the Work, the contractor shall prepare and submit to the Consultant and the Owner for initial review a comprehensive list of substitute manufacturers. The submission of this list does not constitute a formal submittal as specified herein. The Owner shall consider the proposed list of manufacturers and inform the contractor of any manufacturer that will not be considered. The Owner reserves the right to reject, without review, any substitution submittals for manufacturers not included in this list.

.2 A substitute manufacturer will not be considered for reasons of meeting the construction schedule unless the contractor can demonstrate, to the satisfaction of the Consultant and the Owner, that the contractor has made all reasonable efforts to procure the specified product in a timely manner. The Owner reserves the right to verify independently the availability of the specified product.

.3 Request for a substitute manufacturer by means of a shop drawing submission is not acceptable and will be rejected.

.4 The substitute manufacturer represents their product to be of at least equal quality and of the required characteristics as specified, and is fit for the intended purpose.

.5 The burden-of-proof as to the quality and suitability of products proposed by the substitute manufacturer shall be borne by the substitute manufacturer, and they shall supply all information necessary as required by the Consultant at no additional costs to the contract.

.6 The costs of all testing required to prove equality of the product proposed by the substitute manufacturer shall be borne by the contractor or manufacturer.

## 1.6 Substitute Product Procedure

.1 Where it is proposed to use a substitute product from the same manufacturer as a product listed in the technical specification, such substitution is only permitted after review of a substitution request by the Consultant and approval by the Owner.

.2 Substitution requests are subject to the following provisions;

.1 A substitute product will not be considered for reasons of meeting the construction schedule unless the contractor can demonstrate, to the satisfaction of the Consultant and the Owner, that the contractor has made all reasonable efforts to procure the specified product in a timely manner. The Owner reserves the right to verify independently the availability of the specified product.

.2 Requests for a substitute product by means of a shop drawing submittal is permitted (“eligible substitute product”), provided the reason for the substitution is included in the submittal and is due to:

(a) the specified product name/product number has changed, but no material change has been made to the specified product,
(b) the specified product is no longer made, and the substitute product replaces the specified product and meets or exceeds the specification requirements.

.3 Upon submission of a substitute product through the shop drawing submittal process, the Consultant at its sole discretion shall determine if the submittal is eligible for review as a shop drawing. If determined not to be eligible, the substitute product shall be submitted in accordance with all the requirements as for a substitute manufacturer. Otherwise, the eligible substitute product will be reviewed as a shop drawing.

.4 Where a substitute product is not eligible to be reviewed through the shop drawing review process, the substitute product shall be submitted in accordance with all the requirements as for a substitute manufacturer.

## 1.7 Substitute Manufacturer Submittals

.1 Include the following information for each product by a substitute manufacturer;

.1 Confirmation that the submitted product was included in the proposed substitute manufacturer list, and was not previously rejected by the Owner.

.2 A declaration acknowledging that rejection of the substitute manufacturer product will not impact the construction schedule.

.3 A marked-up copy of the project specification prepared by the substitute manufacturer, identifying where the proposed product: complies with, does not complies with, or is different from, the requirements of the specification.

.4 A declaration from the substitute manufacturer that their product is of the requisite quality, meets the technical specifications, and is fit for the intended purpose.

.5 Sufficient product literature to allow ready comparison to the applicable technical specification.

.6 Where the product is required to be listed/certified to a recognized standard, provide listing or certification documentation identifying the standard(s) to which it is certified.

.7 Provide a detailed description of the installation requirements that differ from the specified manufacturer/product installation requirements.

.8 Identify any offered cost-saving credit.

.2 Description of manufacturer’s authorized service personnel, including;

.1 nearest service location,

.2 the nature of the service company (direct manufacturer personnel, authorized dealer/service company, etc),

.3 call-out service level, including a description of availability (i.e. 24 hours per day, 7 days per week), response time management and escalation process, and

.4 confirmation of other service performance levels as required in individual technical specification sections.

.3 Supply additional information on the product as reasonably requested by the Consultant and/or the Owner.

.4 These submittals will not be reviewed or processed as a shop drawing. If the substitution review is acceptable to the the Owner, prepare and submit a formal shop drawing submittal for review by the Consultant.

## 1.8 Substitution Product Submittals

.1 Include the following information for each eligible substitute product, where the product is eligible to be evaluated through the shop drawing submittal process:

.1 all required information as specified for shop drawing submittals applicable to the product,

.2 manufacturers declaration as to the reason for the substitution (as specified herein), and statement of any variance from the technical specification.

.2 Where the product is not eligible to be submitted through the shop drawing review process, submit the following information:

.1 A marked-up copy of the project specification prepared by the substitute product manufacturer, identifying where the proposed product complies with, not complies with, or is different from, the requirements of the specification.

.2 Sufficient product literature to allow ready comparison to the applicable technical specification.

.3 Where the product is required to be listed/certified to a recognized standard, provide listing or certification documentation identifying the standard(s) to which it is certified.

.4 Provide a detailed description of the installation requirements that differ from the specified manufacturer/product installation requirements.

.5 Identify any offered cost-saving credit.

## 1.9 Evaluation of Product Equivalency

.1 The Consultant shall have the sole determination as to the equivalency of the proposed substitution to meet the project technical specification requirements and the general expected quality when compared to listed manufacturers.

## 1.10 Approval

.1 The Owner shall have the sole authourity and responsibility for approval of substitutions and reserves the right to accept or reject any substitution submittal request for any reason.

**End of Section**

# CHANGE PROCEDURES
# 01 26 05

## 1 SUPPLEMENTAL INSTRUCTIONS

.1 During construction, numbered and dated Supplemental Instructions (SI) will be issued by Consultant for clarification of Contract Documents.

.2 Notify Consultant in writing where Contractor considers work described by SI involves changes to Contract Amount. On receipt of such notification Consultant will cancel SI, and issue Notice of Change.

.3 Failure to notify the Consultant within seven working days of receipt of SI will be taken as acceptance, by Contractor, of the “no change in contract amount” provisions inherent in SI process.

.4 On acceptance of SI, instruction to be recorded, circled, and marked with SI number on Record Drawings.

## 2 PROPOSED CHANGES

.1 Numbered and dated Proposed Changes (PC) will be issued by Consultant to describe proposed changes to Contract Documents.

.2 PCs may be generated through SI process, through Requests for Information (RFI) generated by Contractor, or through some instruction to Consultant from Client

.3 Contractor agrees that receipt of NOC describing changes is notification to suspend execution of that work or that part or section of work, pending resolution of change in Contract Amount for proposed change.

.4 Within 10 working days of receipt of PCs submit priced proposal for change in Contract Amount, including complete breakdown of price and copies of any subcontract or suppliers’ quotations to Consultant for approval. Proposal to identify prolongation or reduction, if any, of construction period. Unacceptable, inaccurate or incomplete proposals will be returned for revision and re-submission.

.5 Costs for proposed changes to be inclusive of contract extension impacts.

.6 Issuance of a PCs does not authorize the contractor to proceed with the change until such time as a Change Order is issued.

## 3 CHANGE DIRECTIVES

.1 During construction, numbered and dated Change Directives (CD) will be issued by Consultant and countersigned by Owner to make changes to Contract Documents to incorporate work, not foreseen during design, that is to proceed forthwith.

.2 Contractor agrees to proceed with change to work as described, and to keep records of additions to and reductions in Contract Amount for submission not more than 5 working days after completion of work

.3 Submit priced proposal showing costs incurred for work covered by CD as change in Contract Amount, including complete breakdown of price and copies of any subcontract or suppliers’ quotations. Proposal to identify prolongation or reduction, if any, of construction period. Unacceptable, inaccurate or incomplete proposals will be returned for revision and re-submission.

.4 Costs for changes described in CD to be inclusive of contract extension impacts.

.5 Consultant to review cost adjustment proposal for changes described in CD and on approval a Change Order will be issued to revise the Contract Amount.

## 4 CHANGE ORDERS

.1 Numbered Change Orders (CO) will be issued by Consultant and signed by Owner to confirm approval of priced Change Directives and Proposed Changes.

.2 Record information contained in CD and PC and accepted by CO on Record Drawings circled and marked with CD, PC and CO numbers.

**END OF SECTION**

# MEASUREMENT AND PAYMENT
# 01 29 76

## 1 COST BREAKDOWN

.1 Within seven days of Contract award, furnish Consultant with a breakdown of Contract Price in such form and detail as to permit evaluation of progress payments, and to assist the Owner in assessment of taxation liabilities, and other accounting procedures.

## 2 FAIR WAGES AND LOCAL LABOUR

.1 Wherever possible, give preference to use of labour, manufacturers, building mechanics, suppliers and sub-trades from the local area.

.2 Wage rates, working hours and conditions for persons employed on work to be in accordance with Provincial Codes and as generally recognized and accepted in locality.

## 3 PREMIUM TIME

.1 Chargeable overtime premium for overtime hours authorized and worked due to change in completion schedule where there is no change in scope of work to be the difference between straight time and overtime rates. No charge for overhead or profit to be included.

**END OF SECTION**

# PROJECT COORDINATION
# 01 31 13

## 1 COORDINATION

.1 Coordinate work done by own forces with work done by subcontractors. Mechanical and electrical subcontractors will be required by conditions of Contract to work and co-operate to ensure that services are installed in the spaces allocated.

.2 After Contract Award meet with Consultant and present for approval, person or persons to be responsible for coordination work. Such persons to be appointed for duration of Contract and may not be released or replaced without prior approval from Consultant.

.3 In congested areas of the work inside the building, prepare interference drawings.

  .1 Drawings inside building to use as-built structural conditions and show work of all trades.

  .2 Interference drawings to be produced at 1:50 (1/4in =1ft) inside building, and to be signed off by all trades prior to commencing installation of work.

  .3 Work to be kept within spaces allocated on the drawings;

    (a) above ceilings,
    (b) within furrings,
    (c) within casings or cabinets, or
    (d) within shafts or pipe chases etc.

.4 During coordination process, relocation or off-setting of any of the work within 3 metres (10 feet) of designated position shown on Contract Drawings, to be done without extra cost to Owner.

.5 Any work erected without proper coordination to be relocated without extra cost to Owner.

.6 Check Drawings and Specifications and notify Consultant of any apparent discrepancies or dimensional ambiguities before proceeding with work.

.7 Significant deviation from Specifications and Drawings involving increase or decrease in quantities or changes in quality of work to be drawn to attention of Consultant for approval. Where changes to the contract price are anticipated, documentation will be issued using Contract Change procedures.

## 2 EXAMINATION OF PREVIOUS WORK

.1 Examine work upon which this work is dependent, and report any defects prior to commencement of work. Commencement of work will be taken as acceptance of existing conditions and as a waiver of claims for weakness or unsatisfactory condition of surrounding and supporting work.

## 3 WELDING TO STRUCTURAL STEEL

.1 Do not make any welded connection to any building structural steel member without written approval from Consultant.

.2 Submit details of proposed connection to Consultant for review. Review will be for assessment of impact on building structural steel and not to determine the adequacy of proposed connection.

.3 Persons performing welding operations must be certified.

**END OF SECTION**

# SCHEDULING OF WORK
# 01 32 13

## 1 AWARD OF CONTRACT

.1 The Contract is scheduled for award by June 4th, 2020.

## 2 CONSTRUCTION START

.1 Construction is scheduled to start in various locations..

## 3 CONSTRUCTION COMPLETION

.1 The work of this project to be planned and organized to assure completion of each phase as scheduled.

## 4 PRODUCTION SHUTDOWNS

.1 Shutdowns/tie-ins shall be done after hours and/or on weekends.

.2 During these shutdowns perform "dusty" and “noisy” work that might otherwise inhibit Owners normal operations.

## 5 CONSTRUCTION SCHEDULE

### 5.1 Construction Scheduling at Award of Contract

.1 Upon award of Contract, meet with Consultant to discuss project planning and to establish workable construction schedule and to establish continuing liaison.

.2 Deviation from phased completion dates in attached construction schedule to be confirmed with Owner.

### 5.2 Construction Schedule During Execution of Work

.1 Wherever work conditions or material and equipment deliveries interfere with completion dates, meet with Consultant, revise work plans, determine how lost time will be made up and resubmit revised construction schedule.

## 6 OWNER'S NORMAL WORKING HOURS

.1 Owner's normal working hours are 7:00 a.m. to 7:00 p.m., Monday through Friday. Any work that is allowed outside normal working hours may not be noisy or disruptive.

.2 Contractor may be permitted to work late after normal working hours and at weekends provided Contractor submits written request and obtains written approval from Owner. Request must be made 48 hours minimum prior to requested access time. Permission will only be granted in extenuating circumstances and may be refused.

## 7 DELIEVERY OF CONSTRUCTION MATERIALS AND EQUIPMENT

.1 Delivery of construction materials shall occur during the predefined Owner’s normal working hours.

.2 In the case where materials or equipment is delivered through the emergency department, delivery access may be delayed if there is a trauma

## 8 PROGRESS REPORTS.

.1 Prepare and keep up-to-date a progress chart showing proposed schedule for various trades at various locations within the work area.

.2 Keep daily records of work done, Contractors and subcontractors forces on site, equipment and material deliveries, and weather conditions. Record to show date of commencement and date of completion of various parts of work and performance is to be compared with schedule targets on progress chart.

.3 At the end of each month consolidate daily records into a summary progress report, for submission with Payment Requests.

**END OF SECTION**

# RENOVATIONS
# 01 73 29

## 1 EXTENT OF WORK

.1 This Work includes substantial interior renovation work to extent as shown on Drawings, and specified.

.2 Such work to be carried out in accordance with Specification and best industry practice.

.3 Condition of areas of existing building to be ascertained at time of tendering by inspection of premises.

.4 Removal of, or changes to, mechanical equipment, piping, ductwork and plumbing fixtures is specified in Mechanical Division.

.5 Removal of, or changes to, existing wiring and light fixtures is specified in Electrical Division.

.6 Where piece of equipment, items, or material, is indicated to be removed, relocated, or is required to be temporarily removed and reinstalled, it to be respective contractor's responsibility to remove, relocate, or temporarily remove and reinstall equipment, item or material. Removal, relocation and temporary removal and reinstallation of mechanical and electrical equipment, item and material, is specified in Mechanical and Electrical Divisions.

## 2 COORDINATION

.1 It is essential that on-going operations of Owner be maintained with minimal disruption during period of new construction, renovations, and alterations to existing building.

.2 Co-operate fully with other contractors on work and proceed with this work as rapidly as job conditions permit.

.3 Supply items to be built in, in ample time to be incorporated into work of other trades, together with measurements, templates, or dimensioned sketches.

## 3 INFECTION CONTROL AND PREVENTION (IPAC)

.1 All contractors are to follow CSA Z317.14 for infection control protocols.

.2 Temporary poly/hoarding with vestibule is required at entry to construction zone. Provide magnehelic gauge to ensure negative pressurization.

   .1 Vestibule and construction zone to be negatively pressurized from surrounding spaces.

.3 Provide HEPA filtered exhaust from vestibule and construction zone, connected back to the hospitals return system.

## 4 DEMOLITION, STORAGE AND REMOVAL OF MATERIALS

.1 Demolish obsolete work and prepare existing areas ready for new Work.

.2 Demolished materials, unless otherwise specified to be relocated or retained and handed over to Owner, will become property of Contractor and are to be removed from site.

.3 Store items and materials retained by Owner in location directed by Owner.

## 5 MAINTENANCE OF FIRE SAFETY

.1 Maintain site clean at all times and do not obstruct driveways, corridors, stairways, or doorways.

- .1 Exits, including stairways and exterior doors serving existing building to be maintained.
- .2 Where exit is blocked, provide alternative exit.
- .3 Where exit leads through construction area, provide clearly defined protected route separated from construction area with smoke tight fire separation with ¾ hour fire-resistance rating.

.2 Protect intersections between existing corridors in occupied floor areas and new corridors under construction.

- .1 Erect temporary fire separations from steel studs and gypsum board with ¾ hour fire resistance rating.
- .2 Where access is required provide door of solid core wood or hollow steel, equipped with self closing and latching hardware.

.3 Provide Fire Department access.

- .1 Access roadways designated for fire department equipment to be routed clear of building additions and construction activity.
- .2 Where previously existing access roads are deleted or obstructed, provide alternative routes acceptable to fire department, prior to commencement of construction.

.4 Control combustible materials within construction site.

- .1 Stockpiling adjacent to existing, occupied buildings is prohibited where storage of materials create a fire hazard.
- .2 Combustible materials to be piled in limited quantities in accordance with regulations under the Health and Safety Act.
- .3 Open flame portable heating appliances to be located clear of combustible materials and finishes.

.5 Protect existing occupied areas from exposure to construction in progress

- .1 Glazing to be covered by 5/8 inch gypsum board on suitable framing for duration of construction.
- .2 Doors, louvres, and other openings to be similarly protected or replaced with doors of solid core wood or hollow steel.

.6 Openings through existing floor assemblies and vertical fire separations to be protected.

- .1 Seal around ducts pipes conduits and other services with temporary seals of fire barrier material, mineral wool, or smoke stopping.

## 6 CUTTING AND PATCHING

.1 Coordinate cutting and patching.

- .1 Contractors are required to cut, patch and make good work of their own trade in altered portions of existing building.
- .2 Each trade is responsible for laying out required holes in partitions, roofs, smoke curtains, metal deck or siding and for providing sleeving, fireproofing, and smoke-stopping. Arrange with appropriate Contractor to leave these apertures.
- .3 Where openings are to be made in finished work, accurately saw-cut floors, walls and ceilings. Provide holes and openings no larger than necessary to minimize damage. Core drill circular

holes in concrete. Accurately cut new openings for electrical outlets and other recessed items in walls.

.4 Obtain Consultant's approval prior to drilling through concrete floor and ceiling slabs, structural members and load bearing walls.

.5 Provide temporary supports during cutting and coring.

.2 Where holes are to be cut through exterior walls, roofs, and metal deck, closure to be maintained until after equipment/duct or pipe is in place to minimize rain entering building.

.3 Where alterations occur, patch floors, walls, partitions and ceilings to match existing.

.1 Join new work to existing in neat, accurate manner.

.2 Change, make good and adjust existing floors and ceilings where partitions are removed.

.4 Refer to Drawings for extent of architectural, mechanical, electrical and structural work beyond main area of Work and provide for removal and reinstallation of ceilings and cutting and patching of existing finishes to accommodate this work.

.1 All work outside main area or renovation is to conform to the Owner’s IPAC requirements for construction.

.5 Provide openings in ceilings as required by revisions to mechanical and electrical work and make good afterwards.

**END OF SECTION**

# PROJECT CLOSE-OUT
# 01 78 05

## 1 AS-BUILT RECORDS

### 1.1 As-Built Drawings

.1 Contractor to obtain from Consultant at commencement of work, one complete set of white prints or electronic CAD drawing file of Drawings to be used for purpose of recording the as-built changes and deviations to work.

.2 These prints and/or CAD files to be kept by Contractor in Job Office and made available to all Subcontractors so that all changes and deviations to be recorded by respective trades promptly as they occur by marking in black ink. Deviations and changes to mechanical and electrical systems must be recorded on these Drawings.

.3 Upon completion of work, return these Drawings and CAD files in complete and good condition to Consultant in order that Owner will have record of exact location of all services and equipment.

### 1.2 Operating and Maintenance Manuals

.1 Submit operating and maintenance manuals, as detailed in the specification sections.

## 2 CLEAN UP

.1 Keep premises free from waste, debris or dirt.

.2 Upon completion of work, thoroughly clean work and remove surplus materials and equipment of every description incidental to this work, leaving installation in neat and orderly condition.

## 3 WARRANTIES

### 3.1 Warranty

.1 Remedy any defects due to faulty materials or workmanship appearing within period of one year from date of final acceptance of work and to pay for any damage to other work resulting therefrom which appears within such period and neither final certificate nor payment thereunder to relieve Contractor from this responsibility. Owner to give notice of observed defects promptly. Any work requiring excessive service during warranty period to be considered defective and to be replaced at no additional cost to Owner.

**END OF SECTION**

HHAngus

# Structural Specifications

FOR

## CT SCANNER REPLACEMENT

## Fort St. John Hospital

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

Issued for Construction
October 5th, 2020

**See structural drawings for specifications.**

# Architectural Specifications

FOR

**CT SCANNER REPLACEMENT**

## Fort St. John Hospital

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

Issued for Construction
October 5th, 2020

**See architectural drawings for specifications.**

# Mechanical Specifications

FOR

**CT SCANNER REPLACEMENT**

## Fort St. John Hospital

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

Issued for Construction
October 5th, 2020

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# MECHANICAL GENERAL REQUIREMENTS
# 20 01 01

## 1 GENERAL

### 1.1 General Contract Documents

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

### 1.2 Work Included

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

### 1.3 Document Organization

.1 Applicable Divisions for Mechanical Work:

- .1 Division 20 - Common Work for Mechanical
- .2 Division 21 - Fire Protection
- .3 Division 22 - Plumbing and Drainage
- .4 Division 23 - Heating, Ventilation and Air Conditioning (HVAC)
- .5 Division 25 - Building Automation System

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

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

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

### 1.4 Division 20, as it applies to Divisions 21, 22, 23 and 25

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

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

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

### 1.5 Definitions

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

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

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

## 1.6 Language

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

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

## 1.7 Examination

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

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

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

## 1.8 Design Services

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

## 1.9 Standard of Material and Equipment

.1 Materials and equipment:

- .1 new and of uniform pattern throughout work,
- .2 of Canadian manufacture where obtainable,
- .3 standard products of approved manufacture.
- .4 labeled or listed as required by Code and/or Inspection Authorities,
- .5 registered in accordance with the requirements of TSSA Boilers and Pressure Vessels Safety Division Guidelines for the Registration of Non-nuclear Fittings in the Province of Ontario,
- .6 in compliance with Standards and Regulations with respect to;
  - (a) chemical and physical properties of materials,
  - (b) design,
  - (c) performance characteristics, and
  - (d) methods of construction and installation.
- .7 identical units of equipment to be of same manufacture.
- .8 identical component parts of same manufacture in similar units of equipment, but various component parts of each unit need not be from one manufacturer.

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

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

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

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

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

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

**1.10 Substitutions**

.1 Comply with specification section 01 25 13

**1.11 Owner's Special Requirements for existing sites**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

# 2 SUBMITTALS

## 2.1 Shop Drawings and Product Data Sheets

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

- .1 Submit shop drawings in the same unit of measure as are used on the drawings. Both metric and imperial measures may be included.
- .2 Submitted shop drawings by email to: shopdrawings@hhangus.com

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

- .1 Information required on each submission:
  - (a) Client/Architect name
  - (b) Project Name
  - (c) H.H. Angus project number
  - (d) Date
  - (e) Contractor name
  - (f) Contractor reference no.
  - (g) Manufacturer name
  - (h) Product type
  - (i) Specification section number
  - (j) Contractor trade: mechanical, electrical, elevators, or general trades
  - (k) If a re-submission, the previous submission H.H. Angus reference number.

.3 Submit shop drawings in PDF format;

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

.2 for each item of equipment in following list;

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

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

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

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

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

.7 Shop drawings and product data to show;

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

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

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

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

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

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

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

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

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

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

### 2.2 Field, Fabrication, or Installation Drawings

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

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

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

## 3 REFERENCE CODES STANDARDS AND REGULATIONS

### 3.1 Codes, Standards and Regulations

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

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

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

### 3.2 Permits, Tests and Certificates

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

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

.3 Obtain and submit Inspection Certificates for

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

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

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

## 4 EQUIPMENT

### 4.1 Manufacturers Nameplates

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

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

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

**4.2 Factory Applied Prime Painting**

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

**4.3 Field Painting**

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

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

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

- .1 paint exposed galvanized metal surfaces with one coat of zinc dust galvanized primer and one coat of 100% Alkyd base enamel in an approved colour; and
- .2 paint exposed iron or steel work with one coat of chrome oxide phenolic base primer and one coat of 100% Alkyd base enamel in an approved colour.

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

**4.4 Pre-purchased Equipment Damage and Ownership**

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

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

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

## 5 OFFICE, STORAGE AND TOOLS

### 5.1 Office and Storage

.1 Provide temporary office 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 and provide heat, light and telephone and Internet service

.3 Owners cafeteria is off limits.

### 5.2 Appliances and Tools

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

## 6 COORDINATION

### 6.1 General

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

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

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

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

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

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

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

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

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

### 6.2 Field, Fabrication, and Installation Drawings

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

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

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

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

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

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

### 6.3 Cutting and Remedial Work

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

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

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

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

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

### 6.4 Anchors and Inserts

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

# 7 PROTECTION OF WORK AND PROPERTY

## 7.1 General

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

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

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

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

# 8 WORK IN EXISTING BUILDING

## 8.1 General

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

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

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

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

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

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

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

## 8.2 Continuity of Services

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

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

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

## 9 MOVING AND SETTING IN PLACE OF OWNER'S EQUIPMENT

### 9.1 S.B.O. (Supplied by Owner)

.1 Items marked SBO on drawings will be;

.1 purchased by Owner.

.2 received, checked, and stored and

.3 subsequently unpacked, uncrated, assembled and located by Contractor under Division 1

.2 Connect mechanical and electrical services to this equipment.

### 9.2 E.R. or Ex. Rel. (Existing Relocated) or otherwise so identified

.1 Items so marked on drawings will be;

.1 moved from their present location and reinstalled by Contractor under Division 1.

.2 Disconnect and reconnect mechanical and electrical services to accommodate this equipment relocation.

## 10 FINAL CLEANING AND ADJUSTMENTS

### 10.1 General

.1 Conduct final cleaning as specified herein.

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

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

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

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

## 11 RECORD DRAWINGS

### 11.1 Record drawings

.1 Provide record drawings as specified herein.

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

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

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

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

### 11.2 As-built drawings

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

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

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

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

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

.4 Show on site services as-built drawings survey information provided by Ontario Land Surveyor (OLS) monitoring services installation.

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

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

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

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

## 12 OPERATING AND MAINTENANCE INSTRUCTIONS

### 12.1 Operating and Maintenance Manuals

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

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

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

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

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

.3 Operating data to include;

  .1 control schematics for each system,

  .2 description of each system and associated control elements,

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

  .4 operating instructions for each system and each component,

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

  .6 valves schedule and flow diagram,

  .7 service piping identification charts.

.4 Maintenance data to include;

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

  .2 fault locating guide,

  .3 manufacturer's parts list,

  .4 reviewed shop drawings,

  .5 equipment manufacturer's performance sheets,

  .6 equipment performance verification test results,

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

  .8 spare parts list and an itemized cost,

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

.5 Approval procedure

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

  .2 Make corrections and resubmit as directed.

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

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

**12.2 Operating and Maintenance Instructions**

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

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

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

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

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

.6 Organize each training sessions as follows:

- .1 Fire Protection - Division 21
- .2 Plumbing – Division 22
- .3 HVAC – Division 23
- .4 Building Management System – Division 25

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

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

- .1 General purpose of system (design intent),
- .2 Use of O&M manuals,
- .3 Review of control drawings and schematics,
- .4 Start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, control set-up and programming troubleshooting, and alarms,
- .5 Interaction with other systems,
- .6 Adjustments and optimizing methods for energy conservation,
- .7 Health and safety issues,
- .8 Special maintenance and replacement sources,
- .9 Occupancy interaction issues, and
- .10 System response to different operating conditions.

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

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

## 13 START-UP AND TESTING

### 13.1 Care, Operation and Start-up

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

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

### 13.2 TESTING - General

.1 Methods to comply with following references:

(a) The Ontario Building Code
(b) Ontario Installation Code for Oil-burning Equipment
(c) CSA B149.1 Natural Gas and Propane Installation Code

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

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

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

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

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

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

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

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

**13.3 Testing - Potable Water Piping**

.1 Test potable water systems with water or air as required by The Ontario Building Code, Part 7.

.2 For water service pipes 100 mm (4") and larger, disinfect the pipe with chlorine from the street valve to the first shut-off valve inside the building. Provide testing laboratory certificate confirming water contaminates are below the threshold values in O.Reg. 248/06.

**13.4 Testing - Other Piping**

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

.2 Test natural gas system to CSA B149.1

.3 Test fuel oil systems to CSA B139

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

.5 Test special service piping as detailed.

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

### 13.5 Testing - Ventilation

.1 Test ductwork in accordance with procedures detailed.

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

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

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

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

.6 Testing - Electrical

.7 Make tests of equipment and wiring.

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

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

.10 Replace defective equipment and wiring with new material.

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

## 14 TEMPORARY AND TRIAL USAGE

### 14.1 General

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

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

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

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

## 15 SPECIAL TOOLS AND SPARE PARTS

### 15.1 General

.1 Furnish spare parts as follows

.1 One glass for each gauge glass.

## 16 CONSULTANT REVIEWS

### 16.1 General

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

### 16.2 Site Reviews

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

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

### 16.3 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 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.

### 16.4 Substantial Performance Review

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

### 16.5 Final Review

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

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

.2 Include with the request a written certification that:

.1 reported deficiencies have been completed,

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

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

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

.5 cleaning is finished in every respect,

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

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

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

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

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

## 17 CORRECTION AFTER COMPLETION

### 17.1 General

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

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

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

## 18 ATTACHEMENTS

### 18.1 Shop Drawing Submittal Form

.1 Attached sample of shop drawings submittal form.

HHAngus

1127 Leslie Street
Toronto, Ontario
M3C 2J6 Canada

T 416 443 8200
F 416 443 8290
hhangus.com

## SHOP DRAWING SUBMITTAL

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

| | |
|---|---|
| Client/Architect: | **[Client/Architect name]** |
| Project Name: | **[Project name]** |
| HHA Project No: | **[HHA Project No]** |
| Contract: | **General** |

***Contractor to complete the following for each submission.***

Date: ____________________________

Contractor Name: ____________________________ Ref No: ________________

Manufacturer Name: ____________________________

Product Type: ____________________________

Specification Section No: ____________________________

Contractor Trade:

☐ Mechanical ☐ Electrical ☐ Elevators ☐ General Trades

**If this is a resubmission, check here:** ☐

Previous submission HHA reference no.: ______________________

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

Document1

**END OF SECTION**

# QUALIFICATIONS AND AUTHORITIES – BRITISH COLUMBIA
# 20 01 02

## 1 GENERAL

### 1.1 Scope

.1 The specification section:

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

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

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

### 1.2 Definitions

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

## 2 QUALIFICATIONS

### 2.1 Trades Qualification and Apprenticeship

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

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

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

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

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

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

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

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

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

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

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

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

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

### 2.2 Work-Specific Qualification Licenses

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

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

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

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

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

# 3 AUTHOURITIES

## 3.1 Authorities having Jurisdiction

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

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

# 4 PERMITS, REGISTRATION AND INSPECTION

## 4.1 Building Code Permits

.1 No building permit required.

## 4.2 Other Work Permits, Registration and Inspection

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

.1 Boilers, pressure vessel and pressure piping,

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

.3 Where described elsewhere in Division 20 to 25.

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

**END OF SECTION**

# MECHANICAL COORDINATION AND INSTALLATION DESIGN SERVICES
# 20 01 03

## 1 GENERAL

### 1.1 Scope

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

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

### 1.2 Document Ownership

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

### 1.3 Consultant Drawings

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

### 1.4 Design Commentary

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

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

   .2

   .3 unknown structural conditions

   .4 hidden conduit in slabs and walls

   .5 availability of existing documentation

### 1.5 Requests for Information

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

### 1.6 Itemized Price

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

## 2 INTERFERENCE CO-ORDINATION DRAWINGS

### 2.1 General

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

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

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

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

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

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

### 2.2 Interference Coordination Drawings

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

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

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

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

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

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

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

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

### 2.3 Coordination with Other Trades

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

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

### 2.4 Interconnecting Control and Power Wiring

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

### 2.5 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.

### 2.6 Owners Equipment and Relocated Equipment

.1 The service provisions shown for Owner's supplied equipment and/or relocated equipment is based on the best 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.

## 3 FABRICATION AND INSTALLATION DRAWINGS

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

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

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

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

**END OF SECTION**

# DEFINITIONS AND ABBREVIATIONS - MECHANICAL
# 20 01 13

## 1 GENERAL

### 1.1 Scope

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

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

### 1.2 Definitions

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

## 1.3 Abbreviations

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

**End of Section**

# BASIC MATERIALS AND METHODS
# 20 05 01

## 1 GENERAL

### 1.1 Scope

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

## 2 ACCESSIBILITY FOR CONTROL DEVICES

.1 Mount control devices, intended to be adjusted or to otherwise be used 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 lbsf).

.2 The above requirements do not apply to control devices that are solely located and used by the building operations staff.

## 3 ACCESS DOORS

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

.2 Access is required at;

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

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

.4 Construction:

- .1 constructed of steel, prime coated,.
- .2 flush mounted with 180° opening door, round safety corners, concealed hinges, plaster lock and anchor straps
- .3 600 mm x 600 mm (24 in x 24 in) for personnel entry,
- .4 300 mm x 450 mm (12 in x 18 in) for hand entry, and

.5 constructed of stainless steel in areas finished with tile or marble surfaces

.6 constructed of stainless steel with neoprene gasketed door in damp and high humidity areas

.7 generally fitted with screwdriver operated latches, except in areas subject to security risks (Public Corridors, Psychiatric Patient Areas, Public Washrooms). In these areas doors to be fitted with keyed cylinder locks with similar keys.

*Standard of Acceptance*
- Baird - ABCO
- Stelpro - Type 700
- Williams Brothers - GP
- LeHage
- Acudor Acorn
- Mifab

.5 Installation:

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

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

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

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

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

## 4 DIELECTRIC COUPLINGS

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

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

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

.2 Insulating unions for pipe sizes NPS 2 and under

*Standard of Acceptance*
- Epco - Dielectric
- Watts

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

*Standard of Acceptance*
- Watts No. 3100 or 3200

.4 Insulating gaskets for flanges NPS 5 and over:

.1 compatible with pressure and temperature service,

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

## 5 DRAIN VALVES

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

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

## 6 SLEEVES

### 6.1 General

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

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

### 6.2 Floor and Wall Sleeves

.1 Sleeves in fire separations:

- .1 sized to suit fire stopping methods employed for bare pipes, conduits, insulated pipes, and bare and insulated ducts without fire dampers, and
- .2 sized to suit conditions of approval given in manufacturers installation instructions for fire and smoke dampers.

.2 Sleeves in other construction:

- .1 sized to clear insulated pipes and ducts by 13 mm (½ in) all round, and
- .2 sized to clear conduits, bare pipes, and bare ducts by 6 mm (¼ in) all round.

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

- .1 Schedule 40 steel pipe or 1 mm (20 ga) (minimum) sheet metal, lapped and spot welded.
- .2 Sleeves for pipes, conduits and ducts smaller than 0.4 $m^2$ (4 sq ft) through gypsum board partitions:
  - (a) 1 mm (20 ga) minimum sheet metal, lapped and spot welded with 20 mm (¾ in) lip flange at one and.

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

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

### 6.3 Waterproof sleeves

.1 Applications:

- .1 where pipes and ducts pass through floors in areas subject to water, in mechanical rooms, in kitchens, in washing areas and in slabs over electric and telephone rooms.

.2 Waterproof sleeves for pipes and conduits:

- .1 Schedule 40 pipe, with 75 mm (3 in) wide annular fin continuously welded at midpoint, hot dip galvanized after fabrication.

.3 Waterproof sleeves for ducts less than 0.4 $m^2$ (4 sq ft):

- .1 1 mm (20 ga) galvanized steel, with 40 mm (1½ in) flange at midpoint.

.4 Waterproof sleeves for ducts 0.4 m$^2$ (4 sq ft) and larger and openings with multiple ducts:

 .1 1.6 mm (16 ga) galvanized steel, with 40 mm (1½ in) flange at midpoint, or,

 .2 form opening with wood (removed after concrete is set) and trim opening with welded steel angle frame 75 mm (3 in) high , bolted to slab and caulked, or,

 .3 trim opening with 75 mm x 75 mm (3 in x 3 in) continuous concrete curb doweled to slab.

.5 Modifications for existing construction:

 .1 annular fins and flanges attached to sleeve at point equivalent to surrounding floor level or curb.

**6.4 Installation**

.1 Place and secure sleeves in concrete form work.

.2 Supply sleeves to be set in concrete and masonry walls with installation detail drawings.

.3 Regular sleeves;

 .1 terminate flush with surfaces of concrete and masonry walls.

.4 Waterproof sleeves in new construction;

 .1 extend 75 mm (3 in) above finished floor.

 .2 with flange embedded within concrete floor.

.5 Sleeves in existing concrete and masonry walls and floors;

 .1 installed in neatly cut or drilled holes in existing construction,

 .2 cutting and drilling of structural elements, such as floors, slabs, walls, columns, or beams to be carried out in accordance with procedure set out in Article "Cutting and Patching" below.

 .3 terminate sleeves flush with surfaces of concrete and masonry walls,

 .4 extend waterproof sleeves 75 mm (3 in) above finished floor with flange, countersunk, and bolted down flush into floor surface,

 .5 fill opening between sleeve and wall or floor with 2 hour fire rated fire-stopping sealant with water barrier.

.6 Fill future-use sleeves with weak concrete, gypsum plaster or similar material.

.7 Coat exposed exterior surfaces of un-galvanized ferrous sleeves with heavy application of zinc rich paint

.8 At fire separations and smoke separations, pack and seal void between sleeve and pipe, duct without fire damper, conduit, or insulation in accordance with Article "Fire Stopping and Smoke Seals" in this Section.

.9 At other locations, pack void between sleeve and pipe, conduit, duct or insulation for full depth of sleeve, with mineral wool and seal with silicone-free caulking compound.

.10 Install fire dampers in accordance with conditions of approval given in manufacturer's instructions.

# 7 FIRE STOPPING AND SMOKE SEALS

## 7.1 General

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

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

## 7.2 Products

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

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

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

## 7.3 Installation

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

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

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

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

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

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

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

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

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

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

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

## 8 WALL AND FLOOR PLATES

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

.2 Plates:

- .1 at floor; chrome plated two piece split type with hinge.
- .2 at walls and ceilings; similar to floor plate but with set screw to fasten plate to pipe.

### 8.2 Installation

.1 Plates:

- .1 sized to cover sleeves
- .2 secured tight against finished surfaces, and
- .3 fitted to cover sleeve extensions where sleeves extend above finished floor.

## 9 LINK SEALS

.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 - "Thunderline Linkseal"
- Advance Products & Systems – "Innerlynx"

.4 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 PLATFORMS, LADDERS, COVERS, PIPE SUPPORTS, EQUIPMENT SUPPORTS, AND BASES

### 10.1 Supports for mechanical and electrical work

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

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

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

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

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

### 10.2 Applicable codes and standards;

.1 Ministry of Labour
- .1 Engineering Data Sheets
- .2 Health and Safety Guidelines
- .3 Industrial Alert Bulletins

.2 Regulations made under the Occupational Health and Safety Act;
- .1 Regulations for Industrial Establishments
- .2 Regulations for Health Care and Residential Facilities

.3 The British Columbia Building Code

.4 American Society for Testing and Materials (ASTM)
- .1 ASTM A 53/A53M, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
- .2 ASTM A 269, Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- .3 ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.5 Canadian General Standards Board (CGSB)
- .1 CAN/CGSB-1.40, Anti-corrosive Structural Steel Alkyd Primer.
- .2 CAN/CGSB-1.108, Bituminous Solvent Type Paint.
- .3 CAN/CGSB-1.181, Ready-Mixed, Organic Zinc-Rich Coating.

.6 Canadian Standards Association (CSA)
- .1 CAN/CSA-G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel.
- .2 CAN/CSA-G164, Hot Dip Galvanizing of Irregularly Shaped Articles.
- .3 CAN/CSA-S16.1, Limit States Design of Steel Structures.
- .4 CSA W59, Welded Steel Construction (Metal Arc Welding).

**10.3 Supplementary supports and support brackets:**

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

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

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

**10.4**

**10.4 Installation - Equipment subject to thermal expansion**

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

.1 boilers, hot water heaters,

.2 heat exchangers,

.3 expansion tanks,

.4 dearators and condensate tanks,

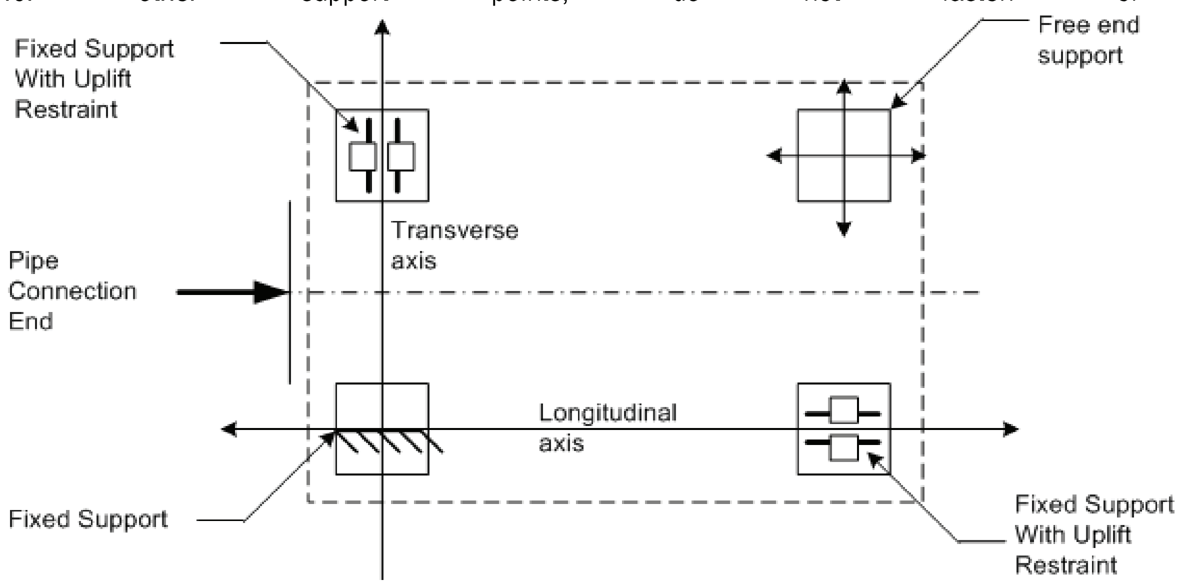
.5 diesel exhaust SCR emission control units.

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

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

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

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




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

**END OF SECTION**

# MECHANICAL WORK IN EXISTING HOSPITALS
# 20 05 02

## 1 GENERAL

### 1.1 Scope

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

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

.3 Except as identified, shut downs of existing services will be restricted from 11PM to 5AM and on Sundays.

.4 All work outside area of renovation and/or outside of IPAC hoarding to be done after hours and/or on weekends. Work to be done in accordance with Hospital's IPAC procedures.

### 1.2 Ventilation

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

### 1.3 Domestic Hot and Cold Water

.1 The systems are always active and serve other occupied areas. Connect to the existing water main by live tapping where line sizes are large enough or by freezing of lines to make required connections.

.2 Co-ordinate with Owner.

### 1.4 Core Drilling and Scanning

.1 Unless stated otherwise all core drilling and scanning for mechanical services is to be done afterhours.

### 1.5 Additional Freezing and Valving of Live Water Services

.1 Include in contract an additional allowance for replacing shut off valves and freezing lines where existing valves do not hold or do not exist. Include valves and freezing for the following:

.1 Freezing of one (1) three inch sprinkler lines

.2 Freezing of two (2) one inch water lines

.3 Freezing of two (2) two inch water lines

### 1.6 Spare Components

.1 Provide the following valves including installation on existing or new piping, modifications to insulation as required:

  .1 Domestic Water service – 2@1/2"

.2 Heating and Cooling service — 2 @3/4", 2 @1/2"

### 1.7 Air and Water Balancing

.1 Provide air/water balancing at the end of ***each*** phase.

.2 Ductwork being cleaned must be done prior to balancing as damper locations often get moved during the cleaning process. If duct cleaning is done after, include for re-balancing of the system to verify original air quantities.

### 1.8 Work in Occupied Areas

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

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

.3 Access to these areas will be after hours as noted above at the discretion of the Hospital

### 1.9 Equipment Maintenance and Operation during Construction

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

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

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

### 1.10 Training of Equipment and Systems

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

### 1.11 Equipment Warrantee

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

## 1.12 Fire Watch and access to fire protection equipment

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

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

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

**END OF SECTION**

# FIRE STOPPING AND SMOKE SEALS
# 20 01 04

## 1 GENERAL

### 1.1 General Contract Documents

**.1** Comply with the General Conditions of the Contract, Supplementary Conditions and other Sections of Division 1 and with Section 20 05 01, Basic Mechanical Requirements.

### 1.2 Work Included

.1 Work of this Section comprises firestopping materials and/or systems to provide closures to fire at openings around penetrations, at un-penetrated openings, at projecting or recessed items, and at openings and joints within fire separations and assemblies having a fire-resistance rating, including openings and spaces at perimeter edge conditions.

.2 Work of this Section also comprises smoke sealants applied over firestopping materials or combination smoke seal/firestop seal material to form air tight barriers to retard the passage of gas and smoke.

.3 The installed firestopping/smoke sealant system shall provide and maintain a fire-resistance rating equivalent to the rating of the adjacent floor, wall or other fire separation assembly to the requirements of and as acceptable to the authorities having jurisdiction and to the Consultant.

.4 Firestopping and smoke seals within mechanical assemblies (i.e. between sleeve and pipe/wire/duct) shall be provided as part of the Work of Divisions 20. Firestopping and smoke seals around the outside of such mechanical and electrical assemblies (ie sleeve and wall) where they penetrate fire-rated separations shall be part of the Work of this Section unless otherwise indicated by the Contractor.

.5 Confirm locations of exposed/non-exposed fireproofed surfaces with consultant prior to application.

**.6** Penetrations will have single or multiple conduits passing through and Work will consist of firestopping all penetrations with pre-approved ULC assemblies.

### 1.3 Quality Assurance

.1 Provide experienced and competent installers, trained by material or system manufacturer.

.2 Applicator Qualifications:

- .1 Applicator shall have at least three years experience in installing materials of types specified and shall have successfully completed at least three projects of similar scope and complexity.
- .2 Applicator shall designate a single individual as project foreman who shall be on site at all times during installation.
- .3 Applicator shall be approved for this Work by Product Manufacturer or listed below:

*Standard of Acceptance*
- Profirestop (Tel: 416-293-0993)
- Custom Insulation Systems (Tel: 905-669-0002)
- Beverly F.S. (Tel: 905-659-3367)
- Dominion Caulking (Tel: 905-883-8355)
- RILI Firestopping (Tel: 905-349-3779

.4 Single source responsibility for firestopping materials:

(a) Obtain firestop materials from single manufacturer for each different product required.
(b) Manufacturer shall instruct applicator in procedures for each material.
(c) Refer to notes on Drawings for additional information, instructions and clarifications.

.5 Regulatory Requirements:

(a) Firestop System installation must meet requirements of CAN/ULC-S 115-95 tested assemblies that provide a fire rating equal to that of construction being penetrated.
(b) Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

.6 Arrange a pre-job conference between Contractor, applicator, inspection and testing representative, manufacturer's representative and Consultant.

.7 Fire Protection Consultant will test (Review) up to 2% of completed Work (Penetrations). Contractor to provide installer and enclosures at Consultant's discretion.

.8 Consultant may or may not require destructive testing to be done. Contractor shall cover costs of repairing fire separation after destructive tests are performed.

**1.4 Submittals**

.1 Shop Drawings:

.2 Submit drawings indicating the ULC or Warnock Hersey assembly number, the required temperature, hose stream, and flame rating, material thicknesses, installation methods and materials of firestopping and smoke seals, primer, supports, damming materials as applicable, reinforcements, anchorages, fastenings and methods of installation for each condition to be encountered.

.3 Designate on shop drawings both fixed and moving penetrants, relative positions, expansion and control joints in rated slabs and walls, firestopping details at receptacles and similar poke-through devices and surrounding permanent materials. Identify re-entry locations.

.4 Manufacturer's Product Data: Submit data for materials and prefabricated devices, providing descriptions sufficient for identification on Site.

.5 Certificates: Submit manufacturer's certification that installed firestopping and smoke seal material comply with specified requirements.

.6 ULC or Warnock Hersey Listings: Submit copies of Listing cards for review.

.7 Samples: Submit only as requested various types of firestopping and smoke seal material.

**1.5 Delivery, Storage and Handling**

.1 Deliver the materials to the job site in the manufacturer's unopened containers, containing the classification label, with labels intact and legible at time of use.

.2 Store material in accordance with manufacturer's recommendations with proper precautions to ensure fitness of material when installed.

.3 Before handling, read product data sheets and material safety data sheets. Do not use damaged or expired materials.

## 1.6 Identification

.1 Identify, through-penetration fire stopping and smoke seal systems with pressure sensitive, self adhesive, printed vinyl labels. Attach labels permanently to surfaces of penetration construction on both sides. Labels must be visible from 5'-0" above the floor. Labels must show the following information:

  .1 the words "Warning: through-penetration firestopping system, Do not disturb"

  .2 the applicators name, address and telephone number

  .3 designation of applicable testing and inspection agency

  .4 date of installation

  .5 manufacturers name for materials

## 1.7 Photography

.1 Provide digital photography of every fire separation penetration showing both the before and after installations. Picture must indicate day and time and be labelled to show exact location.

.2 Duplicate copies of digital photo records are to be submitted directly to the Hospital at the completion of the installation in each building/ wing.

# 2 PRODUCTS

## 2.1 Acceptable Manufacturers / Installation Specialists

.1 General: Manufacturers of firestopping products and installation specialist for this Work are limited to applicable assemblies as required for Project and having ULC or C-UL-US or Warnock Hersey labelled packaging.

.2 Approved manufacturers:

*Standard of Acceptance*

- 3M Canada
- Tremco Canada
- A/D Fire Protection Systems Inc.
- Grace
- Nuco Inc. (1-800-583-3984)

## 2.2 Materials

.1 Firestopping and smoke seals shall conform to the following:

  .1 Asbestos free materials and systems;

  .2 Provide a fire-resistance rating not less than the fire-resistance rating of the surrounding or adjacent floor, wall or other assembly.

  .3 FTH Rated and certified in accordance with CAN/ULC-S115-95, and be labelled (WH, cUL, ULC).

.2 Sealants and putty for overhead and vertical joints shall be non=sagging; seals for floors, self-levelling, silicone based.

.3 Products shall be compatible with abutting dissimilar architectural coatings and finishes at floors, wall, ceiling, waterproofing membranes and the like. Check with requirement of Contract Documents and manufacturer of selected materials being installed.

# 3 EXECUTION

## 3.1 Manufacturer's Instructions

.1 Compliance: Comply with manufacturer's product data including product technical bulletins, product catalogue installation instructions and product packaging instructions.

## 3.2 Preparation

.1 Examine sizes, anticipated movement and conditions to establish correct thickness and installation of back-up materials.

.2 Clean bonding surfaces to remove deleterious substances including dust, paint, rest, oil, grease, moisture, frost and other foreign matter which may otherwise impair effective bonding.

.3 Remove insulation from insulated pipe and duct where such pipes or ducts penetrated a fire separation unless listed assembly permits such insulation to remain within the assembly, or where mechanical trades have installed special fire rated insulated sleeves.

.4 Prepare surfaces, prime, mask adjacent surfaces and clean in accordance with manufacturer's directions and to requirements of tested assembly.

## 3.3 Installation

.1 General

- .1 Mix and apply firestopping, gas and smoke seals in strict accordance with manufacturer's instruction and tested designs to provide required flame rated seal, to prevent the passage of gas and smoke, and where specifically designated, the passage of fluids.
- .2 Provide temporary forming and packing as required. Apply materials with sufficient pressure to properly fill and consolidate the mass to seal openings.
- .3 Tool or trowel exposed surfaces.
- .4 Notify Consultant when random completed installations are ready for review, as directed by Consultant, prior to concealing or enclosing firestopping and as applicable, smoke seals

.2 Identification

- .1 Provide identification of all firestopping as specified.

.3 Photography

- .1 Provide digital photography of every fire separation penetration showing both the before and after installations. Picture must indicate day and time and be labelled to show exact location.
- .2 Duplicate copies of digital photo records are to be submitted directly to the Hospital at the completion of the installation in each building/ wing.

## 3.4 Clean-Up

.1 Remove excess materials and debris and clean adjacent surfaces immediately after application. Remove and or correct staining and discolouring or adjacent surfaces as directed.

**END OF SECTION**

# WIRING REQUIREMENTS FOR MECHANICAL SERVICES
# 20 05 12

## 1 GENERAL

### 1.1 Scope

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

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

### 1.2 Related Sections

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

- .1 20 05 29 Hangers and Supports
- .2 20 05 49 Seismic Restraint.

### 1.3 Definitions

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

- .1 ***Breaker panel (BP)*** - a 120/208 V mechanical power panel with overcurrent protection circuit breakers provided by Division 26.
- .2 ***Control panels –*** an electrical device that controls or monitors mechanical equipment, or that interfaces with instrumentation devices.
- .3 ***Control wiring*** - wiring for the purpose of communication or control of equipment and instrumentation.
- .4 ***Electrical safety code -*** the edition with amendments of CSA C22.1 as adopted by applicable legislation at the location of the Work.
- .5 ***Mechanical breaker panel (MBP)*** means a 120/208 V mechanical power panel with overcurrent protection circuit breakers provided as part of a MCC.
- .6 ***Mechanical Power Panel (MPP) -*** 208 V or 600 V, 3 phase, power distribution equipment with branch circuit overcurrent protection devices provided by Division 26, and dedicated to supply power for equipment provided by mechanical trades work.
- .7 ***Mechanical trades work -*** equipment and systems provided under Divisions 20 to 25.
- .8 ***Motor controllers -*** constant speed motor controllers of the manual, magnetic or solid-state type in accordance with specification section 20 05 14.13.
- .9 ***Motor Control Center –*** has the meaning as specified in section 20 05 14.13.
- .10 ***Packaged equipment -*** equipment containing some or all of: motor(s), controls and/or other electrically powered equipment, such as but not limited to: electric heating equipment, water treatment equipment, packaged HVAC equipment, electric boiler, electric domestic water heaters, etc.)
- .11 ***Power Panel (PP)***: 208 or 600 V, 3 phase, power distribution equipment with branch circuit overcurrent protection devices provided by Division 26, which serves general building loads and may also serve equipment provided by mechanical trades work.
- .12 ***Power wiring*** means wiring that provides electrical power to equipment.
- .13 ***VFD***: variable frequency drives in accordance with specification section 20 05 14.16.
- .14 ***Wiring*** means conductors, cable, conduit, fittings, supports and accessories.

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

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

**1.4 Applicable Codes and Standards**

.1 Legislation:

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

.2 Installation standards and codes:

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

.2 CSA C22.1 Canadian Electrical Code Part 1

.3 Product standards:

.1 CSA C22.2 No. 4 Enclosed and Dead-Front Switches

.2 CSA C22.2 No. 38 Thermoset-Insulated Wires and Cables

.3 CSA C22.2 No. 39 Fuseholder Assemblies

.4 CSA C22.2 No. 106 HRC – Miscellaneous Fuses

.5 CSA C22.2 No. 124 Mineral Insulated Cable

.6 CSA C22.2 No. 131 Type TECK 90 Cable

.7 CSA C22.2 No. 208 Fire Alarm and Signal Cable

.8 CSA C22.2 No. 239 Control and Instrumentation Cables

**1.5 Quality Control**

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

**1.6 Permits, Fees and Inspections**

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

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

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

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

**1.7 Standard Details**

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

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

**1.8 Submittals**

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

.1 service lights.

**1.9 Storage of Materials**

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

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

.3 Where white insulated wire has discoloured:

.1 do not install,

.2 dispose of the wire,

.3 remove and replace wire that has been installed.

## 2 PRODUCTS

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

.1 Application:

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

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

.3 convenience power outlets and service lights.

.2 Conductors:

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

.2 stranded conductors for 10 AWG and larger.

.3 Minimum wire size:

.1 No. 12 AWG for equipment power,

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

.4 Insulation:

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

.2 1000 V insulation for 600 V systems,

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

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

.5 Colour coded conductors:

.1 colour impregnated into insulation at time of manufacture,

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

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

*Standard of Acceptance*

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

## 2.2 Instrumentation and Control Cabling

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

.2 Conductors:

- .1 solid copper wire,
- .2 twisted-multipair, shielded cables with individually shielded pairs, overall shield, drain wires and overall rated jacket,
- .3 insulation: XLPE, colour coded or numbered wires,
- .4 minimum wire size: as specified by equipment manufacturer or controls vendor, unless otherwise shown.

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

.4 Armour:

- .1 corrugated steel, or
- .2 none required if installed in conduit or approved wireway.

.5 Jacket:

- .1 FT4 flame retardant,
- .2 FT6 when installed in open style cable trays in ceiling spaces that are used as return air plenums.

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

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

## 2.3 Fire Rated Mineral Insulated Cable

.1 Application – power feeders:

- .1 conductors: solid annealed copper,
  - (a) 2 conductors, minimum 14 AWG for power wiring for Division 20 to 25 control equipment including dampers and terminal units,
  - (b) 2 or 3 conductor as applicable, size as shown but not less than 12 AWG for power wiring to Division 20 to 25 mechanical equipment (other than control equipment)
- .2 insulation: compacted magnesium oxide (“MI”)
- .3 sheath: seamless annealed copper.
- .4 voltage rating: 600 V
- .5 terminations: as supplied by the cable manufacturer.
- .6 fire rating: listed for 2 hour fire-resistance rating with hose stream test to ULC-S139 cables labelled accordingly.
- .7 ship cables with ends sealed.
- .8 listed to CSA C22.2 No. 124 and ULC-S139.

*Standard of Acceptance*
- Pentair/Pyrotenax System 1850

.2 Application - communication wiring:

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

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

.3 shield: seamless annealed copper.

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

.5 sheath: seamless annealed copper.

.6 voltage rating: 300 V.

.7 terminations: as supplied by the cable manufacturer.

.8 listed for fire alarm cabling CSA FAS 105.

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

.10 ship cables with ends sealed.

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

*Standard of Acceptance*

° Pentair/Pyrotenax System 1850 Twisted Pair

**2.4 Fire Rated Ceramifriable Silicone Rubber Insulated Cable**

.1 Application: controls and communications wiring.

.1 No of conductors:

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

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

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

.4 drain wire: 20 AWG copper,

.5 shield: copper/polyester tape,

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

.7 voltage rating: 72 V maximum,

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

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

*Standard of Acceptance*

° Vitalink (Marmon, Comtran) FAS 105

**2.5 Conduits and Fittings**

.1 Conduits:

.1 rigid hot dipped galvanized steel threaded conduit,

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

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

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

.2 Conduit fastenings:

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

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

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

.4 channel type supports for two or more conduits,

.5 Ø6 mm threaded rods to support suspended channels.

.3 Conduit fittings:

.1 manufactured for use with conduit specified including coatings,

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

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

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

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

## 2.6 Outlet Boxes

.1 Construction:

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

.2 Size:

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

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

## 2.7 Safety (Disconnect) Switches

.1 Construction:

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

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

.3 fused unless shown as unfused,

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

.5 horsepower rated,

.6 type 3R painted metal enclosure,

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

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

.9 six pole for two speed motor applications,

.10 provision for padlocking in the Off switch position,

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

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

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

.2 Fuses:

.1 HRC Class J [fast acting][time delay] up to 600A,

.2 HRC Class L for ratings above 600A,

.3 product of one manufacturer,

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

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

.1 auxiliary status switch;

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

.4 Ratings:

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

.2 NEMA flange mount for all ratings.

*Standard of Acceptance*

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

## 2.8 Equipment Service Lights (Marine Lights)

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

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

.3 Power: 120 VAC.

.4 Wall or ceiling mount.

*Standard of Acceptance*

° Crouse Hinds - Type Pauluhn 700 series

## 2.9 Switches

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

.2 Rating: 20 A at 120 Vac.

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

*Standard of Acceptance*
° Hubbell - HBL1795

## 2.10 Receptacles

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

.2 Receptacle outlet hood:

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

.2 die cast aluminum base and cover with gasket,

.3 vertical mount.

.4 self-closing lift cover.

.5 CSA 3R rated.

*Standard of Acceptance*

- Bryant Electric – WPB26EH

## 2.11 Conduit and Equipment Supports

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

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

*Standard of Acceptance*

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

.3 Upper attachment – concrete inserts

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

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

*Standard of Acceptance*

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

.4 Upper attachment – existing concrete:

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

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

*Standard of Acceptance*

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

.3 threaded inserts for drilled holes.

*Standard of Acceptance*

- Hilti - fig. HDI, Kwick Bolt, HSL

.5 Upper attachment – steel beams:

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

*Standard of Acceptance*

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

.6 Upper attachment - steel joists:

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

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

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

*Standard of Acceptance*

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

.7 Hanger rods:

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

.2 tension load ratings to MSS SP-58,

*Standard of Acceptance*

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

.8 Horizontal Pipe Support – Swivel Ring Hanger

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

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

*Standard of Acceptance*

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

.9 Rooftop conduit supports:

.1 conform to specification section 20 05 29.

### 2.12 Wire Markers

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

*Standard of Acceptance*

- Brady BMP21 Plus series

## 3 EXECUTION

### 3.1 General

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

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

### 3.2 Conduit Support and Hanger Installation

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

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

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

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

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

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

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

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

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

.8 Mechanically fasten supplementary steel to structural steel.

### 3.3 Installation of Power and Control Wiring – General Requirements

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

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

  .1 power wiring for motors and packaged equipment,

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

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

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

  .1 Phase A – Red,

  .2 Phase B – Black,

  .3 Phase C – Blue ,

  .4 Neutral - White,

  .5 Ground - Green,

  .6 Control - Orange.

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

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

  .1 Line – Red,

  .2 Neutral – White,

  .3 Ground – Green.

.5 Install all wiring in conduit or approved raceway.

.6 Conduit selection type:

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

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

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

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

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

**3.4 Installation of Instrumentation, Communications and Control Cabling**

.1 Install wiring in conduit.

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

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

.4 Terminate control cables in equipment with suitable connectors.

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

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

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

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

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

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

**3.5 Installation of Fire Rated Cable**

.1 Provide fire rated cables for power and control wiring for fans, dampers, control devices such as limit switches, etc., and other applicable equipment in the following systems:

.1 fans and dampers for smoke control systems, including areas of refuge,

.2 fans and dampers for smoke venting systems (as an aid to firefighting),

.3 smoke dampers, motorized fire dampers and combination smoke dampers that are required to function as part of a smoke control system (see specification section 25 55 13 for applicable dampers).

.2 Exceptions: fire rated cables are not required under the following conditions;

.1 between an MCC, MPP or other power distribution panel, and the motor controller, VFD or damper actuator, if both the power source panel and the controller/VFD or actuator are in the same room or space,

.2 between a motor controller or VFD, and the motor served if both the controller/VFD and the motor are in the same room or space,

.3 between a motor controller or VFD, and a damper associated with the controlled motor, if the motor controller/VFD and the damper are located in the same room or space,

.4 between a BAS controller and the controlled equipment if both are located in the same room or space,

.5 terminal box units installed in a system required to function for smoke control or smoke venting, where the terminal box unit actuators fail in the open position on loss of power, and fail to the open position on loss of network communications.

.3 Select the type of fire rated cable for power and control wiring as follows:

| Application | Mineral Insulated | Ceramifriable Insulation |
|---|---|---|
| Motor feeders | Yes | N/A |
| Dampers | Yes | Yes |
| Terminal Box Units | Yes | Yes |
| BAS MSTP wiring | Yes | Yes |
| BAS Ethernet wiring | N/A | Yes |

.4 Handle cables with care to avoid cable kinks; it is recommended that cable be uncoiled from supply reel by rolling. Do not install kinked cables.

.5 Install fire rated cables in accordance with ULC S139 and with the manufacturer's written instructions.

.6 Install ceramifriable fire rated cable in conduit. Use conduit, fittings and supports in strict conformance with the cable manufacturer's installation instructions and product certification listing. Use of any other type of conduit, fasteners and support systems are not permitted.

.7 Install cables on hangers or on channels secured to walls, beams or floor slabs, using clamps supplied by or recommended by the manufacturer.

.8 Support cables with clamps, straps, clips of:

.1 copper,

.2 stainless steel,

.3 steel material,

.9 Secure cables so that they cannot contact any dissimilar metals other than the approved supporting materials.

.10 In damp or wet areas, wrap cables with electrical tape where the cable contacts the supporting materials unless the supporting materials are copper or stainless steel.

.11 Support fire rated cables directly from fire rated structure in accordance with its listing requirements, at spacings as required by the manufacturer installation requirements.

.12 Bend cables using a suitable hickey with a bending radius of not less than six times the cable diameter, unless the cable manufacturer instructions specify smaller turning radius.

.13 Terminate cables using glands and seals as supplied by the cable manufacturer. Install gland and seal assemblies using tools specifically designed for the purpose.

.14 Upon completion of cable terminations and prior to energization, test the insulation resistance of each cable with an insulation tester. Where measured values are not acceptable to the Consultant, rework or replace the cable until satisfactory results are obtained.

.15 Provide the services of the cable manufacturer field service representative to inspect the cable installation and termination methods and provide a written report documenting that the cables have been installed in accordance with the requirements of the ULC standard and the ULC listing and in accordance with the manufacturer's recommendations. Submit the report to the Consultant.]

**3.6 Grounding**

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

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

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

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

.5 Except for VFD Inverter Duty cables, ground all motors with separate green insulated copper ground conductor installed in power feeder conduit, wired from ground terminal in the motor controller to a ground lug bolted directly to the motor frame, located inside the motor terminal box. Size the ground conductor per Table 16 of the electrical safety code. Minimum conductor size to be #12 AWG.

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

**3.7 Disconnect Switches**

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

.2 Motorized equipment:

- .1 Provide disconnect switches for motor driven equipment provided under the mechanical trades work.
- .2 Locate the disconnect switches as follows;
  - (a) within 9 m (29 ft) and in the line-of-site of motors serving non-refrigeration motorized equipment, and within 9 m (29 ft) of the motor controller or VFD controlling the equipment,
  - (b) within 3 m (9.5 ft) and in the line-of-site of equipment containing refrigeration compressors and related motorized equipment that forms part of a refrigerant circuit.
- .3 Disconnect switch types:
  - (a) fused type for motor controllers and VFD's,
  - (b) fused type for motorized packaged equipment.
- .4 Exception: a separate disconnect switch is not required where;
  - (a) a motor controller or VFD is provided with an integral disconnect switch with overcurrent protection and is located with respect to the controlled equipment as specified above, or
  - (b) packaged equipment is provided with an integral disconnect switch with overcurrent protection.
- .5 Where a disconnect switch is required between a VFD and the driven motor due to distance limitations being exceeded or the VFD is not in site from the motor, provide an unfused disconnect switch with integral limit switch, at the motor. Wire the limit switch back to the VFD digital input for drive output protection.

.3 Non-motor equipment:

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

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

.2 Locate disconnect switch immediately adjacent to equipment served.

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

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

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

**3.8 Outlet Boxes**

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

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

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

**3.9 Service Lights, Switches and Receptacle**

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

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

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

.1

**3.10 Seismic Restraint**

.1 Provide seismic restraints for electrical conduit in accordance with specification section 20 05 49.

**3.11 Coordination and Division of Responsibility – Division 20 and Division 26**

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

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

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

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

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

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

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

| **Reference** | **Work Element** | **Div. 20** | **Div. 26** |
|---|---|---|---|
| All | Motor Control Centers, motor controller racks, motor controllers, VFDs, and disconnect switches | ● | |
| Dedicated Power Panels for Mechanical Equipment (Note 1) | Mechanical Power Panels (MPP) and Mechanical Breaker Panels (MBP), including branch overcurrent protection devices. | | ● |
| | Power wiring from MPPs and/or MCCs to:<br>- motors, including between motors and motor controllers, VFDs and/or disconnect switches as applicable,<br>- packaged equipment, including disconnect switches as applicable,<br>- equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc) | ● | |
| | Power wiring from BP and/or MBP to:<br>- motors, including between motors and motor controllers,<br>- packaged equipment, including disconnect switches as applicable,<br>- equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc) | ● | |
| Non-dedicated Power Panels (Note 2) | Non-dedicated Power Panels (PP) and breaker panels (BP), including branch overcurrent protection devices. | | ● |
| | Distribution splitters | | ● |
| | Power wiring from PPs and/or distribution splitters to:<br>- motor controller,<br>- disconnect switch ahead of VFD,<br>- disconnect switch for package equipment,<br>- packaged equipment (with integral disconnect switch)<br>- equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc) | | ● |
| | Power wiring from BP to:<br>- motor controller or disconnect switch,<br>- disconnect switch for package equipment,<br>- packaged equipment (with integral disconnect switch),<br>- equipment not requiring motor controllers or disconnect switches (control panels, heat tracing, etc) | | ● |
| | Power wiring from:<br>- disconnect switch to a VFD,<br>- motor controller or VFD to the motor,<br>- disconnect switch to packaged equipment | ● | |
| Terminal Unit Boxes | Control power of 120 V, single phase terminating adjacent to designated building automation control panels. | | ● |

| Reference | Work Element | Div. 20 | Div. 26 |
|---|---|---|---|
| | Control power of 120 V, single phase terminating in a junction box for each group of terminal boxes with maximum of 12 terminal unit boxes fed from one junction box [Note 3]. | | ● |
| | Control power at 24 VAC/DC, from building automation control panels to terminal unit box controller [Note 3]. | ● | |
| | Control power of 120 VAC power wiring to each terminal unit box controller (from junction box provided by Division 26 for each group of controllers [Note 3]. | ● | |
| | 3 phase, 208 V and higher voltage wiring direct to terminal unit box. | | ● |
| | Power wiring for controls in service rooms: fed from dedicated power panels to the BAS and OEM control equipment. | ● | |
| | Power wiring for controls other than in service rooms: fed from dedicated power panels and/or allocated breakers | ● | |
| | 120 V, single phase power supply with a junction box at specific control devices as shown. | | ● |
| | Breaker tamper-protection locks. | ● | |
| | Instrumentation and actuator power and control wiring, for both BAS controls and OEM controls. | ● | |
| | Control wiring to interlock motor controllers and to connect safety and operating controls. | ● | |
| Plumbing Fixtures | 120 V, single phase power supply with a junction box or pull box at plumbing fixtures requiring control power | | ● |
| | Wiring from adjacent junction box or pull box to plumbing fixtures requiring control power | ● | |
| | Control transformers and extra-low voltage wiring | ● | |
| Equipment Service Lights | 120 VAC, 15A power circuits for equipment service lights, terminated in an outlet box on an adjacent wall, column or ceiling. | | ● |
| | Power wiring from adjacent junction boxes to light switches/service convenience outlets and fixtures | ● | |
| | Equipment service lights, switches and convenience outlets. | ● | |

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

### 3.12 Wiring Diagrams

.1 Wiring diagrams following at end of this section:

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

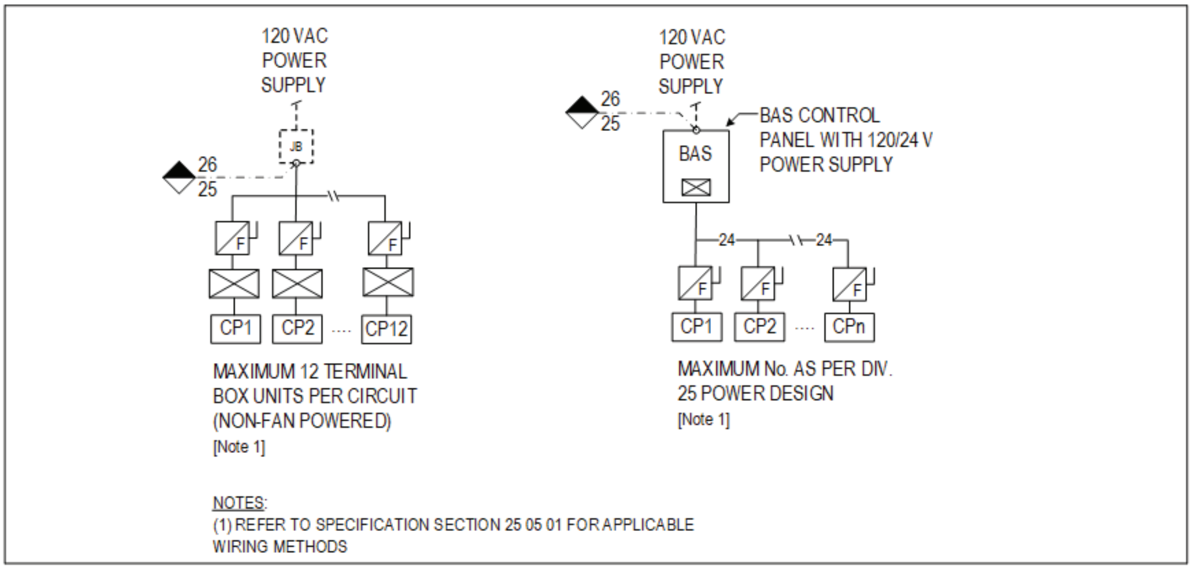
.2 20 05 12 - 02 Mechanical – Electrical Coordination (Sheet 2 of 2)

.3 20 05 12 - 03 Variable Frequency Drives Single Line Schematic

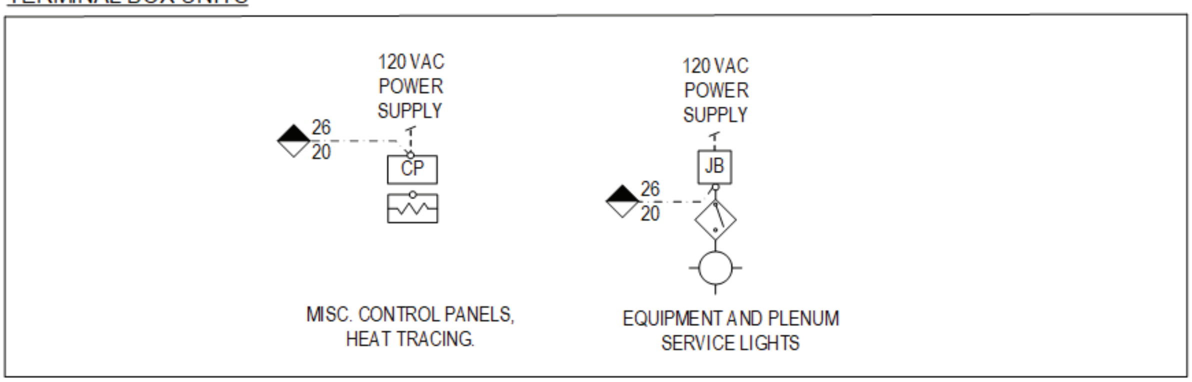
.4 20 05 12 - 04 Rooftop Custom A.H.U. – Maintenance Receptacles

.5 20 05 12 - 05 Rooftop HVAC Equipment – Maintenance Receptacles

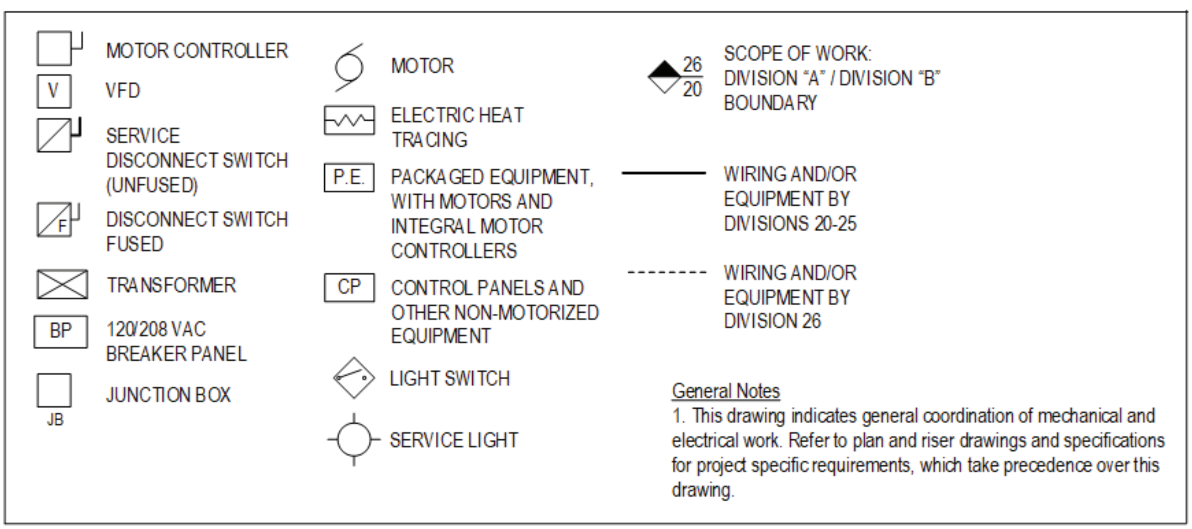
**END OF SECTION**




TERMINAL BOX UNITS

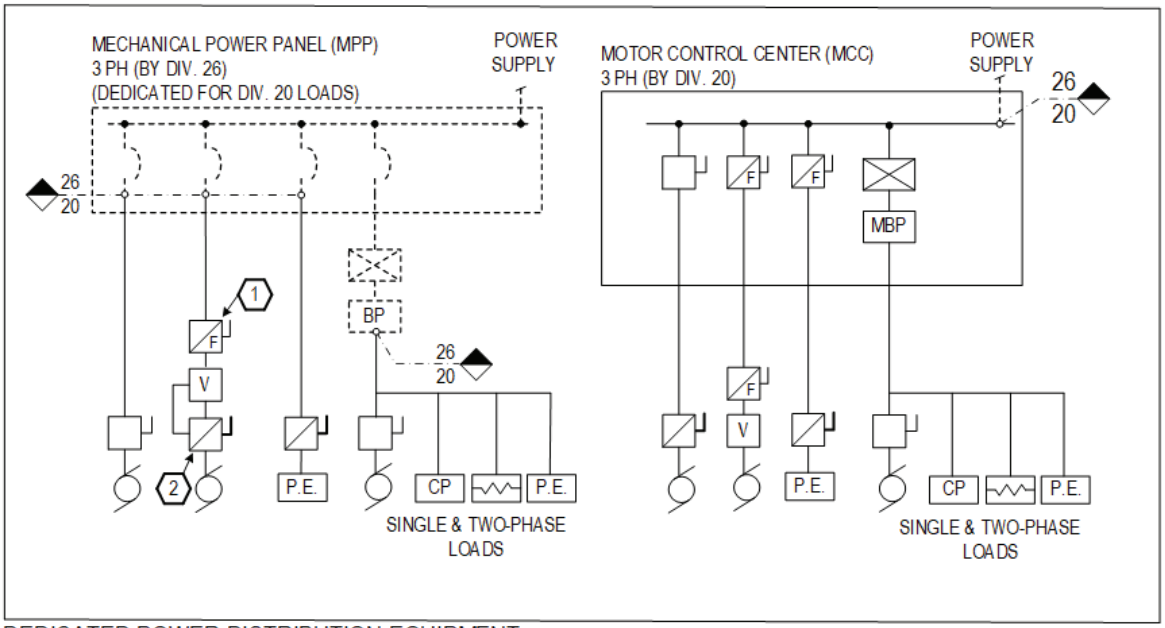



MISCELLENOUS NON-MOTORIZED EQUIPMENT

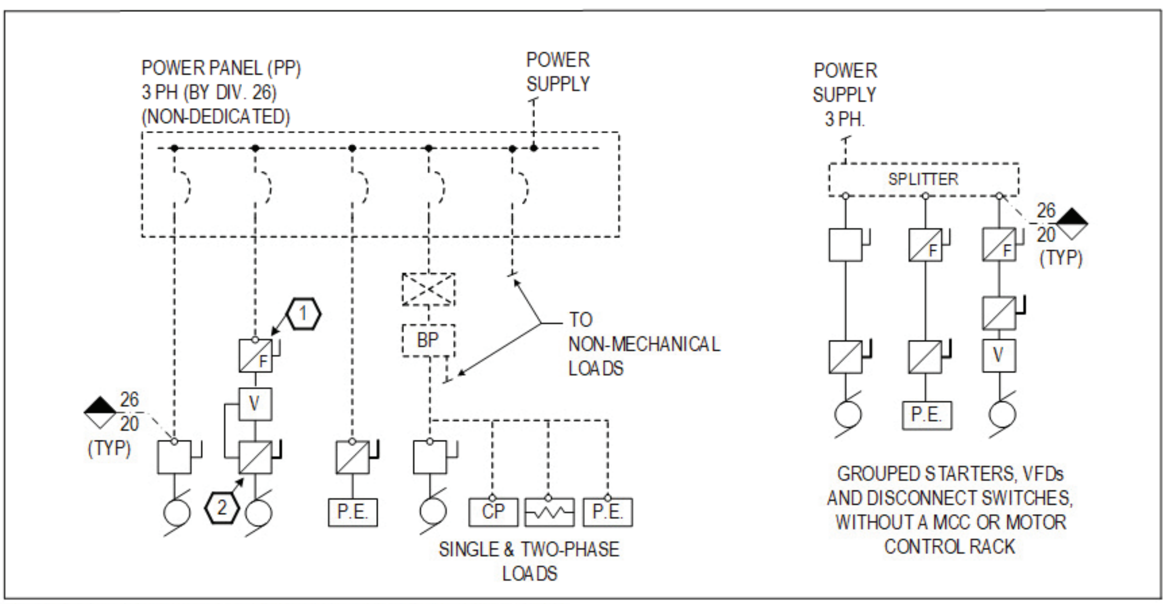



LEGEND

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




DEDICATED POWER DISTRIBUTION EQUIPMENT




NON-DEDCATED POWER DISTRIBUTED EQUIPMENT

KEY NOTES:

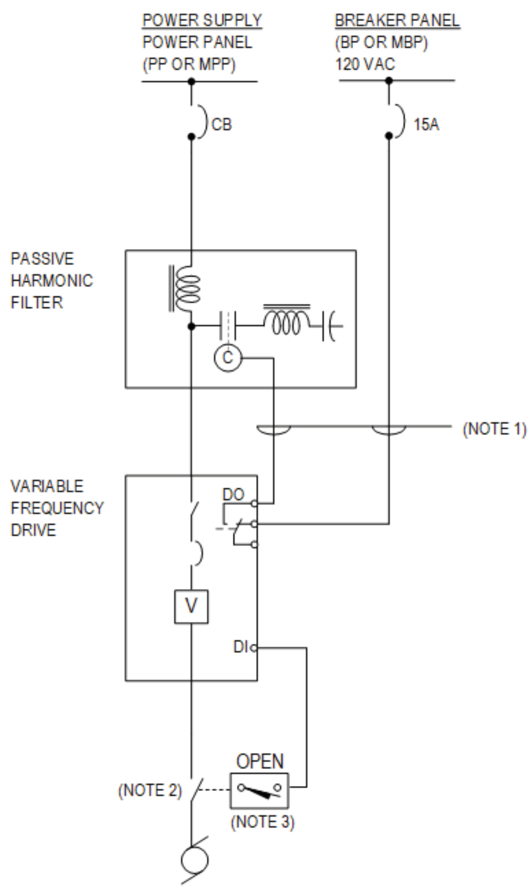
1. SEPARATE FUSED DISCONNECT WHEN NOT PROVIDED INTEGRAL TO THE V.F.D. (TYP)
2. SEPARATE UNFUSED DISCONNECT WHERE V.F.D. IS REMOTE FROM THE MOTOR. PROVIDE DISCONNECT SWITCH POSITION INTERLOCK WIRED BACK TO THE V.F.D. (TYP)

General Notes

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

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

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

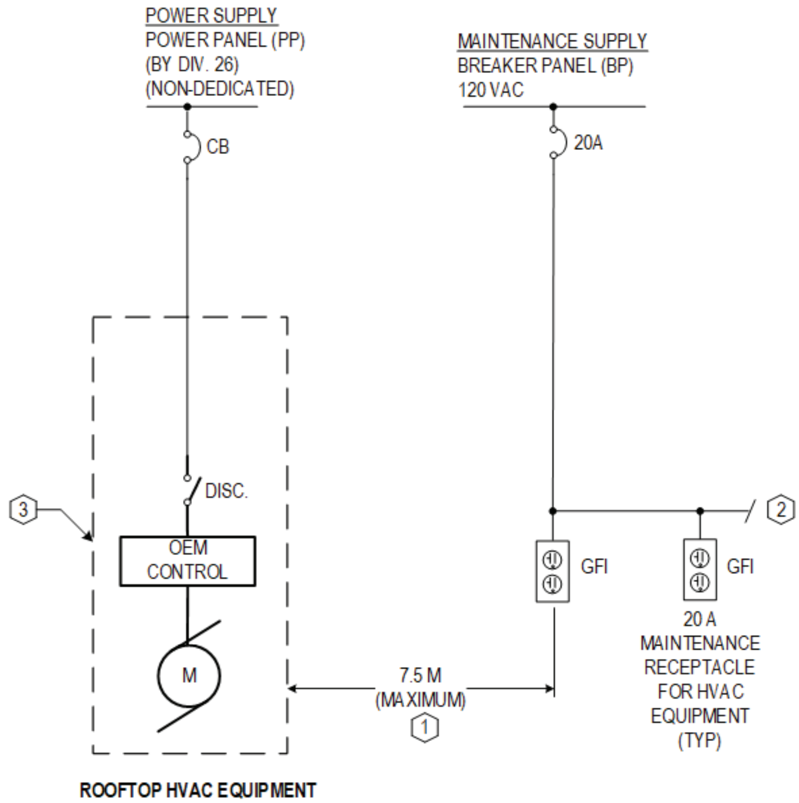



NOTES:

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

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

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



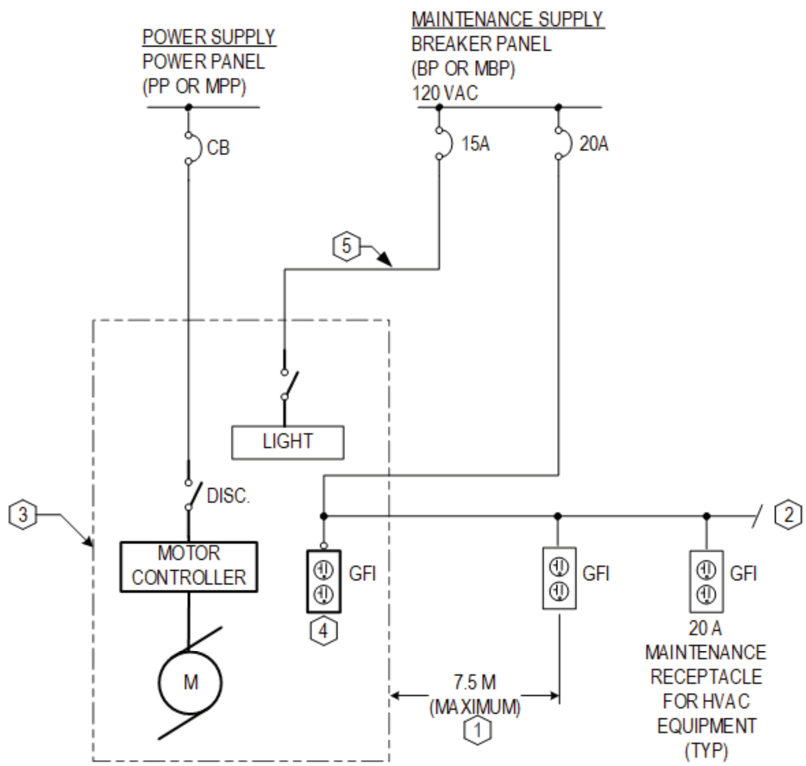

KEY NOTES:

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

General Notes

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

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




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

KEY NOTES:

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

General Notes

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

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

# GENERAL REQUIREMENTS FOR VALVES
# 20 05 23

## 1 GENERAL

### 1.1 Scope

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

.2 This specification section provides general requirements for valves.

### 1.2 Related Sections

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

22 05 23.13 General-Duty Valves for Plumbing Piping

23 05 23.13 General-Duty Valves for HVAC Water Piping

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

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

### 1.3 Submittals

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

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

.1 applicable standard by name and reference number,

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

.3 the testing organization file reference number.

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

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

### 1.4 Applicable codes and standards

.1 Legislation:

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

.2 Installation standards, codes and guidelines:

.1 CSA B51 Boiler and Pressure Vessel Code.

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

.3 Product standards:

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

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

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

### 1.5 Quality and Equivalence

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

## 2 PRODUCTS

### 2.1 General

.1 Refer to related specification sections.

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

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

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

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

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

# 3 EXECUTION

## 3.1 Valve Selection Criteria

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

**Table 2: Valve Function Selection**

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

***Notes:***

[1] Gear operator with position limit memory stops.

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

## 3.2 Piping System Drain Valves

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

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

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

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

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

.3 On pipe ains NPS 8 and larger:

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

## 3.3 Valve Installation - General

.1 Install shut off valves at:

  .1 branch take-offs,

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

  .3 in locations shown.

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

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

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

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

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

## 3.4 Valve Orientation and Accessibility

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

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

.3 In horizontal piping (see figure 1);

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

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

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

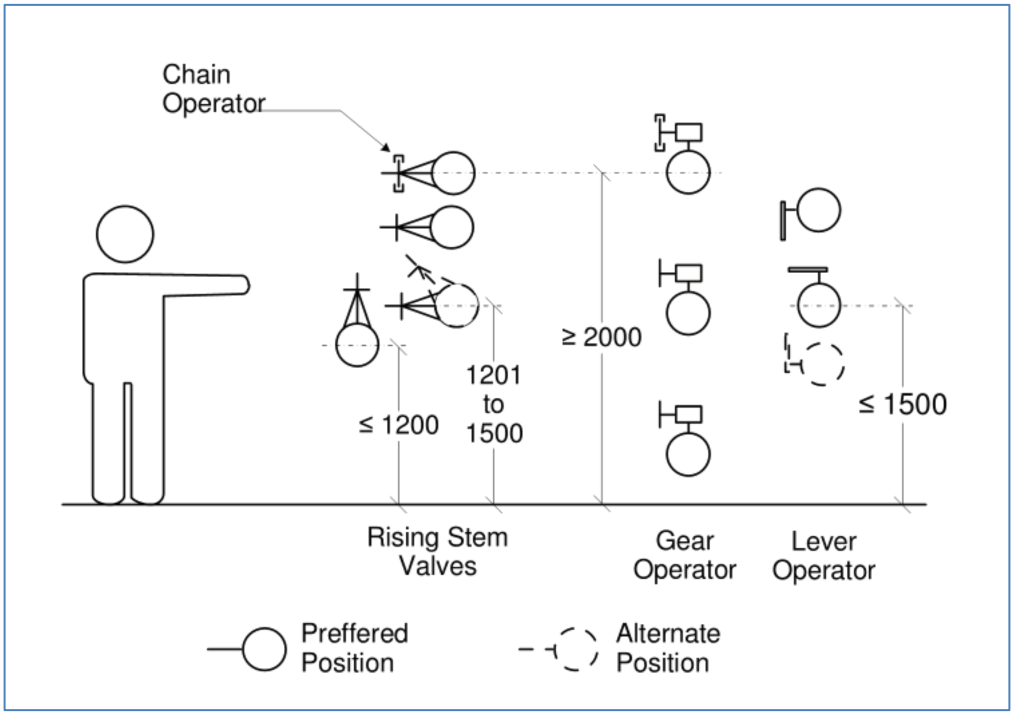



*Figure 1: Valve Spindle Arrangement*

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

### 3.5 Double Regulating Valves Installation

.1 Consult with double regulating valve manufacturer to ensure correct valve selection. Balancing valves to be sized according to design flow

.2 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 | **Nominal Flow** | | | |
| **Size (in)** | **Min. (l/s)** | **Max. (l/s)** | **Min. (gpm)** | **Max. (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 |

.3 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.

.4 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.

**END OF SECTION**

# WELDING AND BRAZING
# 20 05 24

## 1 GENERAL

### 1.1 Scope

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

### 1.2 Definitions

.1 The following definitions apply to this specification section:

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

.2 In this specification,

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

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

### 1.3 Applicable Standards

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

## 2 PRODUCTS

### 2.1 Not used

## 3 EXECUTION

### 3.1 Welding and Brazing Qualification and Welding Procedures

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

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

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

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

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

**3.2 Weld Quality**

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

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

**3.3 Welded Connections to Existing Pressure Piping Systems**

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

.1 acceptable dimensional misalignment between old and new pipe;

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

.3 sample guided bent test; and

.4 sample fillet weld test.

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

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

**3.4 Welding Examination**

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

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

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

**3.5 Welding Inspection**

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

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

**END OF SECTION**

# COMMON HANGER AND SUPPORT REQUIREMENTS FOR PIPING 20 05 29

## 1 GENERAL

### 1.1 Scope

.1 Provide hangers and supports for piping.

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

- .1 21 05 01 for fire protection piping,
- .2 Division 22 sections for plumbing and drainage piping,

### 1.2 Related Work

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

- .1 20 05 48 Vibration Isolation
- .2 20 07 19 Piping Insulation
- .3 20 05 49 Seismic Restraint

.2 The following definitions apply to this section.

- .1 ***Cold piping***: piping with a service temperature at or below 16°C (61°F).
- .2 ***Ambient piping***: piping with a service temperature greater than 16°C (61°F) and up to 40°C (104°F).
- .3 ***Hot piping***: piping with a service temperature greater than 40°C (104°F).
- .4 ***Service temperature***: the fluid maximum operating temperature.

### 1.3 Applicable Codes and Standards

.1 Product and installation codes and standards:

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

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

### 1.4 Design Criteria

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

- .1 the total load on the support rods or similar elements shall not exceed 75% of its published tension load rating data,
- .2 a trapeze hanger deflection shall not exceed 1/240$^{th}$ of the support span, and not exceed 60% of the trapeze material yield strength, under all static and dynamic loads.

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

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

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

.2 horizontal piping is supported on;

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

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

.1 custom engineered systems are restricted to:

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

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

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

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

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

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

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

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

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

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

## 1.5 Submittals

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

.1 load ratings,

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

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

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

.4 Submit engineered design drawings for custom supports:

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

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

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

## 1.6 Quality Control

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

# 2 PRODUCTS

## 2.1 General

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

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

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

.1 outdoors: hot dipped galvanized,

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

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

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

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

*Standard of Acceptance*

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

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

## 2.2 Upper Attachments – Concrete Inserts

.1 For new cast-in-place concrete.

.2 Concrete inserts –wedge type;

.1 single hanger support,

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

.3 listed to ULC/ORD-C203 or UL 203 for fire protection piping, for pipe NPS ¾ through NPS 8.

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

(a) single rod support, for pipes NPS 6 and smaller,
(b) double rod support, for pipes NPS 10 and smaller,

*Standard of Acceptance*
° Anvil - fig. 281
° Unistrut - fig. P-3245

.3 Concrete inserts – tapped coil type;

.1 single hanger support,

.2 plated carbon steel insert, tapped coil design, with flat washer base and closed ferrule,

.3 constructed to receive tapped bolts or rods, or with manufacturer lag bolts.

.4 maximum tension load rating: 15.0 kN (3375 lbs) within 125 mm (5 in.) of nearest concrete edge.

(a) single rod support, for pipes NPS 8 and smaller,
(b) double rod support, for pipes NPS 12 and smaller.

*Standard of Acceptance*
° Acrow Richmond – fig. LF-W

.4 Concrete inserts –iron cross type;

.1 single hanger support,

.2 stainless steel body with two 300 mm (12 in.) long fiberglass reinforcing rods in a cross-pattern, to MSS SP-58 type 18,

.3 body reinforcing rods tied to concrete rebar,

.4 maximum tension load rating: 26.2 kN (5,900 lbs) based on rod size,

(a) single rod support, for pipes NPS 14 and smaller,
(b) double rod support, for pipes NPS 24 and smaller,

*Standard of Acceptance*
° Anvil - fig. 286
° Unistrut - fig. P-3246

.5 Concrete inserts – channel type;

.1 single hanger or multiple hangers support,

.2 12 Ga 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:

| | |
|---|---|
| (a) 200 mm (8 in) channel: | 4.4 kN (1000 lbs) |
| (b) 300 mm (12 in) channel: | 6.6 kN (1500 lbs) |
| (c) 450 mm (16 in) and longer channels: | 28.8 kN/m (2000 lbs/ft), but not less than 17.8 kN (4000 lbs), |

*Standard of Acceptance*
- Unistrut - fig. P-3249 to P-3270 series.

## 2.3 Upper Attachments – Existing Concrete

.1 Surface mount on existing concrete:

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

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

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

.2 Piping or equipment supported from existing concrete construction:

.1 threaded inserts for drilled holes.

*Standard of Acceptance*
- Hilti - fig. HDI, Kwick Bolt, HSL

## 2.4 Upper Attachments – Steel Structure

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

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

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

*Standard of Acceptance*
- Anvil - fig. 218
- Myatt - fig. 500

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

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

.2 with weldless eye nut when used with clevis supports.
- Anvil - fig. 228 or 292
- Myatt - fig. 510 X-HEAVY, or 511 X-HEAVY.

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

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

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

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

*Standard of Acceptance*
- Anvil - fig. 60
- Myatt - fig. 545

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

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

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

*Standard of Acceptance*

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

## 2.5 Upper Attachments – Wall Brackets

.1 Medium and heavy-duty wall mounting brackets:

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

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

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

*Standard of Acceptance*
- Anvil - fig. 195 and 199
- Myatt - fig. 321 and 322

.2 Light-duty wall mounting brackets:

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

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

.3 FM approved,

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

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

## 2.6 Upper Attachment - Swivels

.1 Clevis swivel:

.1 to allow rotation movement of suspended clevis hangers,

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

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

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

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

.2 Weldless eye nut swivel:

.1 to allow rotation movement of suspended clevis hangers,

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

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

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

*Standard of Acceptance*

- Anvil - fig. 290
- Myatt - fig. 480

### 2.7 Hanger Rod

.1 Continuous threaded rod:

.1 carbon steel, USS national course thread,

.2 tension load ratings to MSS SP-58,

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

.2 Welded eye rod:

.1 carbon steel, USS national course thread,

.2 tension load ratings to MSS SP-58,

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

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

### 2.8 Horizontal Pipe Support – Pipe Roller

.1 Suspended support - adjustable:

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

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

.2 Bottom support - adjustable:

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

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

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

.3 Bottom support – pipe roll stand:

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

.2 fixed base and adjustable base.

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

### 2.9 Horizontal Pipe Support – Clevis

.1 Clevis support:

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

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

.3 sized for outside dimension of pipe and insulation,

.4 nominal pipe size:

(a) steel pipe: NPS ½ to NPS 30
(b) ductile or cast iron pipe: NPS 3 to 24

*Standard of Acceptance*
- Anvil - fig. 260
- Anvil - fig. 590 (for ductile or cast iron pipe)
- Myatt - fig. 124
- Myatt - fig. 126 (for ductile or cast iron pipe)

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

.1 carbon steel, adjustable clevis to MSS SP-58, type 1, ULC listed, with yoke bolt reinforcing tube,

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

.3 sized for outside dimension of pipe and insulation,

.4 nominal pipe size: NPS ¾ to NPS 6,

.5 piping system design temperature limits: 4.4 to 93°C (40 to 200°F).

*Standard of Acceptance*
- Anvil - fig. 260 ISS

.3 Clevis support for copper pipe and tube:

.1 carbon steel yoke and clevis, adjustable clevis to MSS SP-58, type 1, copper plated finish,

.2 nominal pipe size: NPS ½ to NPS 4,

.3 sized for outside dimension of pipe/tube, or outside diameter of pipe and insulation as applicable.

*Standard of Acceptance*
- Anvil - fig. CT-65
- Myatt - fig. 151 CT

.4 Light-duty, side-opening clevis support:

.1 for fire protection service only,

.2 galvanized carbon steel, adjustable clevis with fixed yoke,

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

.4 sized for outside dimension of pipe (and insulation if applicable).

.5 sized for outside dimension of pipe (and insulation where applicable),

.6 nominal pipe size: NPS 2 to NPS 8.

*Standard of Acceptance*
- Hilti - fig. MH-SLC Speed Lock]

## 2.10 Horizontal Pipe Support – Slides

.1 Sliding pipe base supports – welded attachment:

.1 Tee or H shaped pipe support for welding to pipe, to allow axial and lateral movements,

.2 carbon steel, structural shape or fabricated, to ANSI/MSS SP-58 Type 35,

.3 PTFE bonded to underside of slide,

.4 matching lower steel plate with bonded PTFE element (for fastening to structural support beam),

.5 operating temperature range: -28 to 200°C (-20 to 400°F),

.6 pipe guide variants:

(a) lug restraints to limit lateral movement to 1.6 mm (1/6 in) or 25 mm (1 in),
(b) lug restraints to limit uplift movement to 1.6 mm (1/6 in),

.7 nominal pipe size: NPS ½ to NPS 30.

*Standard of Acceptance*
- Anvil - figs. 257, 436, 439
- Myatt - figs. 705, 706

**2.11 Horizontal Pipe Support – Swivel Ring Hanger**

.1 For non-insulated stationary piping and tubing only.

.2 Pipe swivel ring hangers:

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

.2 copper plated or epoxy-coated for use on copper tubing,

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

.4 nominal pipe size: NPS ½ to NPS 4.

*Standard of Acceptance*
- Anvil - fig. 69, CT-69
- Myatt - fig. 41, 42, 43

**2.12 Horizontal Pipe Support – Trapeze**

.1 Manufactured trapeze support:

.1 load ratings as per manufacturers data sheets,

.2 carbon steel, double-C channel (strong-backs), HSS shape and equal-leg angles.

*Standard of Acceptance*
- Anvil - fig. 45, 46, and 50
- Myatt - fig. 173, 600, and 650

.2 Fabricated trapeze support:

.1 designed and sealed by a professional engineer licensed in the jurisdiction of the work.

.2 performance:

(a) maximum deflection between supports: 1/250 (0.4%) of span
(b) minimum factor of safety: five (5) times load to ultimate tensile or compressive strength, but not to exceed 60% of yield strength.

.3 carbon steel shapes, to suit load application,

(a) hollow steel section,
(b) equal leg El section, or
(c) double C channel “strong-back”, with welded clips.

.3 Hanger rods:

.1 minimum of two support rods per trapeze,

.2 rods selected for minimum factor of safety of 4 times load for tensile or compressive strength of the rod.

.4 Pipe restraint:

.1 restrain pipes from lateral movement with:

(a) bolt-on angle brackets or pipe U-bolts for manufactured hangers,
(b) welded-on angles for fabricated hangers,

.2 restraints to permit axial linear movement and axial-rotation, except where otherwise shown to be a guide or an anchor.

## 2.13 Horizontal Pipe Support – Drainage MJ

.1 For horizontal cast iron drainage piping, as an alternative to clevis hangers.

.1 carbon steel, plain finish,

.2 pipe size: NPS 2 to NPS 6

*Standard of Acceptance*
- Anvil - fig. 250

## 2.14 Vertical Pipe Riser Clamps

.1 Steel pipe, cast iron pipe:

.1 carbon steel clamps for carbon steel piping and cast iron piping,

.2 stainless steel clamps for stainless steel piping,

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

.4 supplied with field-welded pipe support lugs of same material as supported steel pipe (not including cast iron pipe).

.5 floor supported pipe riser clamps, to ANSI/MSS SP-58, type 8,

*Standard of Acceptance*
- Anvil - fig. 261
- Myatt - fig. 182 or 183

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

*Standard of Acceptance*
- Anvil - fig. 40, 40SS
- Myatt - fig. 190 or 191

.2 Copper pipe and tube:

.1 floor supported pipe riser clamps, carbon steel with copper plated finish, to ANSI/MSS SP-58, type 8,

*Standard of Acceptance*
- Anvil - fig. CT-121
- Myatt - fig. 150CT

**2.15 Vibration Isolation Supports**

.1 Provided under specification section 20 05 48.

***SPEC NOTE: The following variable spring load supports are used to handle changing loads due to vertical movement of piping due to thermal expansion/contraction. They are not intended to perform a function of vibration isolation.***

***These spring supports are designed to limit the variation in supported load not to exceed 25% of the operating supported load. This change in load will cause pipe loads to shift to adjacent hangers. Used mostly for horizontal piping in mechanical rooms, but may also be used to support the top of risers within these load variation limits.***

***If these supports are required, they must be shown on the riser diagrams, and include the estimated support load and amount of pipe displacement.***

**2.1 Variable Spring Load Supports**

.1 General:

.1 variable spring load supports to maintain supported load under pipe thermal movement conditions, so that the variation in supported load does not exceed 25% of the operating load.

.2 selected for piping loads and estimated travel under service conditions.

.2 Construction:

.1 carbon steel housing and spring, to MSS SP-58 types 51, 52 and 53.

.2 pre-compressed spring,

.3 load indicator,

.4 welding to ASME Section IX

.5 welded attachment points

.6 finish: semi-gloss primer coat.

*Standard of Acceptance*
° Anvil – fig 82, 268, 98
° Myatt - fig. Rigid-Spring

**2.2 Cast Iron Pipe Joint Restraint**

.1 Joint restraint rodding assembly for cast iron and asbestos cement drain waste and vent pipe, for each branch, tee, wye and clean-out fittings on drainage piping NPS 5 and over.

.2 Clamp and rod joint restraint:

.1 carbon steel pipe clamps with four bolt fasteners and rod washers, plain finish, to MSS SP-58, Type 8,

.2 carbon steel threaded rods and load nuts,

.3 two pipe clamps and two restraint rods required for each joint.

*Standard of Acceptance*
° Myatt - fig. 595 with 594 and 146.

**2.3 Saddles and Shields at Pipe Supports**

.1 Insulation shields:

.1 galvanized steel protection shield, thickness and length as applicable to pipe size, to MSS SP-58 type 40.

*Standard of Acceptance*
- Anvil - fig. 167 (up to NPS 24)
- Anvil - fig. 168 - Riblok (up to NPS 8)
- Myatt - fig. 251

.2 Pipe saddles:

.1 Carbon steel or stainless steel (to match pipe material) saddle welded to pipe with insulation inserted between saddle and pipe, to MSS SP-58 type 39.

*Standard of Acceptance*
- Anvil - fig. 160 to 166
- Myatt - fig. 210 to 240

# 3 EXECUTION

## 3.1 General

.1 Where the specific requirements for pipe supports are specified in other sections of Division 20 to 25, the requirements of those sections take precedence over the requirements of this specification section. Refer

## 3.2 Coordination with Concrete Work

.1 Supply and deliver concrete inserts to site in ample time to be built into the work of Division 03.

.2 Correctly position and set concrete inserts onto concrete formwork for pipes and equipment hangers. Secure inserts firmly to formwork before concrete is poured.

.3 Do not use explosive drive pins in any section of the Work without obtaining prior approval from the Consultant.

## 3.3 Horizontal Pipe Support Spacing and Hanger Rod Size

.1 Provide horizontal pipe supports at the spacing and hanger rod size as detailed in the following tables, unless specified otherwise in other sections of Division 20 to 25:

.1 carbon steel, galvanized steel, and stainless steel pipe; standard weight, schedule 40 and schedule 80: to Table 1A.

.2 stainless steel pipe, schedule 10S: to Table 1B

.3 copper tube, stainless steel tube: to Table 1C.

| Table 1A: Horizontal Pipe Support Spacing for Carbon Steel, Galvanized Steel, Stainless Steel Piping Standard Weight, Schedule 40 and 80 | | | |
|---|---|---|---|
| Pipe Size NPS | Rod Diameter | Maximum Spacing, Liquids m, (ft) | Maximum Spacing Steam, Gases [Note 1] m (ft) |
| ½ | M10 (3/8 in) | 1.8 (6) | 1.8 (6) |
| 3/4 to 1¼ | M10 (3/8 in) | 2.1 (7) | 2.1 (7) |
| 1½ | M10 (3/8 in) | 2.7 (9) | 2.7 (9) |
| 2 | M10 (3/8 in) | 3.0 (10) | 4.0 (13) |
| 2½ | M12 (½ in) | 3.3 (11) | 4.3 (14) |
| 3 | M12 (½ in) | 3.3 (12) | 4.6 (15) |
| 4 | M16 (5/8 in) | 4.2 (14) | 5.2 (17) |
| 6 | M20 (3/4 in) | 5.1 (17) | 6.4 (21) |
| 8 | M20 (3/4 in) | 5.7 (19) | 7.3 (24) |
| 10 | M20 (7/8 in) | 6.7 (22) | 7.9 (26) |
| 12 | M20 (7/8 in) | 7.0 (23) | 9.1 (30) |
| 14 | M24 (1 in) | 7.5 (25) | 9.8 (32) |
| 16 | M24 (1 in) | 8.0 (27) | 10.7 (35) |
| 18 | M24 (1 in) | 8.4 (28) | 11.3 (37) |
| 20 | M30 (1-1/4 in) | 9.0 (30) | 11.9 (39.0) |
| 24 | M36 (1-1/2 in) | 9.6 (32) | 12.8 (42.0) |

**Notes:**
*[1] Where piping is hydrostatically tested with water, temporary pipe supports are required to limit pipe span to the “liquids” values.*

| Table 1B: Horizontal Pipe Support Spacing for Schedule 10S Stainless Steel Pipe | | |
|---|---|---|
| Pipe Size NPS | Rod Diameter | Maximum Spacing |
| ½ | M10 (3/8 in) | 2.1 m (6.7 ft) |
| ¾ | M10 (3/8 in) | 2.4 m (7.7 ft) |
| 1 | M10 (3/8 in) | 2.8 (9.0) |
| 1-1/4 | M10 (3/8 in) | 3.2 (10.3) |
| 1½ | M10 (3/8 in) | 3.2 (10.3) |
| 2 | M10 (3/8 in) | 3.6 (11.6) |
| 2½ | M10 (3/8 in) | 4 (12.8) |
| 3 | M10 (3/8 in) | 4.3 (13.8) |
| 4 | M12 (1/2 in) | 4.7 (15.1) |
| 6 | M12 (1/2 in) | 5.4 (17.3) |
| 8 | M16 (5/8) | 5.9 (18.9) |
| 10 | M16 (5/8) | 6.5 (20.9) |
| 12 | M16 (5/8) | 7 (22.5) |
| 14 | M20 (3/4) | 7.0 (22.5) |
| 16 | M20 (3/4) | 7.3 (23.4) |
| 18 | M20 (3/4) | 7.5 (24.1) |
| 20 | M24 (1) | 8.0 (25.7) |
| 24 | M24 (1) | 8.6 (27.6) |

| Table 1C: Horizonal Pipe Support Spacing for Copper Tube, and Stainless Steel Tube | | |
|---|---|---|
| Pipe Size NPS | Rod Diameter | Maximum Spacing |
| ½ | M10 (3/8 in) | 1.5 m (5 ft) |
| 3/4 to 1¼ | M10 (3/8 in) | 1.8 m (6 ft) |
| 1½ | M10 (3/8 in) | 2.4 m (8 ft) |
| 2 | M10 (3/8 in) | 2.4 m (8 ft) |
| 2½ | M12 (½ in) | 3.0 m (10 ft) |
| 3 | M12 (½ in) | 3.0 m (10 ft) |
| 4 | M16 (5/8 in) | 3.0 m (10 ft) |

.2 Hanger spacing and hanger rod diameter for steel pipe or copper tube with flexible roll groove joints;

.1 to be as shown in the above tables for the appropriate pipe material, with not less than one hanger between joints, and

.2 provided with anchors and guides located to maintain piping true to line and grade.

.3 Support plastic and other special piping, including anchors and guides, in accordance with the pipe manufacturer's requirements.

**3.4 Vertical Pipe Supports**

.1 Pipe riser clamps:

.1 provide pipe riser clamps 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 Support cold- and hot-piping and tubing risers at pipe anchors and provide additional supports as follows:

.1 for riser height of 25 m (82 ft) or less: provide spring vibration isolator supports attached to pipe riser clamps, at not less than every 10 m (32 ft),

.2 for riser height between 25 m (82 ft) and 50 m (165 ft): provide variable spring supports as follows;

(a) at least one per riser,
(b) for each length of pipe that is connected to an expansion joint in the riser,
(c) and as otherwise shown.

.3 for riser height greater than 50 m (164 ft): provide constant load supports as follows:

(a) at least one per riser,
(b) for each length of pipe that is connected to an expansion joint in the riser,

(c) at the top of the riser,
(d) and as otherwise shown.

### 3.5 Horizontal Pipe Hanger and Support Selection

.1 Swivel ring pipe hangers may only be used for;

.1 fire protection piping, NPS 4 and smaller,

.2 drain waste and vent (DWV) piping and tubing, NPS 4 and smaller,

.3 medical gas piping and laboratory gas piping, NPS 4 and smaller,

.4 compressed air piping and tubing located downstream of a refrigerated dryer, NPS 2 and smaller,

.5 chemical treatment piping NPS 2 and smaller

.2 For cast iron drainage and vent piping;

.1 use clevis hangers for suspended supports,

.2 drainage MJ type hangers may be used on hub-less cast iron piping,

.3 use roller or slide type supports for bottom supported piping. For slide supports, use a variant incorporating pipe band clamps in lieu of welded attachment.

.3 Do not use clevis hangers for piping subject to thermal movement, except under selected piping conditions specified herein.

.4 Select pipe support types in accordance with Table 2 based on pipe size, except where limited by Tables 3A or 3B based on pipe thermal movement.

.1 The following abbreviations apply to Table 2.

CL Clevis hanger

CL(Sa) Clevis hanger with integral polypropylene saddle

RL Roller support

SD(T) Slider, T shape

SD(H) Slider, H shape

TZ Trapeze

Table 2: Pipe Support Basic Selection, Based on Pipe Size (except cast iron drainage pipe)

| Pipe Size | Support Type | | | | | |
|---|---|---|---|---|---|---|
| | CL | CL(SaD | RL | SD(T) | SD(H) | TZ |
| ¾ - 4 | ● | ● | ● | ● | | ● |
| 6 | ● | ● | ● | ● | ● | ● |
| 8 | ● | | ● | ● | ● | ●[1] |
| 10 – 14 | ● | | | ● | ● | ●[1] |
| 16-18 | | | | ● | ● | ●[1] |
| 20 – 24 | | | | | ● | ●[1] |

**Notes:**
*[1] When used in conjunction with a slide support.*

.2 For pipe size NPS 16 to 24, a clevis hanger may be used to support a concentrated load, provided it is used only to support the concentrated load and there is a separate pipe run support within one-third of the maximum allowable span on each side of the concentrated load.

.5 The support types of Table 2 are limited based on the expected thermal movement of piping as follows:

.1 where the length of the hanger rod is 300 mm (12 in.) or less measured between the upper attachment and the rod attachment point to the pipe support element, the selection of pipe support type is limited as follows:

(a) for hot piping, do not use clevis hangers,
(b) for cold piping, clevis hangers may be used for pipes NPS 4 and smaller.

.2 for cold piping and hot piping where the length of the hanger rod is greater than 300 mm (12 in.) measured between the upper attachment and the rod attachment point to the pipe support element, the selection of support types is limited to the following:

(a) carbon steel and galvanized steel pipe: to Table 3A.
(b) copper tube, and stainless steel pipe and tube: to Table 3B.
(c) select support type based on piping system maximum operating temperature and spacing between adjacent pipe anchors on each system. For intermediate values, use the next higher criteria; do not interpolate.

| Table 3A: Suspended Carbon Steel and Galvanized Steel Pipe<br>Pipe Support Selection Based on Thermal Movement<br>Support Rod Length 300 mm or Longer | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pipe System Maximum Operating Temperature | | Pipe Run Distance Between Anchors m (ft) | | | | | |
| °C | (°F) | 5 (15) | 10 (33) | 15 (49) | 20 (65) | 25 (82) | 30 (100) |
| 10 | (50) | | | | | | |
| 20 | (68) | | | | | | |
| 30 | (86) | | | | | | |
| 40 | (104) | | | Clevis, | | | |
| 50 | (122) | | | Trapeze, | | | |
| 60 | (140) | | | Roller, or | | | |
| 70 | (158) | | | Slide | | | |
| 80 | (176) | | | | | | |
| 90 | (194) | | | | | | |
| 100 | (212) | | | | | | |
| 120 | (250) | | | | | | |
| 150 | (302) | | | | | Roller or Slide | |
| 200 | (392) | | | | | | |

Table 3A: Suspended Carbon Steel and Galvanized Steel Pipe
Pipe Support Selection Based on Thermal Movement
Support Rod Length 300 mm or Longer

| Pipe System Maximum Operating Temperature | | Pipe Run Distance Between Anchors m (ft) | | | | | |
|---|---|---|---|---|---|---|---|
| °C | (°F) | 5 (15) | 10 (33) | 15 (49) | 20 (65) | 25 (82) | 30 (100) |
| 250 | (482) | | | | | | |

Table 3B: Suspended Copper Tube, and Stainless Steel Pipe and Tube
Pipe Support Selection based on Thermal Movement
Support Rod Length 300 mm or Longer

| Pipe System Maximum Operating Temperature | | Distance Between Anchors m (ft) | | | | | |
|---|---|---|---|---|---|---|---|
| °C | (°F) | 5 (15) | 10 (33) | 15 (49) | 20 (65) | 25 (82) | 30 (100) |
| 10 | (50) | | | | | | |
| 20 | (68) | | | | | | |
| 30 | (86) | | | | | | |
| 40 | (104) | | | Clevis, | | | |
| 50 | (122) | | | Trapeze, | | | |
| 60 | (140) | | | Roller, | | | |
| 70 | (158) | | | Slide | | | |
| 80 | (176) | | | | | | |
| 90 | (194) | | | | | | |
| 100 | (212) | | | | | | |
| 120 | (180) | | | | | | |
| 150 | (302) | | | | | Roller, | |
| 200 | (392) | | | | | Slide | |
| 250 | (482) | | | | | | |

## 3.6 Support and Hanger Installation

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

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

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

.4 Do not support piping or tubing in direct contact with hangers or supports of dissimilar metallic material.

.5 Coordinate location of pipe supports with pipe flexible connectors, pipe guides and pipe anchors provided under specification section 20 05 16.

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

- .1 fabricate supplementary steel from standard HSS sections, single EL section, double C “strongback” sections, or pipe rolls,
- .2 size supporting steel to limit span deflection to 1/250 (0.4%) between support points,
- .3 mechanically fasten supplementary steel to structural steel.

.7 Offset hangers so that rods are within 4° of vertical when in the operating position.

.8 Provide a pipe support within 300 mm (12 in.) of;

- .1 an elbow or tee,
- .2 a concentrated load, including but not limited to valves, strainers and flanges,
- .3 a connection to equipment.

.9 Where hanger rods are used, provide load nuts on top and underside of attachment to the pipe support, including clevis hangers, roll supports, roll yoke hangers, and trapeze hangers.

## 3.7 Clevis Hangers

.1 Where clevis hangers are used for cold- or hot-piping, provide hanger rods with a clevis swivel and weldless eye nut at the building attachment connection, to allow free-rotation movement of the hanger rod in the same direction as axial movement of the associated pipe.

.2 Where clevis hangers are used for stainless steel pipe or tube and for copper tube;

- .1 use copper or epoxy finished clevis hangers for copper pipe/tube,
- .2 use stainless steel or alloyed steel clevis hangers (for stainless steel pipe/tube), or
- .3 use a standard clevis hanger with integral non-metallic insulation saddles and hangers are sized for outside of the pipe and insulation.

## 3.8 Trapeze Hangers:

.1 Provide shim pipes on common trapeze hangers to slope each pipe in required direction, and mechanically fasten or tack-weld shim plates to the trapeze hanger,

.2 Provide U-bolts or fabricated angles to restrict lateral pipe movement; while allowing pipe thermal axial motion and rotation;

- .1 fasten U-bolts or angles to the trapeze hanger,
- .2 fabricated angles to extend vertically at least one-quarter the outside pipe/insulation diameter,
- .3 where seismic restraint is required, only use U-bolts.

## 3.9 Pipe Saddles and Shields

.1 Provide pipe saddles and shields for insulated piping in accordance with the following table 4

| Table 4: Insulation Hanger Protection | | | | |
|---|---|---|---|---|
| Pipe Service | Service Temperature °C (F) | Pipe Size NPS | Pipe Saddle | Insulation Shield [Note 1] |
| Hot Piping | > 93 to ≤ 205 (> 200 to ≤ 400) | ≥ 1-1/2 | Yes | --- |
| | | ≤ 1-1/4 | --- | Yes |
| | > 60 to ≤ 93 (> 140 to ≤ 200) | > 6 | Yes | --- |
| | | ≥ 1-1/2 and ≤ 6 | --- | Yes |
| | | ≤ 1-1/4 | --- | Yes |
| | > 40 to 60 (≥ 104 to ≤ 140) | ≥ 1-1/2 | --- | Yes |
| | | ≤ 1-1/4 | --- | Yes |
| Ambient Piping (Insulated) | > 16 to ≤ 40 (> 60 to ≤ 104) | All | --- | Yes |
| Cold Piping | ≤ 16 (60) | ≥ 1-1/2 | --- | Yes |
| | | ≤ 1-1/4 | --- | Yes |

**Notes:**
*[1] Refer to specification section 20 07 19 for high density insulation insert requirements.*

.2 Provide pipe shields for uninsulated glass and plastic piping NPS 1-1/2 and larger.

.3 Where piping is insulated and requires pipe shields, install the shields between pipe insulation and pipe support. Provide high-density insulation insert between pipe and insulation shields in accordance with specification section 20 07 19.

.4 Where piping is not insulated and requires a pipe shield, install the shields between the pipe and the pipe support.

.5 Where clevis hangers with integral insulation saddles are used, apply insulation sealant to the polypropylene saddle in accordance with the pipe hanger manufacturer's instructions;

.1 for hot piping, coordinate with the pipe insulation contractor to apply sealant coating to the integral saddle at the time pipe insulation is installed,

.2 for cold piping, seal the saddle's pipe contact surfaces with vapour-barrier sealant before the piping is installed. Finish sealing the remainder of the saddles' exposed faces when pipe insulation is installed.

## 3.10 Vibration Isolation Supports

.1 Provide vibration isolation for vertical pipe supports as previously specified herein. In addition, coordinate with the work under specification section 20 05 48 to provide vibration isolation pipe supports where specified in that section.

.2 When installed with clevis hangers, install the vibration isolators below and separate from the upper attachment clevis; do not use the vibration isolator for the purpose of rotation movement of the support rod.

## 3.11 Variable Load Supports

.1 Provide variable load supports for vertical pipe supports as previously specified herein. In addition, in mechanical rooms, where piping transitions from horizontal to vertical where it enters a vertical service shaft, provide a variable load support adjacent to the elbow or tee, where the expected displacement due to thermal movement is not more than 6 mm (1/4 in.).

.2 Provide vibration isolation hangers for other locations in accordance with Section 20 05 48 Vibration Isolation.

**3.12 Load Nut Retention**

.1 For steel framed buildings, industrial buildings, and areas subject to high structure born vibration, provide double-nutting on pipe and equipment hangers in addition to use of Loctite 266, as follows:

.1 Double- nut the top load nut on the building attachment point.

.2 Double- nut the lower load nut on the pipe, duct or equipment hanger.

.3 Double- nut the clevis bolt nuts.]

**3.13 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.

**3.14 Standard Details**

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

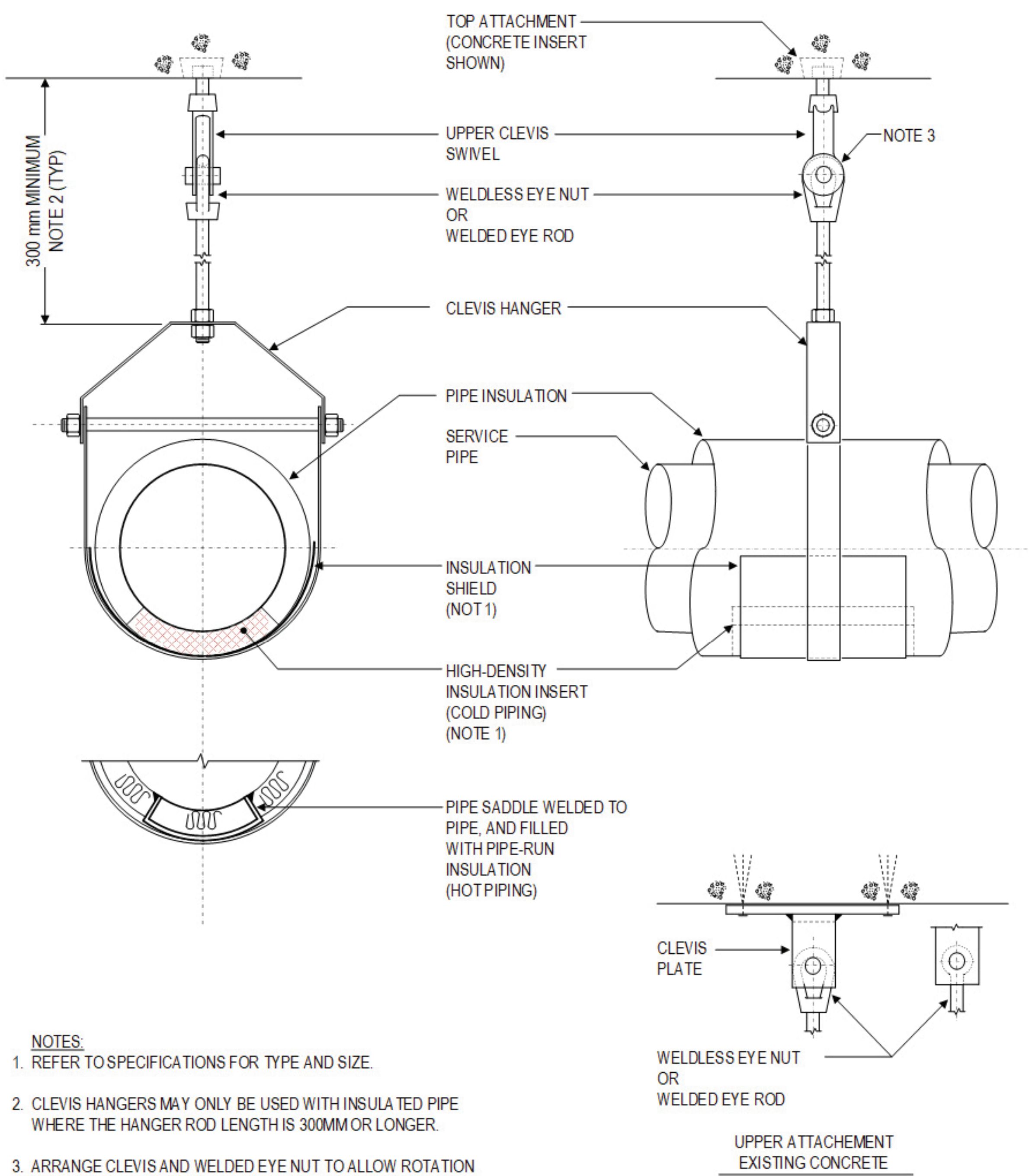
.1 20 05 29-011

.2 20 05 29-012

.3 20 05 29-013

.4 20 05 29-014

**END OF SECTION**

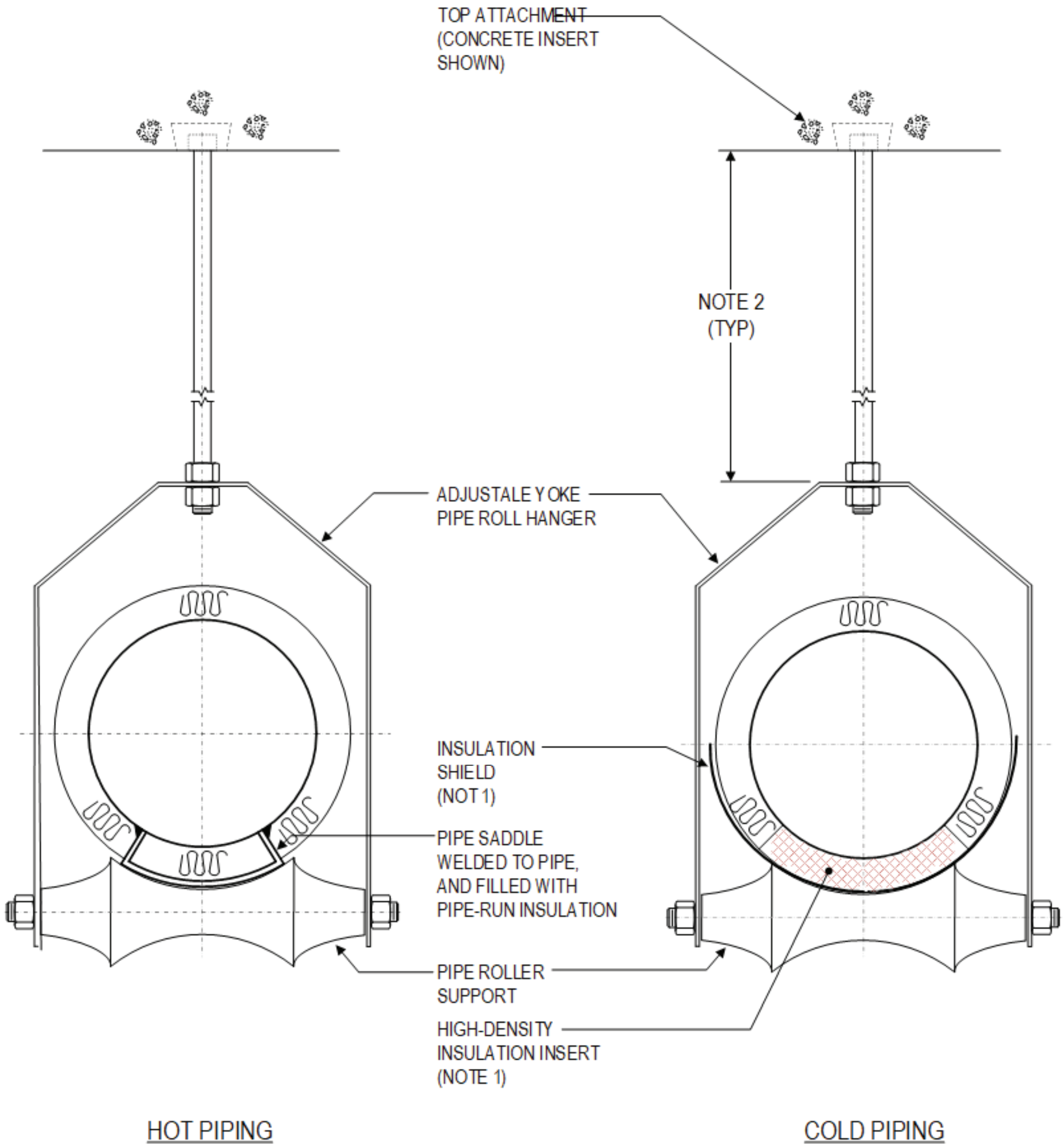



NOTES:

1. REFER TO SPECIFICATIONS FOR TYPE AND SIZE.
2. CLEVIS HANGERS MAY ONLY BE USED WITH INSULATED PIPE WHERE THE HANGER ROD LENGTH IS 300MM OR LONGER.
3. ARRANGE CLEVIS AND WELDED EYE NUT TO ALLOW ROTATION IN THE SAME AXIAL PLANE AS THE PIPE.

NOT TO SCALE

| | | | | |
|---|---|---|---|---|
| HHAngus | Sheet Title: CLEVIS PIPE HANGER TYPICAL DETAIL | Date: 17 JAN 2020 | Rev. No.: 00 | Checked: PS |
| | | Standard Detail No. 20 05 29 - 011 | | |

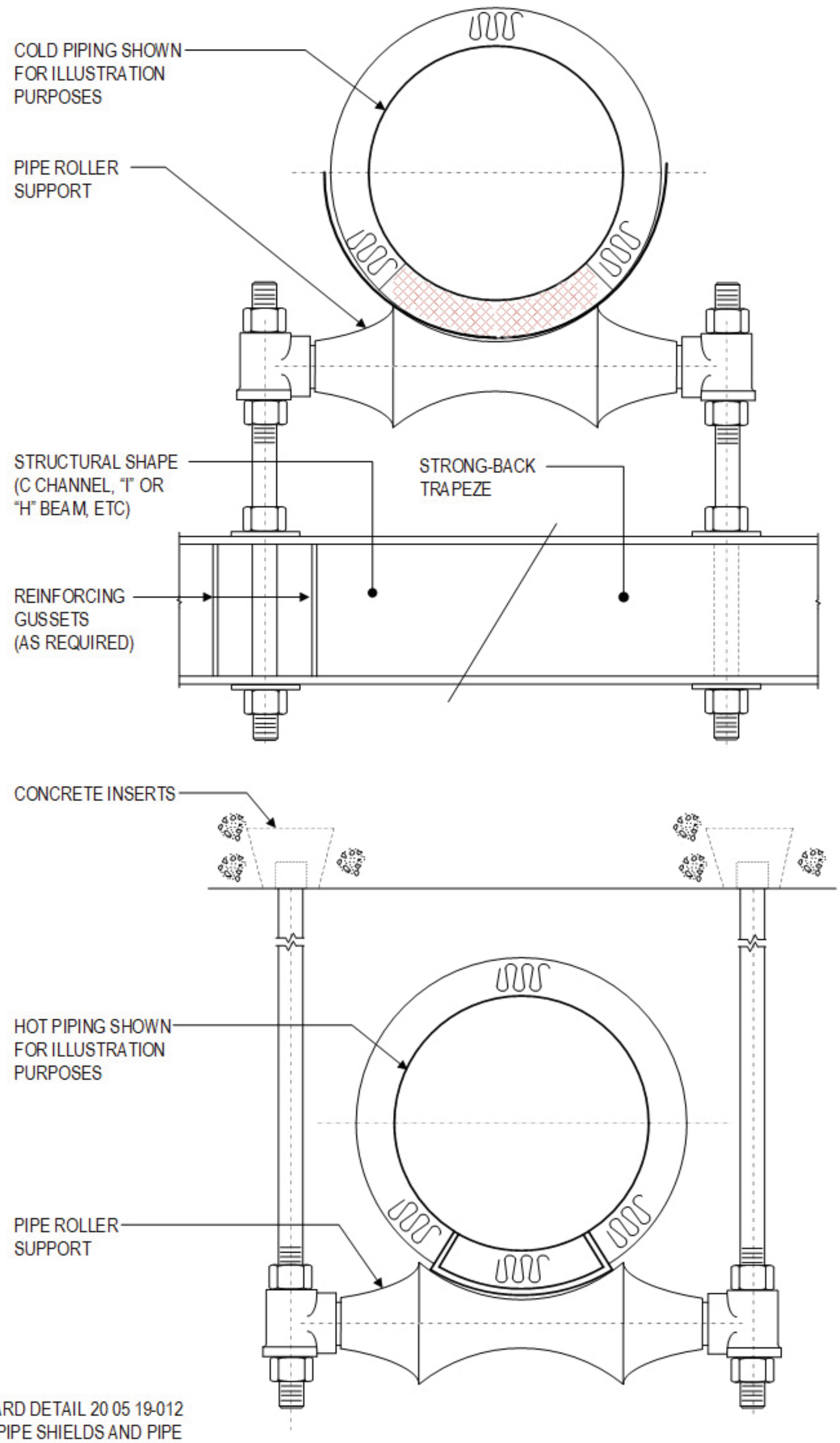



NOTES:

1. REFER TO SPECIFICATIONS FOR TYPE AND SIZE.
2. WHERE HANGER ROD LENGTH IS LESS THAN 300MM FOR INSULATED PIPING, ROLLER, SLIDE OR TRAPEZE HANGERS ARE REQUIRED
3. ARRANGE CLEVIS AND WELDED EYE NUT TO ALLOW ROTATION IN THE SAME AXIAL PLANE AS THE PIPE.

NOT TO SCALE

| | | | | |
|---|---|---|---|---|
| HHAngus | Sheet Title: YOKE PIPE ROLL HANGER TYPICAL DETAIL | Date: 17 JAN 2020 | Rev. No.: 00 | Checked: PS |
| | | Standard Detail No. 20 05 29 - 012 | | |

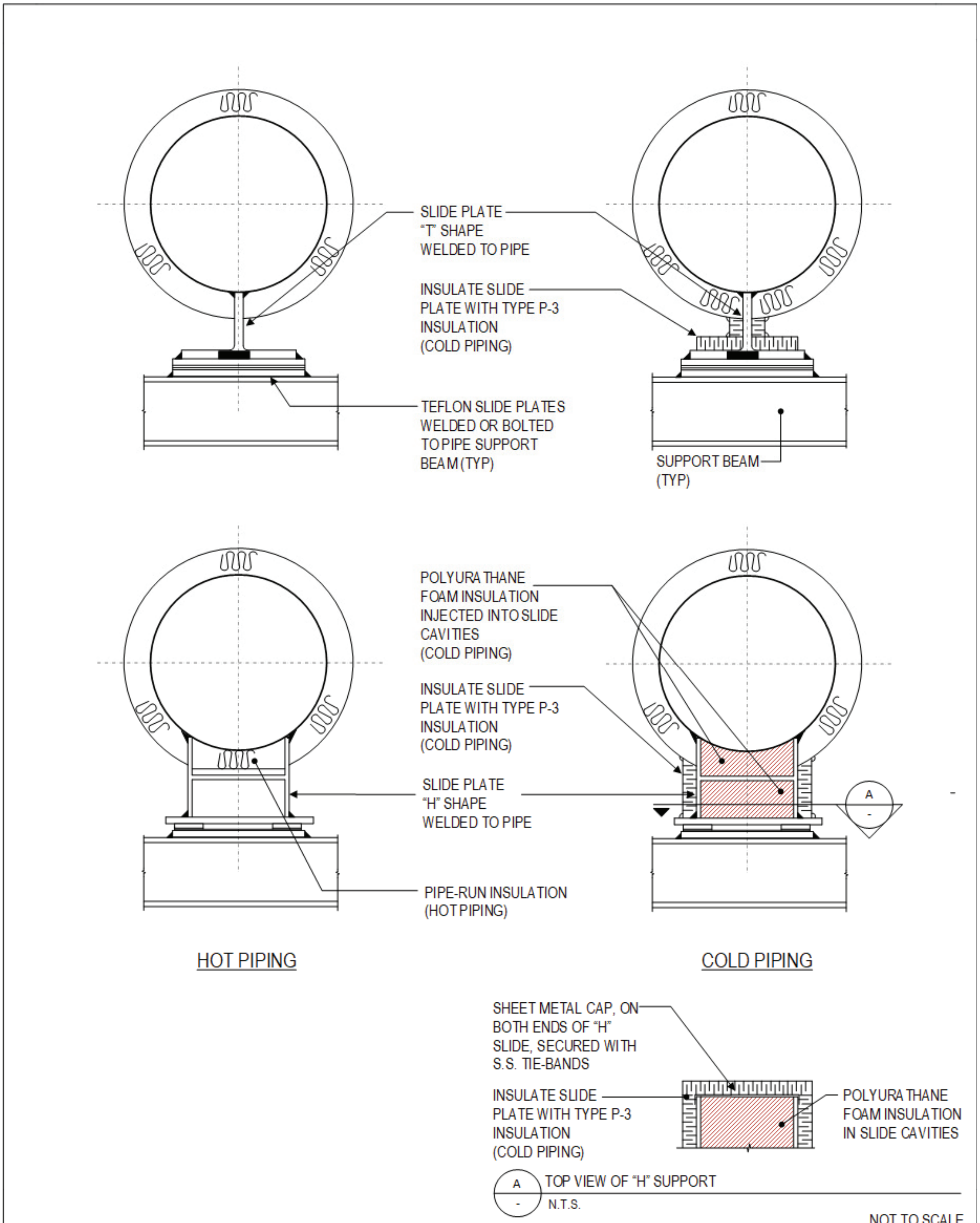



NOTES:

1. REFER TO STANDARD DETAIL 20 05 19-012 FOR INSULATION, PIPE SHIELDS AND PIPE SADDLES REQUIREMENTS.

NOT TO SCALE

| HHAngus | Sheet Title: PIPE ROLLER SUPPORT TYPICAL DETAIL | Date: 17 JAN 2020 | Rev. No.: 00 | Checked: PS |
|---|---|---|---|---|
| | | Standard Detail No. 20 05 29 - 013 | | |




| HHAngus | Sheet Title: SLIDE BASE SUPPORTS TYPICAL DETAIL | Date: 17 JAN 2020 | Rev. No.: 00 | Checked: PS |
|---|---|---|---|---|
| | | Standard Detail No. 20 05 29 - 014 | | |

# VIBRATION ISOLATION
# 20 05 48

## 1 GENERAL

### 1.1 Scope

.1 Isolate motor driven mechanical equipment.

.2 Provide restraints for equipment mounted on vibration isolation to limit movement during start-up and normal operation.

.3 Isolator and base type designations are taken from appropriate chapter of current ASHRAE Applications Handbook.

.4 Base type, isolator type and minimum static deflection are shown in equipment schedules and equipment selection sheets.

.5 Information shown in equipment schedules is to establish minimum standards, vibration isolation equipment to be selected to maintain noise levels in building below RC levels in following schedule.

| AREA | NOISE CRITERIA (NC level) |
|---|---|
| Offices - private | 32 to 34 |
| -open plan | 36 to 38 |
| -business machine areas | 40 to 42 |
| -conference/boardrooms | 30 to 32 |
| Operating Rooms | 25 to 27 |
| Private Bedrooms | 26 to 28 |
| Hospital Wards | 30 to 32 |
| Public Areas | 38 to 40 |

.6 Coordinate vibration isolation with seismic requirements.

### 1.2 Related Sections

.1 Additional requirements for seismic restraint: to Section 20 05 49 Seismic Restraint

.2 Pipe movement control to Section 20 05 16 Flexible Connections, Expansion Joints, Anchors & Guides

.3 Piping constant load supports to Section 20 05 29 Hangers and Supports

### 1.3 Shop drawings

.1 Show vibration isolation for each piece of equipment hung from the structure or supported from the floor.

.2 Submit product data sheets for isolation components.

.3 Show fabrication details, location and size of anchor bolts and concrete requirements for inertia bases.

.4 Provide vibration isolation equipment by one manufacturer.

*Standard of Acceptance*
- Vibron / Kinetics
- BVA
- KorfundMason
- Tecoustics

# 2 PRODUCTS

## 2.1 Resilient isolator Type 1 (R1)

.1 Rubber waffle or ribbed pads:
  .1 30 durometer natural rubber, minimum of 13 mm (½ in) thick,
  .2 selected for maximum loading of 350 kPa (50 psi).

.2 Rubber-steel-rubber pads:
  .1 two layers of rubber waffle or ribbed pad, 13 mm (½ in) thick, as specified above,
  .2 bonded to 6 mm (¼ in) steel plate with holes sleeved and fitted with isolation washers.

.3 Neoprene jacketed pre-compressed moulded fibreglass.

## 2.2 Resilient isolator Type 2 (R2)

.1 Elastomer rubber:
  .1 threaded insert,
  .2 hold down bolts.

.2 Neoprene, 50 mm (2 in) free height:
  .1 natural frequency not to exceed 15 Hz at full load,
  .2 capable of sustaining load of 110 kg (250 lb) with maximum deflection of 5 mm (3/16 in).

## 2.3 Elastomeric mounts (E1)

.1 Construction:
  .1 colour coded neoprene in shear with
  .2 maximum durometer of 60,
  .3 threaded insert,
  .4 two bolt down holes,
  .5 ribbed top and bottom surfaces.

## 2.4 General requirements for spring mounts

.1 Isolator springs:

.1 designed so that ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height,

.2 selected for 50% travel beyond rated load,

.3 cadmium plated,

.4 colour coded.

.2 Mounts:

.1 zinc or cadmium plated hardware,

.2 rubber isolation washers,

.3 housings coated with rust resistant paint,

.4 levelling devices, and

.5 6 mm (¼ in) thick ribbed rubber sound pad bonded to load plate.

.3 Clearance between metal parts: 6 mm (¼ in) minimum.

**2.5 Spring isolator Type 1 (S1)**

.1 Open spring isolators:

.1 extra stiff springs with ratio of lateral to axial stiffness of 1.0.

**2.6 Spring isolator Type 2 (S2)**

.1 Controlled spring isolators with

.1 heavy rigid steel base frames,

.2 built-in vertical limit stops,

.3 removable spacers, and

.4 extra stiff springs with ratio of lateral to axial stiffness of 1.0.

**2.7 Spring isolator snubber Type 3 (S3)**

.1 Open spring isolators:

.1 horizontal arrangement

.2 heavy rigid steel equipment base mount, and structure mount

.3 open spring, with 25 mm (1 in) deflection range.

.4 isolator bushings.

**2.8 General requirements for isolation hangers**

.1 General

.1 swivel arrangement to permit hanger box or rod to move through 20  arc without metal to metal contact.

**2.9 Hanger Type 1 (H1)**

.1 Spring hanger:

.1 welded steel housing with one coat anti-rust paint,

.2 colour coded spring,

.3 retaining cups,

.4 elastomeric washers.

**2.10 Hanger Type 2 (H2)**

.1 Rubber isolation hanger:

.1 welded steel housing with one coat anti-rust paint,

.2 25 mm (1 in) colour coded neoprene in shear with maximum durometer of 60,

.3 threaded insert.

**2.11 Hanger Type 3 (H3)**

.1 Horizontal thrust restraint:

.1 spring and elastomeric element

.2 housed in box frame with rods and angle brackets to connect unit between isolated equipment and fixed object, and

.3 fitted with means to adjust maximum start-stop movement to 9 mm (⅜ in).

**2.12 Acoustic barriers for anchors and guides**

.1 Manufactured from 25 mm (1 in) thick neoprene isolation with duck reinforcing material.

**2.13 Equipment base Type A**

.1 Direct isolation:

.1 used where equipment is unitary and rigid

.2 motor slide rails welded to unit.

**2.14 Equipment base Type B**

.1 Prefabricated steel base:

.1 welded from structural sections and

.2 reinforced for drive with;

(a) isolation elements attached to base brackets and
(b) adjustable motor slide rails.

.3 minimum vertical section of base selected on basis of motor size from following;

| Motor Size Horsepower | Motor Size kW | Vertical Side mm (in) |
|---|---|---|
| up to 3 | up to 2.2 | 75 (3) |
| 7.5 | 5.5 | 100 (4) |
| 20 | 15 | 150 (6) |
| 50 | 37 | 200 (8) |
| over 50 | 37 | 250 (10) |

## 2.15 Equipment base Type C

.1 Concrete filled inertia base:

.1 Type B base and,

.2 full depth perimeter structural section or formed plate channel frame with;

(a) welded in place reinforcing rods running in both directions and
(b) 1 mm (20 ga) metal pans,
(c) base section filled with concrete, vibrated into place.

.3 spring mount units carried by gusseted brackets welded to frame and

.4 'T' shaped bases to support pump elbows.

## 2.16 Base Type D

.1 Roof curb isolation rails:

.1 manufactured with structural steel or aluminum upper and lower members, with

(a) continuous flexible reinforced water and air tight seal fastened to upper and lower members,

.2 protected by removable metal weather shield.

.3 supported from lower members by stable steel springs, with

.4 maximum deflection 50 mm (2 in) and

.5 closed cell neoprene gaskets.

.6 constructed with neoprene cushioned restraints to resist wind load in any direction.]

# 3 EXECUTION

## 3.1 General

.1 Install vibration isolation equipment in accordance with manufacturer's instructions and locate isolation for equipment to provide stable support under saddles, frames and projections of equipment.

## 3.2 Equipment vibration isolation

.1 Provide additional steel in bases and rails to obtain rigidity and uniform load distribution.

.2 Pumps, fans and motor driven equipment to be mounted on vibration isolation as shown.

.3 Packaged boilers, and water chillers, located in mechanical areas on framed slabs:

.1 supported on Type S1 spring isolators,

.2 located as so that piping systems and equipment is isolated from building structure.

.4 Packaged cooling towers, located in mechanical areas on framed slabs:

.1 supported on Type S2 spring isolators,

.2 located as so that piping systems and equipment is isolated from building structure.

.5 Packaged boilers, water chillers, and cooling towers, located in mechanical areas where floor slab is directly in contact with ground:

.1 supported on Type R1 rubber-steel-rubber pads.

.6 Reciprocating air compressors in any location within building to be supported on

.1 individual Type 'C' inertia bases with

.2 Type 3 spring isolators.

.7 Suspended fans to be supported on

.1 Type A or B base with

.2 Type H3 hangers.

.8 Provide Type S3 horizontal thrust restraints for high pressure horizontal discharge fans developing over 1.5 kPa (6 in wg), arranged symmetrically on either side of unit and attached at centre line of thrust.]

.9 Block and shim bases level at correct operating height.

.1 Bases to clear housekeeping pads by:

(a) 25 mm (1 in) minimum for concrete and
(b) 50 mm (2 in) minimum for steel.

.10 Where isolation is bolted to floor, housekeeping slab or overhead structure:

.1 provide vibration isolation rubber washers.

.11 Where pumps are mounted on vibration isolators

.1 provide flanged or grooved coupling steel removable spool pieces on inlet and discharge connections to allow future installation of flexible connectors,

.2 locate spool pieces between system isolating valve and pump with flange to flange lengths as follows;

| Pipe size (inches) | Spool Length (inches) | Pipe Size (mm) | Spool Length (mm) |
|---|---|---|---|
| 2 | 18 | 50 | 450 |
| 2½ & 3 | 24¼ | 65 & 75 | 616 |
| 4 & 5 | 24⅝ | 100 & 125 | 625 |
| 6 to 12 | 25 | 150 to 300 | 635 |

.12 Where ducts attach to resiliently mounted equipment, flexible connections will be provided by ductwork installer.

## 3.3 Service connection vibration isolation

.1 Make pipe, duct and electrical connections to isolated equipment so as to maintain isolation system flexibility.

## 3.4 Piping vibration isolation

.1 Piping connected to isolated equipment:

.1 supported with;

(a) spring mounts or spring hangers with static deflection of twice deflection of isolated equipment at first point of support and
(b) 25 mm (1 in) minimum static deflection at remaining supports.

.2 installed with distance between support points selected as for regular pipe hangers and using spring type for

(a) first three supports for piping up to NPS 4.
(b) first four supports for piping NPS 5 to NPS 8.
(c) first six supports for piping NPS 10 and over.

.3 Isolated, with acoustic barrier material, at anchors and guides within pipe shafts, duct shafts, equipment and fan rooms, and up to first anchor outside these rooms or areas.

.2 Where piping crosses building expansion joint

.1 provide spring hangers at first two support locations of piping at either side of joint line.

**3.5 Start-up and set-up**

.1 After installation of connections to resiliently mounted equipment;

.1 remove shims and blocking and adjust mountings to level equipment,

.2 adjust connections, hangers, snubbers, and restraints ,

.3 ensure that there is no physical contact between isolated equipment and building structure.

.2 On completion of installation and start-up of equipment;

.1 make arrangements for manufacturer/supplier of Vibration Isolation equipment to visit site, check performance of systems, inspect installation, adjust seismic restraints, and submit written recommendations,

.2 make corrections to installation in accordance with manufacturer/suppliers recommendations,

.3 provide notice 24 hours in advance of this site visit.

**3.6 Testing**

.1 Engage and pay for an experienced sound and vibration professional to take measurements of sound and vibration generated by HVAC systems.

.2 Co-operate with manufacturer/supplier of Sound Attenuation equipment in this measurement and testing.

.3 Sound measurements to extend over full audio frequency range and to be taken in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and main electrical rooms.

.4 Submit outline of tests to be performed, details of instrumentation to be used and floor plans showing test locations prior to commencing work.

.5 Provide notice one week in advance of commencement of tests.

.6 Submit complete report of tests addressing noise and vibration levels measured in occupied areas and adequacy of Sound Attenuation and Vibration Isolation equipment.]

**END OF SECTION**

# SEISMIC RESTRAINT
# 20 05 49

## 1 GENERAL

### 1.1 Scope

.1 Provide seismic restraint systems to limit movement of piping, ducts, conduits, bus ducts, cable trays and equipment.

.2 Provide design, selection and provision of materials, installation instructions, installation and inspection of seismic restraint of mechanical piping, ductwork, fire protection and equipment.

.3 The requirements under this Section are in addition to the requirements for equipment, piping and duct supports and vibration isolation specified in other Sections.

.4 Where specifications of materials of this Section differ from those in other Sections of Division 20, this Section governs, including but not limited to vibration isolation devices.

### 1.2 Systems

.1 Seismically restrain the following equipment and systems:

- .1 Piping:
  - (a) medical gas, natural gas, vacuum, petroleum based liquids and compressed air, NPS 1 and larger,
  - (b) piping located inside of mechanical equipment and service rooms, NPS 1¼ and larger,
  - (c) all other piping NPS 2½ and larger.
- .2 Fire protection piping – Sprinkler Systems:
  - (a) design and install systems in accordance with NFPA 13.
- .3 Ductwork:
  - (a) rectangular and oval ductwork with cross sectional area 0.55 $m^2$ (6 $ft^2$) and greater,
  - (b) round ducts with diameters 710 mm (28 in) and larger.
- .4 Electrical conduit:
  - (a) conduit 64 mm (2½ in) I.D. and larger,
  - (b) cable trays supporting conduit which is sized 64 mm ( 2½ in) I.D. and larger.
- .5 Equipment:
  - (a) vibration isolated equipment,
  - (b) rigidly or gravity supported equipment.

### 1.3 Exemptions

.1 The following portions of systems do not require seismic restraint:

- .1 piping suspended from hangers at a distance of 305 mm (12 in) or less, measured from the top surface of the pipe, to the underside of the supporting structure above,
- .2 ductwork suspended by hangers at a distance of 305 mm (12 in) or less, measured from the top surface of the duct to the underside of the supporting structure above,
- .3 electrical conduit or cable trays suspended by hangers at a distance of 305 mm (12 in) or less, measured from the top surface of the conduit / tray to the underside of the supporting structure above.

## 1.4 Applicable Codes and Standards

.1 Comply with the latest edition of the following:

.1 SMACNA - “Seismic Restraint Manual Guidelines for Mechanical Systems”

.2 NFPA 13 - “Installation of Sprinkler Systems”

.3 ASHRAE - “HVAC Applications, Seismic and Wind Restraint Design”

.4 Applicable Codes and Standards.

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

.1 MSS SP-127 Bracing for Piping Systems Seismic - Wind - Dynamic Design, Selection, Application.

## 1.5 Design Criteria

.1 Design seismic restraint systems to conform to the British Columbia Building Code for the project location:

Fort St. John B.C.: Class C

.2

.2 For Fire Protection systems constructed to NFPA 13, the horizontal force is:
$F_p$ = “K” x $W_p$ x 1.15, <u>where $W_p$ = weight of pipe and water</u>

.3 For Fire Protection systems constructed to NFPA 13, the vertical uplift force is:
$F_v = 0.15 \times F_p$

.4 For all other pipework, and duct systems, the vertical uplift force is restrained by the systems as defined in the SMACNA standard.

## 1.6 Shop Drawings

.1 Submit shop drawings in accordance with Division 1.

.2 Submit test certificates for each seismic restraint device, identifying maximum tested load capacities.

.3 Submit calculations for each piece of restrained equipment, piping, ductwork and conduit, including seismic forces, restraint selection, and selection data.

.4 Provide a calculation analysis summary (spreadsheet is acceptable) for each piece of equipment, including the following information:

.1 Equipment ID

.2 Floor level

.3 Horizontal seismic force factor

.4 Equipment weight

.5 Horizontal seismic force

.6 Vertical uplift seismic force (where applicable)

.7 Equipment centre of gravity in three directions

.8 Design condition (worst case) overturning moment

.9 Number of restraint fastenings

.10 Pull-out tension per fastener

.11 Horizontal shear per fastener

.12 Pull-out tension load rating per fastener

.13 Horizontal shear rating per fastener.

.5 Include worst case combination of tension and shear loads at each snubber and restraint location.

.6 Include anchor bolt diameters, embedment depth, full welding details including type and length for field welds, and required housekeeping base dimensions.

.7 Calculations to be sealed by a Professional Engineer licensed in the province of British Columbia.

### 1.7 Sample Materials

.1 None required.

### 1.8 Quality Assurance

.1 Pre-Construction meeting:

.1 Request and arrange a meeting with the Consultant to review seismic restraint approach, prior to any restraint installation. Obtain approval from the Consultant before commencing work.

.2 Testing and Review

.1 Install the first three lateral and three longitudinal braces for each of: each fire protection systems; one (1) building service piping system; and one (1) ductwork system.

.2 request and arrange for a review of the installation by the Consultant. Obtain approval of the installation before commencing remainder of the work.

.3 Provide services of the manufacturer’s technical representative to conduct site inspections of the Work in progress, and to conduct a final inspection of the work. Provide a copy of the final inspection report to the Consultant for review.

.4 Request and arrange for a construction review by the Consultant of the completed seismic restraint installation, before any ceilings are installed.

## 2 PRODUCTS

### 2.1 Material

.1 Seismic restraint design and material supply

*Standard of Acceptance*

- Vibron/Kinetics Noise Control Inc.
- BVA
- VMC/Korfund
- Tecoustics
- Hilti

### 2.2 Seismic Snubber Restraints

.1 Type “SS1” – Single-Axis Limit Stop Snubber Assemblies:

.1 steel construction, attached to equipment structure and equipment, maximum of 6 mm (¼ in) seismic movement .

.2 designed to restrict movement in one axis.

.3 minimum 6 mm (¼ in) thick resilient neoprene pads to prevent metal-to-metal impact.

.4 minimum four (4) snubbers for each piece of equipment.

.2 Type “SS2 / SS3” – Multi-Axis Limit Stop Snubber Assemblies:

.1 interlocking steel construction, attached to equipment structure and equipment, maximum of 6 mm (¼ in) seismic movement .

.2 designed to restrict movement in two (2) or three (3) axis.

.3 minimum 6 mm (¼ in) thick resilient neoprene pads to prevent metal-to-metal impact.

.4 minimum two (2) snubbers for each piece of equipment.

**2.3 Seismic Vibration Isolators**

.1 Type “2-S” – All Direction Neoprene Isolator:

.1 molded, oil resistant neoprene compound, with encapsulated cast-in-place top steel load plate, and steel base plate with anchor holes

.2 designed for seismic loads in all directions with no metal-to-metal contact.

.2 Type “3-S” – Restrained Spring Isolator – Constant Load:

.1 colour coded seismic-controlled spring isolator, single or multiple spring coils, with minimum 6 mm¼” neoprene pad.

.2 removable coil spring element without having to disturb supported equipment.

.3 lateral stiffness greater than 1.2 times rated vertical stiffness.

.4 minimum 50% overload capacity

.5 non-welded spring elements: epoxy coated, with a minimum 1000 hour rating when tested in accordance with ASTM B-117.

.6 steel housing design to limit lateral and vertical movement of the supported equipment.

.7 neoprene snubber, to limit maximum equipment movement in any direction to 6 mm¼”.

.8 adaptor base suitable sized for larger anchors, when required to suit anchorage capacity.

.3 Type “4-S” – Restrained Spring Isolator – Variable Load:

.1 colour coded seismic-controlled spring isolator, single or multiple spring coils, with minimum 6 mm (¼ in) neoprene pad.

.2 removable coil spring element without having to disturb supported equipment.

.3 lateral stiffness greater than 1.2 times rated vertical stiffness.

.4 minimum 50% overload capacity

.5 non-welded spring elements: epoxy coated, with a minimum 1000 hour rating when tested in accordance with ASTM B-117.

.6 steel housing design to limit lateral and vertical movement of the supported equipment.

.7 top load plate with adjustable and leveling bolts.

.8 adjustable vertical restraints

.9 isolation washers

.10 bottom load plate with internal non-skid isolation pads and anchor holes

.11 hot dipped galvanized for outdoor installations.

.12 neoprene snubber, to limit maximum equipment movement in any direction to 6 mm (¼ in).

.13 adaptor base suitable sized for larger anchors, when required to suit anchorage capacity.

### 2.4 Piping and Ductwork Restraint

.1 Type “SCR” – Cable Restraints for Suspended Piping and Ductwork:

.1 manufactured system consisting of cable, building attachment, and vertical rod reinforcement assembly,

.2 field-built assemblies are not acceptable,

.3 steel wire strand cables:

(a) galvanized steel aircraft cable
(b) sized for seismic load with a safety factor of 2,
(c) arranged for restraint in both longitudinal and transverse directions.
(d) Rope connections: overlap wire “U” clips, or, tool-less wedge insert lock connectors.
(e) Connector strength rating equal to 90% of cable breaking strength rating.

.4 Building and equipment attachment brackets: designed to permit free cable movement in all directions up to a 45 degree misalignment:

(a) protective thimbles at sharp corners to protect against cable wear,
(b) Selected to exceed the cable working design load by 50%,
(c) Single sided “C” beam clamps are not acceptable.

.5 Vertical Suspension Rods:

(a) braced to avoid potential for buckling due to vertical up-lift forces,
(b) structural steel angle or formed channel brace selected to prevent support rod buckling,
(c) brace attached to support rod with a series of adjustable clips, without the use of hand-tools.

.2 Type “SRR” - steel angles or channels:

.1 sized for seismic load with a safety factor of 2,

.2 arranged for restraint in both longitudinal and transverse directions.

### 2.5 Rigidly Mounted Equipment Restraint

.1 Undercut or Heavy-Duty Sleeve type, for post concrete-cure installation:

.1 carbon steel bolt, nut and sleeve,

.2 selected for concurrent shear and tension loads with a safety factor not less than 2.0 x estimated load.

## 3 EXECUTION

### 3.1 General:

.1 Design seismic restraints to;

.1 keep equipment in place during and after seismic events in accordance with local building code,

.2 resist vertical loading simultaneously with transverse or longitudinal seismic loading .

.2 Give special consideration to design for adjacent connections, insulation treatment, thermal movement, vibration isolation, and relation to building seismic joints.

.3 Building structure attachments;

.1 concrete construction:

(a) cast in place anchor
(b) drill-in wedge anchor

.2 steel construction:

(a) double sided beam clamp, loaded perpendicular to beam, or
(b) specifically designed welded or bolted connection.

.3 single sided "C" type beam clamps for support rods for piping, ductwork, conduit, bus duct, cable trays or other equipment are unacceptable as seismic restraint anchor points.

.4 Brace installation;

.1 install cable restraints snug,

.2 install solid braces only in rigidly supported situations,

.3 brace hanger rods forming a part of seismic restraint to accept resulting compressive loads,

.4 transverse and longitudinal braces to be no more than 45° above or below centerline of pipe, duct, or tray.

.5 Equipment;

.1 equipment secured rigidly to wall, floor, or housekeeping pad to have resilient neoprene bushings and washers between equipment and anchor bolts.

## 3.2 Selection of Bracing Details

.1 Select application type;

.1 single hanger or

.2 trapeze support.

.2 Determine required force level, based on weight of equipment and specified factors.

.3 With required force level, develop transverse and longitudinal brace spacing for single or trapeze hanger in accordance with;

.1 break length into separate straight runs, which are considered to be single straight section between any bends except where bend is at an offset of less than 610 mm (2 ft),

.2 brace each straight run in transverse direction at both ends. Check required spacing for transverse bracing and compare it to the length of straight run. If length of straight run is greater than allowable distance for transverse bracing add transverse braces until spacing does not exceed allowable transverse brace distance,

.3 each straight run must have at least one longitudinal brace. Add longitudinal braces so that the spacing does not exceed allowable longitudinal brace spacing. Transverse brace may act as longitudinal brace for an adjacent run when it is located within 610 mm (2 ft) of adjacent straight run,

.4 where several short runs occur one after other, each straight run requires longitudinal brace when adjacent short runs exceed offset length of 610 mm (2 ft). When adjacent short runs do not exceed maximum offset length the longitudinal braces can act as transverse braces as long as allowable transverse brace spacing is not exceeded. Multiple offsets can be treated as single run when the total offset is less than maximum offset length,

    .5 when flexible connection or swing joint is used, such as at pipe drop to mechanical equipment, pipe may cantilever at length equal to or less than half allowable transverse brace spacing. When pipe drop cantilever is greater than half allowable transverse brace spacing, support to floor is required.

.4 Select brace anchorage detail.

.5 Calculate hanger rod load and select rod attachment to structure to suit.

.6 Check if rod stiffeners are required to prevent hanger rod from buckling under compressive load.

**3.3 Installation**

.1 Install seismic restraint devices in accordance with manufacturer's instructions.

.2 Install snubber devices only after equipment is installed and operating, to ensure no metal-to-metal contact.

.3 Seismic restraint manufacturer to provide training to the installation contractor on installation methods.

.4 Anchors on piping systems used for thermal expansion may be used as both a lateral and longitudinal restraint where they are designed for concurrent thermal and seismic loadings.

.5 Pipe and duct penetrations through floors are acceptable as lateral restraints, provided sleeves and fire stopping materials are installed correctly.

.6 Racked piping systems may have the rack braced (laterally, longitudinally, or combination thereof), provided each pipe supported by the rack is restrained to the rack.

.7 Each lateral or longitudinal brace must be secured to the building structure, and not any other building service.

.8 Pipe and duct penetrations through masonry and poured concrete wall partitions are acceptable as a lateral restraint, provided sleeves and fire stopping materials are installed correctly.

    .1 Drywall partitions, including demountable partitions, are not to be used for lateral restraint.

**3.4 Equipment Restraints - Floor Mounted Vibration Isolated Equipment**

.1 Select basic vibration isolator as per Section 20 05 48.

.2 Select seismic restraint for each piece of equipment either:

    .1 integrated seismic vibration restraint type 2-S, 3-S or 4-S, or

    .2 vibration isolator as per 20 05 48 combined with seismic snubbers SS1, SS2 or SS3.

.3 Do not mix type of restraint on the same piece of equipment.

**3.5 Equipment Restraints - Suspended Vibration Isolated Equipment**

.1 Select basic vibration isolator as per Section 20 05 48.

.2 Provide hanger rod reinforcement.

.3 Provide SCR restraints in longitudinal and lateral directions.

.4 Do not include ductwork or piping restraints to restrain equipment.

### 3.6 Equipment Restraints - Rigidly Floor Mounted Equipment

.1 Anchor all floor mounted equipment with anchor bolts, minimum four bolts for rectangular equipment bases, and three bolts for circular equipment bases.

.2 For round equipment, such as expansion tanks with floor-support ring without mounting flanges, use type SS3 snubbers or custom seismic snubbers.

.3 Provide resilient neoprene bushings and washers between equipment and anchor bolt.

### 3.7 Equipment Restraints - Surface wall-mounted Equipment and Panels

.1 Select bolts for concurrent shear dead-weight without deduction for uplift load, and tension restraint load.

.2 In block-wall;

  .1 up to three bolts, each bolt rated for 2.0 times estimated restraint load, or

  .2 for four bolts or more, each bolt is rated for 1.0 times estimated concurrent load.

.3 In dry-wall;

  .1 minimum of four self-tapping screws drilled into the studs, with each screw rated for 1.0 times estimated restraint load.

### 3.8 Equipment Restraints - Recessed wall-mounted Equipment and Panels

.1 Same as for surface mounted equipment, except fasten through top bottom and sides of panels to adjacent block wall or wall studs.

### 3.9 Piping, Ductwork and Conduit

.1 Provide restraint in accordance with the SMACNA guideline and manufacturers' instructions.

.2 Do not mix cable restraints and rigid bar restraints on the same piping or duct system, except:

  .1 On piping or ductwork which is suspended on vibration isolators, use cable type SCR restraints and provide a small amount of slack in the cable to prevent vibration short-circuiting.

### 3.10 Manufacturer’s Services

.1 Review design drawings and specifications, and shop drawings.

.2 Provide design and selection of seismic restraints, and preparation of shop and installation drawings.

.3 Provide training of contractor personnel for the installation of seismic restraints.

.4 Conduct site inspections of the Work in progress, and to conduct a final inspection of the work. Provide a copy of the final inspection report to the Consultant for review, including photographs of representative installations of each type of restraint used in the Work.

**END OF SECTION**

# IDENTIFICATION
# 20 05 53

## 1 GENERAL

### 1.1 Scope

.1 Provide equipment nameplates, piping and duct identification, and valve tags.

### 1.2 Shop Drawings

.1 Submit list of nameplates, with proposed wording, prior to engraving.

.2 Submit sample board with pipe and duct identification materials.

### 1.3 Applicable Codes and Standards

.1 Medical gas pipe marking: to CSA Z7396.1

## 2 PRODUCTS

### 2.1 General

.1 Manufactured identification systems:
- .1 laminated vinyl or polyester,
- .2 resistant to chemical, ultraviolet,
- .3 minimum operating temperature: -25°C (-12°F)
- .4 maximum operating temperature: 121°C (250°F)

*Standard of Acceptance*
- ° Brady - identification tapes, bands, and markers.
- ° Seton - Setmark Pipe Markers.
- ° Smillie McAdams Summerlin.
- ° Craftmark Identification Systems.

### 2.2 Equipment Identification Nameplates

.1 Identification plates are in addition to manufacturers plates.

.2 Identification plates:
- .1 provided for equipment identified with number designations in schedules and equipment selection sheets.
- .2 marked with equipment ID, service and power source using wording and numbering used in contract documents.

.3 Fabrication:
- .1 laminated plastic,
- .2 black lettering on white background for “Normal” power equipment
- .3 white lettering on red background for “Emergency” power equipment
- .4 minimum size 90 mm x 40 mm x 2.5 mm (3 in x 1½ in x ⅛ in),

.5 engraved with 10 mm (⅜ in) high lettering.

## 2.3 Piping Identification

.1 Flexible coil-wrap manufactured markers:

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

.2 applicable WHIMS pictogram for identification of material hazard.

.2 Self-adhesive manufactured pipe markers and colour bands:

.1 50 mm (2 in) wide tape wrapped around pipe or covering with ends overlapping one pipe diameter but not less than 25mm (1 in) for colour bands,

.2 minimum 20 mm (¾ in) high lettering,

.3 colour band tape with flow direction arrows,

.4 waterproof and heat resistant plastic marker tags for pipes and tubing 20 mm (¾ in) nominal and smaller.

.5 applicable WHIMS pictogram for identification of material hazard.

## 2.4 Ductwork Identification

.1 Paint stencilled letters 25mm (1 in) high showing;

.1 duct service,

.2 fan number, and

.3 arrows showing direction of flow,

## 2.5 Valve and Steam Trap Identification

.1 Brass valve tags or plastic lamacoid:

.1 brass with stamped numbers and letters filled with black enamel,

.2 plastic lamacoid with black lettering on a white background,

.3 brass or stainless steel chain or S-hook,

# 3 EXECUTION

## 3.1 Equipment Identification

.1 Locate nameplates to be easily read.

.2 Do not paint over equipment manufacturer or field installed nameplates.

.3 Fasten securely with mechanical fasteners.

.4 Provide standoffs on insulated equipment.

.5 Examples:

.1 at equipment (fan, pump, etc.):

| |
|---|
| **F-1** |
| **Auditorium Supply Fan** |

.2 at motor starter, adjustable frequency drive, and separate local disconnect:

| |
|---|
| **P-3** |
| **Condenser Water Pump** |
| **Fed from PDP-12-1** |

### 3.2 Piping Identification - Except for Non-Medical Gas Systems

.1 Provide manufactured tape markers:

.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 canvas or embossed metal jackets.

.3 Install markers on cleaned and prepared surfaces free of dirt and oil.][

.2 Locations:

.1 maximum every 15 m (50 ft) along length of pipe, except for medical gas, 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.

### 3.3 Piping Identification - Medical Gas Systems

.1 Provided identification markings on medical gas systems:

.1 maximum every 6 m (20 ft) along length of pipe,

.2 before and after barriers, floors and walls,

.3 at each valve,

.4 behind access doors ,

.5 inlet and outlet points including vents.

### 3.4 Ductwork identification

.1 Paint stencilled letters 25mm (1 in) high showing;

.1 duct service,

.2 fan number, and

.3 arrows showing direction of flow,

.2 Locations:

.1 exposed ducts,

.2 concealed ducts next to access doors, and

.3 throughout length of ducts at intervals not exceeding 15 m (50 ft).

.3 Stencil indication on prepared surfaces, and locate on both sides of any penetration.[][

**3.5 Valve Identification**

.1 Provide every valve on job with a numbered tag showing valve type and size, attached to valve stem or wheel handle with non-ferrous chain or S-hook.

.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) within site of equipment or apparatus they control provided there is no branch piping between valve and equipment served.

.2 Identification information:

.1 indicating service, sequential valve number by service or specific equipment ID for control valves, location identifier, purpose of valve, valve type and size.

.2 valve type designation:

(a) **B** (ball valve), **GT** (gate valve), **GL** (globe valve), **CBV** (circuit balancing valve), **BF** (butterfly valve).

.3 valve size:

| |
|---|
| **Domestic Cold Water #12**<br>**Riser C-1**<br>**Service Valve - B2** |

(a) for valve size, use NPS designation.

.4 examples:

(a) domestic cold water riser isolating valve, sequence number 12, located near column C-1, NPS 2 ball valve:

(b) hot water terminal reheat supply valve, sequence number 57, located in a corridor and not in site of equipment served, circuit balancing valve NPS 3/4:

| |
|---|
| **Reheat Supply #57**<br>**Room 2-254**<br>**Balancing Valve - CBV ¾** |

(c) automatic control valve used for pressure balancing the system, with an equipment schedule ID of CV-15, and is globe style NPS 3:

| |
|---|
| **Constant Pressure Differential Valve**<br>**CV-15**<br>**Automatic Control Valve - GL 3** |

.3 Provide a tag schedule for each system, designating number, service, function, size, and location of each tagged item and normal operating position of each valve.

.4 Submit two copies of valve tag schedules, encased in clear plastic, bound in vinyl covered, hardbacked 210 mm x 297 mm (8½ in x 11 in) three ring binders.

**3.6 Pipe and Valve Identification Classification**

.1 Use existing coding system for building additions and alterations.

**END OF SECTION**

# COMMON REQUIREMENTS FOR MECHANICAL INSULATION
# 20 07 11

## 1 GENERAL

### 1.1 Scope

.1 Common requirements for insulation of mechanical services provided under Division 20 to 25 of the Work. The requirements of this specification section apply to separate specification sections for insulation of ductwork, equipment and piping.

### 1.2 Related Sections

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

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

.2 20 07 13 Duct Insulation

.3 20 07 19 Piping Insulation

### 1.3 Definitions and Abbreviations

.1 The following definitions apply to this section.

.1 ***Ambient***: as applied to temperatures means the interior or outdoor air temperature at time of installation.

.2 ***Coating***: light-consistency compound for indoor applications used in conjunction with reinforcing membrane, to provide either a breathable or vapour barrier finish to insulation.

.3 ***Cold services***: means cold ductwork, equipment and/or equipment.

(a) ***Cold ductwork***: mechanical ductwork with a service temperature greater than 1°C and up to and including 16°C (34°F to 61°F).
(b) ***Cold equipment***: mechanical equipment with a service temperature of 16°C (61°F) or less,
(c) ***Cold piping***: mechanical piping with a service temperature of 16°C (61°F) or less,

.4 ***Concealed services***: mechanical services that are located: in the space above opaque suspended ceilings; within trenches not located in service rooms; within pipe and/or duct shafts; or in non-accessible chases and wall cavities.

.5 ***Conditioned air***: air supplied from air handling units that heats, cools, dehumidifies, or humidifies the air.

.6 ***Conditioned space***: an enclosed space or room that is heating, cooled, dehumidified and/or humidified.

.7 ***Dual temperature services:*** means dual temperature ductwork, piping and/or equipment that operates, at different times, at both hot and cold temperatures.

(a) ***Dual temperature ductwork***: mechanical ductwork that operates at temperatures greater than 1°C and up to and including 38°C (34°F to 100°F), at different times or at different locations in the duct system and includes cooling systems with terminal reheat.
(b) ***Dual temperature equipment***: means mechanical equipment that operate, at different times, at cold equipment temperatures and at hot equipment temperatures.
(c) ***Dual temperature piping***: mechanical piping that operate, at different times, at cold piping temperatures and at hot piping temperatures.

.8 ***Ductwork***: includes ducts, fans, air handling equipment casings, and plenums.

.9 ***Exposed services***: mechanical services that are located in areas that are not "concealed" as defined above for concealed services. For greater certainty, the following locations are exposed services:

(a) services in tunnels,
(b) services in space beneath raised floors.
(c) trenches located in service rooms.

.10 ***Finish covering***: final protective layer for insulation that provides an aesthetic finish but that may also provide weather-protective, moisture and/or vapour protection.

.11 ***Hot services***: means hot ductwork, equipment and/or equipment.

(a) ***Hot ductwork***: mechanical ductwork with a service temperature greater than 28°C and up to and including 65°C (80 to 150°F) and does not have any mechanical cooling.
(b) ***Hot equipment***: mechanical equipment with a service temperature 38°C (100°F) and greater.
(c) ***Hot piping***: mechanical piping at service temperatures as shown in Table 1 of specification section 20 07 19.

.12 ***Mastic***: heavy-consistency waterproof compound for outdoor applications, used in conjunction with reinforcing membrane that remains adhesive and generally pliable with age, to provide either a breathable or vapour barrier finish for outdoor insulation.

.13 ***Mechanical services***: equipment, piping, ductwork and related accessories provided under Division 20 to 25 of the Work.

.14 ***Outdoor (services)***: mechanical services located outside of the building envelope including services located beneath overhangs, located in unconditioned soffits, or exposed to any outdoor condition including temperature, sun exposure, or precipitation.

.15 ***Pure water***: water that has been treated with filtration equipment, including but not limited to reverse osmosis, deionization, ultra-filtration, ultra-violet, distillation or any combination of such or similar equipment, to achieve water quality significantly free of impurities.

.16 ***Service temperature***: the highest (for hot mechanical services) or the lowest (for cold mechanical services) gas or vapour design operating temperature, or the liquid supply operating temperature.

.17 ***Surface temperature***: for the purpose of this specification, has the same meaning as service temperature.

.18 ***Unconditioned (space)***: rooms or spaces that are not conditioned spaces, and includes ceiling spaces which are not part of a ceiling return air plenum system.

.19 ***Wet area:*** spaces subject to high humidity or where mechanical services may be exposed to direct contact with water, including not limited to: pools, shower rooms, tub rooms, medical device reprocessing, dishwashers, sterilizers, cart-washing, vehicle washing, and emergency showers.

## 1.4 Applicable Codes and Standards

.1 Installation codes and standards:

| | | |
|---|---|---|
| .1 | NFPA 90-A | Installation of Air-Conditioning and Ventilating Systems |
| .2 | ASHRAE/IES 90.1 | Energy Standard for Buildings Except Low-Rise Residential Buildings |
| .3 | NFPA 255 | Test of Surface Burning Characteristics of Building Materials |

.2 Product standards:

| | | |
|---|---|---|
| .1 | CAN/ULC-S102 | Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies |
| .2 | CAN/ULC-S102.2 | Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies |

| | | |
|---|---|---|
| .3 | CAN/ULC-S114 | Standard Method of Test for Determination of Non-Combustibility in Building Materials |
| .4 | ASTM B209 | Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| .5 | ASTM B240 | Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications |
| .6 | ASTM C177 | Standard Test Method for Steady-State Het Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus |
| .7 | ASTM C411 | Standard Test Method for Hot Surface Performance of High Temperature Thermal Insulation |
| .8 | ASTM C449 | Standard Specification for Mineral Fibre Hydraulic-Setting Thermal Insulation and Finishing Materials |
| .9 | ASTM C518 | Standard Test Method for Steady State Thermal Transmission Properties by Means of Heat Flo Meter Apparatus |
| .10 | ASTM C533 | Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation |
| .11 | ASTM C534 | Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form |
| .12 | ASTM C547 | Standard Specification for Mineral Fiber Pipe Insulation |
| .13 | ASTM C552 | Standard Specification for Cellular Glass Thermal Insulation |
| .14 | ASTM C553 | Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications |
| .15 | ASTM C591 | Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation |
| .16 | ASTM C612 | Standard Specification for Mineral Fiber Block and Board Thermal Insulation |
| .17 | ASTM C795 | Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel |
| .18 | ASTM C1126 (Gr.1) | Standard Specification for Faced and Unfaced Rigid Cellular Phenolic Thermal Insulation |
| .19 | ASTM C1290 | Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts |
| .20 | ASTM C1393 | Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks |
| .21 | ASTM E84 | Standard Test Method for Surface Burning Characteristics of Building Materials |
| .22 | CGSB 51-GP-52MA | Vapour Barrier, Jacket and Facing Material for Pipe, Duct, and Equipment Thermal Insulation. |
| .23 | CGSB 51.53-95 | Poly(Vinyl Chloride) Jacket Sheeting, for Insulated Pipes Vessels and Round Ducts. |

## 1.5 Qualified Tradespersons

.1 Work to be performed by a recognized specialist firm with an established reputation in this field.

*Standard of Acceptance*

- Fattal's Thermocanvas

- Alpha-Maritex 3451-RW
- Clairmont Diplag 60
- Glass-Cell FR
- Newtex - Zetex Rewettable

**1.6 Quality**

.1 Manufacturers and products are listed in this section to establish quality and manufacturing standards. Products from other manufacturers with explicitly similar characteristics may be acceptable but must be submitted as an alternative product submission.

## 2 PRODUCTS

**2.1 General Requirements**

.1 Adhesives, coatings, finish coverings, lagging, sealers, and tapes:

.1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84.

.2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84.

.3 exception: vapor barrier mastics on mechanical services located outside of the building.

**2.2 Adhesives, Fasteners, and Tape**

.1 Contact bond cement:

.1 for quick setting for metal surfaces.

.2 Volatile Organic Content: maximum 80 g/L.

*Standard of Acceptance*

- Bakor - fig. 220-05
- Foster – fig. Drion 85-75

.2 Adhesive for flexible closed cell foam insulation:

.1 Volatile Organic Content: maximum 80 g/L.

*Standard of Acceptance*

- Armacell - Armaflex 520 BLV
- Armacell - Armaflex. Low VOC Spray Contact Adhesive

.3 Lap seal adhesive:

.1 for joints and lap sealing of vapour barriers.

.2 Volatile Organic Content: maximum 250 g/L.

*Standard of Acceptance*

- Bakor - fig. 220-05
- Childers - fig. CHIL-STIX FRN CP-82

.4 Fibrous insulation adhesive:

.1 Volatile Organic Content: maximum 250 g/L

*Standard of Acceptance*

- Childers - fig. CHIL-STIX FRN CP-82
- Foster - fig. 85-70

.5 Vapour barrier tape:

.1 colour matched and foil faced

.2 listed to UL 181A.

*Standard of Acceptance*
- Johns Manville - fig. Zeston Z-Tape
- MacTac Canada Ltd – fig. Vinyl Scrim or Foil Scrim Kraft
- Compac Corp.
- Fattal Canvas Inc. - fig. Insultape

.6 Weld pins, studs, clips and washers:

.1 Galvanized steel or copper plated steel, stainless steel or aluminium to match ductwork material.

.2 Attachment method:

(a) welded for outdoor ducts,
(b) welded for indoor ducts,
(c) self-adhesive base may be used for vertical surfaces of rectangular ducts.

*Standard of Acceptance*
- Midwest - fig. Fasteners
- Jordahl - fig. Studwelding

.7 Staples:

.1 Monel, flare type, minimum size 12 mm (½ in).

.8 Tie wire:

.1 1.6 mm (16 ga) stainless steel with twisted ends.

.9 Caulking for sheetmetal jackets (outdoor use only)

.1 fast-drying, aluminum colour finish, flexible butyl elastomer based vapour barrier sealant.

*Standard of Acceptance*.
- Foster - fig. 95-44

**2.3 Coatings and Reinforcing Membranes**

.1 Reinforcing membrane:

.1 synthetic fibre:

(a) Leno weave,
(b) indoor and outdoor use.

*Standard of Acceptance*
- Foster - fig. Mast-A-Fab

.2 glass-fibre fabric:

(a) indoor use.

*Standard of Acceptance*
- Childers - fig. Chil-Glas #5/#10

.3 glass-fibre fabric for use with elastomeric closed cell foam:

(a) indoor use.

*Standard of Acceptance*
- Childers - fig. Chil-Glass #10

.2 Breather coating - Indoors:

.1 for breather coatings and lagging adhesive,

.2 Volatile Organic Content: maximum 50 g/L

.3 white in colour,

*Standard of Acceptance*
- Childers- fig. CP-50A HV2
- Foster - fig. 30-36

.3 Breather mastic - Outdoors:

.1 for breather coatings and lagging adhesive,

.2 abrasion resistive, flexible,

.3 UV stabile,

.4 grey in colour.

*Standard of Acceptance*
- Childers - fig. Vi-Cryl CP-10/11
- Foster - fig. 35-00 / 45-00
- Bakor - fig. 120-10

.4 Vapor barrier coatings - Indoors:

.1 Volatile Organic Content: maximum 50 g/L.

.2 for vapor barrier coatings and lagging adhesive except for elastomeric closed cell foam,

(a) permeance rating 0.02 perms maximum,
(b) white in colour

*Standard of Acceptance*
- Childers - fig. Chil Perm CP-34/35
- Foster - fig. 30-80, 30-90

.5 Vapor barrier mastic - Outdoors:

.1 for vapor barrier coatings and lagging adhesive,

.2 asphalt cutback,

.3 permeance rating 0.02 perms maximum,

.4 grey in colour.

.5 for outdoor use only.

*Standard of Acceptance*
- Childers - fig. Chil-Pruf CP-22
- Foster - fig. 60-25/60-26

.6 Vapour barrier coatings – elastomeric foam insulation:

.1 for indoor and outdoor use,

.2 water bases sealer/finishing coat, water and UV resistant.

.3 white in colour.

*Standard of Acceptance*
- Armacell - fig. ArmaFlex WB Finish

## 2.4 Insulation and Finishing Cement

.1 Mineral fibre, hydraulic-setting insulation cement, to ASTM C449

.2 Temperature rating: 650°C (1200°F)

*Standard of Acceptance*

- ° Johns Manville - fig. CalCoat-127
- ° Ramco Insulation - fig. Ramcote 1200 (PKI Quick Cote)

## 2.5 Field Applied Coverings

.1 Fabric finish jacket:

.1 plain weave cotton fabric at 220 g/m2 (6 oz/sq yd), treated with fire retardant lagging adhesive, or

.2 re-wetable fiberglass lagging fabric with water activated self-adhesive.

.3 suitable for field painting.

*Standard of Acceptance*

- ° Fattal - fig. Thermocanvas
- ° Clairmont - fig. Diplag 60
- ° Newtex - fig. Zetex Rewettable

.2 PVC jackets:

.1 PVC sheeting, or pre-cut and rolled sheeting to suit OD of pipe and insulation, with UV inhibitor for white colour product,

(a) minimum thickness:
- indoors: 0.5 mm (20 mil-in.),
- outdoors: 0.8 mm (30 mil-in.),

(b) maximum operating temperature: 66°C (150°F) at the material,
(c) listed to CAN/ULC-S102/S102.2 or ASTM E84,

.2 PVC fitting jacket with integral insulation inserts:

(a) minimum 0.5 mm (20 mil-in) thickness,
(b) pre-molded fitting covers, one or two piece,
(c) maximum operating temperature: 66°C (150°F) at the material,
(d) self-sealing longitudinal joints or field applied sealer adhesive,
(e) listed to CAN/ULC-S102/S102.2 or ASTM E84,

.3 colour: match existing

.4 foam-glass or glass-fibre insulation molded insert, including for elbows, tees, valves, end-caps, and mechanical pipe couplings,

.5 multiple layers where required for thicker pipe insulation thicknesses.

.6 pressure sensitive, colour matching vinyl tape.

*Standard of Acceptance*

- ° Johns Manville - fig. Zeston 2000
- ° Proto PVC - fig. LoSMOKE
- ° ACWIL Insulations
- ° Sure Fit Systems

.3 Metal finish jacket:

.1 straight pipe, duct or plenum:

(a) stucco embossed aluminum 3105 or 3003 to ASTM B-209, not less than 0.45 mm (0.016 in) thick sheet, with integral 3 mil polyfilm moisture barrier on the interior surface, lock-forming quality,

(b) stainless steel type 304 to ASTM A-240, not less than 0.25 mm (0.010 in) thick sheet, lock-forming quality;
- stucco embossed,
- 0.19 mm (3/16 in) corrugated.

.2 fittings:

(a) custom made swaged ring or lobster back covers on bends and die shaped fitting covers over pipe fittings, round duct fittings, valves, strainers, flanges, and grooved couplings.

.3 bands:

(a) 12 mm (½ in) wide stainless steel with mechanical fasteners.

*Standard of Acceptance*
- Alcan Canada Products - fig. Thermaclad Type 1
- Childers Products Inc. - fig. Fab Straps
-

.4 Protective finish for elastomeric cellular foam insulation

.1 indoors and outdoors:

*Standard of Acceptance*
- Armaflex WB Finish

### 2.6 Insulation

.1 Refer to specification sections for duct, equipment, and piping insulation.

## 3 EXECUTION

### 3.1 General Requirements

.1 Apply insulation after pressure and leakage testing is completed and accepted, and heat tracing (if any) is installed.

.2 Surfaces to be clean and dry before application of insulation.

.3 Store and use adhesives, mastics, and insulation cements at ambient temperatures and conditions recommended by the product manufacturers.

.4 Do not apply insulation on chrome plated surfaces of piping, valves, fittings, and equipment.

.5 Cut and bevel insulation around nameplates and pressure vessel certification stamps, seals or similar markings.

.6 Neatly finish insulation at supports, protrusions, and interruptions.

.7 Where insulation media is exposed, seal the insulation with reinforced vapor barrier or breather coating or mastic.

### 3.2 Installation of Insulation

.1 Refer to specification sections for duct, equipment, and piping insulation.

### 3.3 Sealing of Insulation – General Requirements

.1 The following requirements apply to all mechanical insulation unless otherwise specified in each mechanical service insulation specification section. Refer to separate specifications for specific sealing requirements for ductwork, equipment and piping insulation.

.2 Apply sealer coatings and mastic in accordance with the following:

.1 use breather coating/mastics for hot services:

.2 use vapour barrier coating/mastic for cold and dual temperature services:

.3 only use mastics on outdoor installations.

.4 apply mastics and coatings when ambient temperature is above 4°C (40°F), unless manufacturer's instructions permit colder ambient installation conditions.

.3 Maintain integrity of vapour barrier through sleeves, around fittings and at hangers and supports.

**3.4 Insulation Finish Coverings**

.1 Where required to be provided by other mechanical insulation specification sections, install protective finish coverings (jackets) in accordance with the following.

.2 Install protective finish coverings on insulation after breather and vapor barrier sealing is completed.

.3 For hot services that are exposed in wet areas, secure and seal coverings in accordance with the requirements for cold and dual temperature services.

.4 Cut finish covering materials to allow 50 mm to 100 mm (2 in to 4 in) overlaps onto adjacent sheets. On vertical services, arrange circumferential overlaps to be on the lower end of each cover section.

.5 PVC jackets:

.1 Adhesives and sealers to be compatible with PVC material.

.2 Hot services;

(a) secure sheeting with colour matched tape around circumference, at least two places per section of sheet, and by stapling longitudinal and circumferential edges,
(b) except in wet areas, do not seal major joint edges with vapour barrier tape,
(c) seal PVC fitting covers at throat and heel seams by stapling and secure over adjacent insulation covers by banding or taping ends to adjacent finish covering with colour matched tape.
(d) Install PVC covers in accordance with the requirements for cold and dual temperature services.

.3 Cold and dual temperature services:

(a) seal longitudinal edges with vapor barrier coating adhesive or colour matched vapour barrier tape for the full length and depth of the overlap,
(b) seal circumferential butt edges of PVC fitting covers with reinforced vapour barrier coating adhesive extending over adjacent pipe insulation section with an overlap of at least 50 mm (2 in),
(c) seal PVC fitting covers at throat and heel seams by solvent bonding and secured over insulation with reinforced vapor barrier coating overlapping adjacent service insulation a minimum of 50 mm (2 in),
(d) neatly finish exposed edges with vapour barrier sealant/mastic.

.6 Metal jackets:

.1 use stucco embossed metal jackets on round surfaces with diameter of 2.4 m (8 ft) and smaller; refer to applicable duct, equipment and piping specification sections for metal type.

.2 use corrugated stainless steel metal jackets on flat surfaces, and on round surfaces with diameters greater than 2.4 m (8 ft).

.3 apply metal jacketing over mechanical services, with a 60 mm (2-1/2 in) overlap,

.4 use lock-on systems or secure sheeting with bands 450 mm (18 in) apart.

.5 make-up curved surfaces with custom made swaged ring or lobster back covers.

.6 for indoor mechanical services;

(a) seal cover joints for cold and dual temperature services with clear or colour-matched calking.

.7 on outdoor mechanical services;

(a) seal cover joints for cold and dual temperature services with clear or colour-matched calking to permit expansion of metal jacket.

.7 Fabric jackets:

.1 Cotton lagging:

(a) apply cotton lagging with minimum two coatings of breather or vapor barrier coating adhesive as applicable to the piping system, and finish to provide a smooth surface free of wrinkles and sags.

(b) where cotton lagging with appropriate coating is used this satisfies the requirements of a sealer coating for cold and dual temperature services.

.2 Fiberglass lagging:

(a) apply re-wettable fiberglass lagging in accordance with manufacturer instructions, and finish to provide a smooth surface free of wrinkles and sags.

(b) for cold and dual temperature services, apply a finish coat of vapour barrier sealer.

(c) where re-wettable fiberglass lagging is used this satisfies the requirements of a breather coating for hot piping systems,

## 3.5 Mechanical Damage Protection - Indoors

.1 Protect visible pipe insulation extending up through a floor sleeve at the floor line with 1.2 mm (18 ga) stainless steel jacket approximately 100 mm (4 in) high, secured to floor slab. Conceal fastenings by use of a floor plate.

.2 For piping systems using finishes, this protection cover is in addition to the specified pipe finish cover.

## 3.6 Field Quality Control

.1 The Consultant reserves the right to have protective finish coverings removed on up to 1% of all cold service and dual temperature service surfaces, fittings, flanges, couplings, valves, and ductwork/pipeline accessories to review the installation of the insulation, at no additional cost.

.2 If insulation sealing is found to be incorrect at any one sampled location, remove the protective finish on all fittings, flanges, couplings, valves, and pipeline accessories for review, at no additional cost.

.3 Repair defective insulation sealing and replace protective coverings at no additional cost.

**End of Section**

# DUCTWORK INSULATION
# 20 07 13

## 1 GENERAL

### 1.1 Scope

.1 Provide insulation, coatings, finish coverings and mechanical protection for ducts, casing, plenums, fans and associated equipment.

.2 insulation is not required on factory insulated casings and/or over acoustically lined ductwork except as otherwise shown.

.3 Conform to specification section 20 07 11 for common requirements for mechanical insulation.

### 1.2 Related Sections

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

.1 20 07 11 Common Requirements for Mechanical Insulation

## 2 PRODUCTS

### 2.1 General Requirements

.1 Insulation, adhesives, coatings, finish coverings, lagging, sealers, and tapes:

.1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84,

.2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84,

.3 exception: vapor barrier mastics on mechanical services located outside of the building.

### 2.2 Ductwork Insulation

.1 Type D-1 (glass-fibre roll blanket):

.1 flexible glass-fibre blanket, formaldehyde-free to ASTM C1290,

.2 density: 12 kg/m$^3$ (0.75 pcf),

.3 service temperature with jacketed: up to 65°C (150°F),

.4 foil skim kraft (“FSK”) jacket of aluminum foil reinforced with glass fibre yarn, and laminated to kraft paper,

.5 vapour transmission: maximum 0.02 perms to ASTM E96 Procedure A,

.6 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.7 minimum RSI values at a mean temperature of 24°C (75°F) at the pre-installed nominal insulation thickness:

| Nominal Thickness mm (in) | RSI m·°C/W | Nominal Thickness mm (in) | RSI m·°C/W |
|---|---|---|---|
| 25 (1) | 0.53 | 55 (2.2) | 1.06 |
| 40 (1.5) | 0.74 | 110 (4.4( | 2.11 |

*Standard of Acceptance*

° Johns Manville - Microlite FSK Duct Wrap

- ° Owens Corning - SOFTR Duct Wrap
- ° Knauf Fibreglass - Atmosphere Duct Wrap

.8 Same as above except provided with a PSK (polypropylene-scrim-draft) vapour barrier jacket.

*Standard of Acceptance*

- ° Johns Manville - Microlite Black PSK

.2 Type D-2 (rigid glass fibre board):

.1 rigid glass-fibre insulation board to ASTM C612,

.2 density:

(a) indoors: 48 kg/m$^3$ (3.0 lb/ft$^3$),
(b) outdoors: 96 kg/m$^3$ (6.0 lb/ft$^3$),

.3 service temperature:

(a) unfaced board: up to 232°C (450°F),
(b) faced board: up to 65°C (150°F),

.4 foil skim kraft (“FSK”) jacket of aluminium foil reinforced with glass fibre yarn, and laminated to kraft paper,

.5 vapor transmission: maximum 0.02 perms,

.6 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.7 minimum RSI values at a mean temperature of 24°C (75°F) at the specified insulation thickness:

| Nominal Thickness mm (in) | RSI m·°C/W | Nominal Thickness mm (in) | RSI m·°C/W |
|---|---|---|---|
| 25 (1) | 0.76 | 50 (2) | 1.51 |
| 40 (1-1/2) | 1.14 | 75 (3) | 2.27 |

*Standard of Acceptance*

- ° Johns Manville - Manville 814 Spin-Glas
- ° Owens Corning - 703 Board
- ° Knauf Fiberglass - Insulating Board

.3 Type D-3 (mineral fibre board, high temperature)

.1 rigid-board, mineral fibre to ASTM C411,

.2 density: 145 kg/m$^3$ (9.1 lb/ft$^3$),

.3 service temperature: up to 700°C (1292°F),

.4 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.5 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

| Mean Temperature °C | Conductivity W/(m·°C) | Mean Temperature °C | Conductivity W/(m·°C) |
|---|---|---|---|
| 100 | 0.044 | 700 | 0.158 |

*Standard of Acceptance*

° Roxul - ProRox SL 980

# 3 EXECUTION

## 3.1 Applicable Systems to be Insulated

.1 Insulate ductwork, plenums, casings and equipment in accordance with the following, and of the insulation type and thickness in accordance with Table 1 at the end of this specification section.

.2 Externally insulate casings and equipment:

.1 air handling units producing conditioned supply air,

.2 air handling units conveying exhaust air downstream of heat recovery devices,

.3 free-standing supply air fans (not enclosed in a casing or plenum).

.3 Externally insulate ductwork and plenums:

.1 cold and dual temperature ductwork conveying conditioned supply air including downstream of reheat coils,

.2 hot ductwork conveying conditioned supply air up to the space served but not within the space itself,

.3 unconditioned supply air ducts and plenums located in unheated spaces,

.4 return air and exhaust air ducts and plenums in unheated spaces,

.5 outside air intake ducts and plenums,

.6 exhaust air plenums at point of discharge to outside of building,

.7 exhaust air ducts and plenums downstream of heat recovery devices,

.8 exhaust air ducts between exhaust air damper and point of discharge to outside of building,

.9 mixed air plenums and ducts;

(a) for recirculating type ventilation systems without cooling coils, terminate outside air intake insulation 300 mm (12 in) downstream of mixing plenum,

.10 150 mm (6 in) entering and leaving length overlap of acoustically lined ductwork,

.11 sheet metal blank-off plates behind unused sections of air intake louvres.

.4 Externally insulate ductwork located outdoors:

.1 conditioned supply ducts,

.2 return ducts,

.3 general and process exhaust ducts between building and rooftop exhaust fan,

(a) excluding outdoor fan discharge duct,

.4 kitchen exhaust ducts between building and rooftop exhaust fan, with more than 3 m (10 ft) length of duct on roof,

(a) excluding outdoor fan discharge duct.

.5 External insulation is not required on:

.1 casings, ducts or plenums which have been lined with acoustic insulation, except as described above,

.2 ducts, plenums, casings and freestanding supply fans conveying unconditioned air,

.3 portions of intake ducts or plenums, unit casings and conditioned air plenums which are of double wall insulated construction,

.4 factory insulated flexible ducts,

.5 factory insulated air handling units,

.6 for non-recirculating make-up air type ventilation systems with a supply air temperature less than 27°C (80°F),

(a) terminate casing insulation 300 mm (12 in) downstream of heating coil or heating unit, and
(b) insulation is not required on the supply ductwork.

### 3.2 Installation of Rigid Insulation - Indoors

.1 Attach insulation fastener pins, studs and clips to all surfaces of ducts, casings, plenums and fans, at approximately 300 mm (12 in) centers, each direction, but not less than two (2) rows per duct. Attachment method:

.1 welded type for outdoor ducts,

.2 welded type for indoor ducts,

.3 self-adhesive base type may be used for vertical surfaces of rectangular ducts.

.2 Install rigid board insulation with joints staggered and tightly butted and no visible gaps. Install horizontal boards to overlapping over vertical boards.

.3 Secure rigid insulation by impaling on insulation fastener pins, apply speed washers and cut off excess pin length flush with speed washer. Cover washers with vapour barrier tape extending at least 50 mm (2 in) beyond the washer.

.4 Where space restrictions do not permit the use of mechanical fasteners, secure the insulation with 100% coverage of contact adhesive along with stainless steel banding on 300 mm (12 in) centers, with a band within 50 mm (2 in) of each duct corner.

.5 Neatly finish insulation at supports, protrusions, and interruptions.

.6 Apply colour matched vapour barrier tape neatly and firmly to all joints, including outside and inside corner joints, and at any exposed ends of insulation and cuts or damage to the insulation jacket. Alternatively, apply two heavy coats of applicable sealer coat and with reinforcing membrane. Extend tape or coating at least 50 mm (2 in) on each side of joint, exposed ends of insulation or repairs to insulation jacket.

### 3.3 Installation of Flexible Insulation – Indoors

.1 On rectangular ducts 600 mm (24 in) and wider, and round ducts 450 mm (18 in) and wider, attach mechanical fastener pins, studs and clips to the bottom exterior surface of the duct at approximately 300 mm (12 in) centers, each direction, but not less than two (2) rows per duct. For round ductwork, the bottom of the duct is measured as being half the circumference of the duct.

.2 Cut flexible insulation to required circumferential length and pull-out to final installed thickness in accordance with manufacturer instructions, and to overlap insulation 50 mm (2 in) on each lap joint, and tightly butt end edges together.

.3 Secure flexible insulation by:

.1 impaling on mechanical fastener pins and secure with speed washers, and either;

(a) secure insulation with stainless steel wire or stainless steel banding on 300 mm (12 in) centers, or by stapling laps, or
(b) secure insulation with 100% insulation adhesive coverage.

.4 Cut off excess pin length flush with speed washer. Cover washers with vapour barrier tape extending at least 50 mm (2 in) beyond the washer.

.5 Neatly finish insulation at supports, protrusions, and interruptions.

.6 Apply colour matched vapour barrier tape neatly and firmly to all joints, including outside and inside corner joints, and at any exposed ends of insulation and cuts or damage to the insulation jacket. Alternatively, apply two heavy coats of applicable sealer coat and with reinforcing membrane. Extend tape or coating at least 50 mm (2 in) on each side of joint, exposed ends of insulation or repairs to insulation jacket.

### 3.4 Insulation of Fittings, Flanges and Accessories

.1 Cut and miter rigid insulation at elbows and fittings and attach to ductwork with mechanical fasteners as specified for ducts, and in addition secure insulation with 50% coverage of adhesive.

.2 At junctions between external insulation and acoustically lined ducts, overlap external insulation 300 mm (12 in) over acoustically lined ducts.

.3 Insulate flanges, support angles and standing seams with 100 mm (4 in) wide overlapping strips of insulation matching adjacent ductwork and of same thickness, and seal with two coats of breather mastic with reinforcing membrane.

### 3.5 Sealing Insulation - Hot Ductwork

.1 Seal hot ductwork insulation in accordance with specification section 20 07 11 and/except as specified herein.

.2 Indoor installation (except wet areas):

- .1 apply vapour barrier tape to butt joints, overlapping by at least 50 mm (2 in) each side,
- .2 do not tape longitudinal lap seams except as required to secure the insulation.

.3 Indoor installations – wet areas:

- .1 apply vapour barrier tape to:
  - (a) all longitudinal lap seams and butt edges,
  - (b) 100% coverage of insulation at pipe joints, fittings, couplings, etc.
  - (c) over insulation fasteners including pins/washers and staples.

### 3.6 Sealing Insulation - Cold and Dual Temperature Ductwork

.1 Seal cold and dual temperature ductwork insulation in accordance with specification section 20 07 11 and/except as specified herein.

.2 Indoor installation (except wet areas):

- .1 tightly seal insulation lap seams and butt joints, using factory lap seams or field-fabricated lap seams and butt strips,
- .2 apply vapor barrier coating with reinforcing membrane to all corners, lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side,
- .3 cover insulation pin/washer fastener penetrations including staples with vapour barrier coating with reinforcing membrane, overlapping the fasteners by a minimum of 50 mm (2 in) in all directions.

.3 Indoor installation – wet areas:

- .1 tightly seal ductwork located within wet areas in accordance with the requirements for outdoor installation except use vapour barrier coatings.

.4 Outdoor installation:

- .1 apply two coasts of vapour barrier mastic with reinforcing membrane to all corners, lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side, and to all insulation that does not have a factory installed jacket,
- .2 cover mechanical fastener penetrations including staples with two coats vapour barrier mastic with reinforcing membrane, overlapping the fasteners by a minimum of 50 mm (2 in) in all directions.

### 3.7 Insulation Finish Covering

.1 Provide insulation protective finish coverings selected in accordance with Table 2 at the end of this specification section and installed in accordance with specification section 20 07 11 and/except as specified herein.

.2 For self-adhesive weather barrier (SAWB) coverings;

.1 apply SAWB in accordance with manufacturer's instructions,

.2 apply 100 mm x 100 mm (4 in x 4 in) sections of SAWB over insulation pin/washer fasteners before applying SAWB over entire duct,

.3 for rectangular ducts, overlap adjacent covering surface with an overlap of not less than 100 mm (4 in) as follows:

(a) for top horizontal surfaces, overlap higher covering surface over lower surface across the duct in the direction of sloping insulation,
(b) for top horizontal surfaces, overlap covering surface in one direction along the duct run,
(c) overlap top horizontal surfaces over adjacent vertical surfaces, with an overlap of not less than 100 mm (4 in),
(d) overlap vertical surfaces over adjacent bottom horizontal surfaces, with an overlap of not less than 100 mm (4 in), and secure with an additional 50 mm (2 in) wide strip applied across the overlap seam on the underside of the duct.

.4 for round ducts,

(a) do not place an overlap within one-eighth duct diameter on each side of the duct top centerline,
(b) overlap higher layers over lower layers with an overlap not less than 100 mm (4 in).

### 3.8 Painted Ductwork

.1 Not applicable.

### 3.9 Mechanical Damage Protection - Indoors

.1 Protect exposed insulated ductwork from floor level up to a height of 1200 mm (4 ft) above the floor with 0.9 mm (20 ga) galvanized steel jacket, with riveted longitudinal seams and mechanically fastened to the floor with countersunk stainless steel screws.

.2 Where waterproof floor sleeves are required, the floor sleeve may be combined with this requirement.

### 3.10 Insulating and Finishes Tables

.1 The insulating and finishing tables follow:

.1 Table 1 - Ductwork, Insulation Type and Thickness

.2 Table 3 - Ductwork Insulation Protective Finishes.

**Table 1:**
**Ductwork Insulation Type and Thickness**

| Duct Nominal Air Temperature | Location | Equipment Description | Insulation Type | Insulation Thickness mm (in) [Note 1] |
|---|---|---|---|---|
| 5°C to 65°C (40 to 150°F) | Indoors | Air handling unit casings and plenums, Free standing supply fans | D-2 | 50 (2) |
| | | Rectangular ducts and plenums – exposed or concealed | D-2 | 25 (1) |
| | | Rectangular ducts - concealed | D-1 | 25 (1) |
| | | Round and Oval ducts - exposed | | |
| | Unconditioned Space | Rectangular ducts and plenums | D2 | 40 (1-1/2) |
| | | | D1 | 55 (2.2) |
| | | Round and Oval ducts | D1 | 55 (2.2) |
| | Outdoors | Rectangular – Supply, Return | D-2 | 75 (3) |
| | | Round and Oval – Supply, Return | D-1 | 110 (4.4) [Note 2] |
| | | Rectangular – Process and General Exhaust | D-2 | 1 (25) |
| | | Round – Process and General Exhaust | D-1 | 1.5 (40) |
| | | Rectangular - Kitchen Exhaust | D-3 | 50 (2) |

…. continued on next page

**Table 1: (continued)**
**Ductwork Insulation Type and Thickness**

| Duct Nominal Air Temperature | Location | Equipment Description | Insulation Type | Insulation Thickness mm (in) [Note 1] |
|---|---|---|---|---|
| -40 to +40°C (-40 to 104°F) | Indoors | Plenums and Casings – Air Intakes | D2 | Two layers 50 (2) |
| -10 to +40°C (14 to 104°F) | Indoors | Plenums and Casings – Exhaust | D2 | 50 (2) |
| 5 to 16°C | Indoors | Drain Pans | D2 | 1 (25) |

***Notes:***
*[1] Type D-1 flexible duct insulation thickness is "out of box" before installation.*
*[2] Insulation thickness may be provided by two layers, so that the total insulation thickness "out of the box" is equal to or greater than the specified thickness.*

**Table 2:**
**Ductwork Insulation Protective Finish Coverings**

<table>
<tr><th>Exposed/ Concealed</th><th>Location</th><th>System/ Space</th><th>Protective Finish Covering</th></tr>
<tr><td>Concealed</td><td>Indoors</td><td>All</td><td>None</td></tr>
<tr><td rowspan="3">Exposed</td><td rowspan="2">Indoors</td><td>Service Rooms</td><td>Fabric</td></tr>
<tr><td>Public Spaces</td><td>Fabric</td></tr>
<tr><td>Outdoors</td><td>All</td><td>N/A</td></tr>
</table>

**End of Table 2**

**End of Section**

# PIPING INSULATION
# 20 07 19

## 1 GENERAL

### 1.1 Scope

.1 Provide insulation, coatings, finishing coverings and mechanical protection of piping, valves, fittings, and pipeline accessories.

.2 Conform to specification section 20 07 11 for common requirements for mechanical insulation.

### 1.2 Related Sections

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

- .1 20 05 29 Common Hanger and Support Requirements for Piping
- .2 20 07 11 Common Requirements for Mechanical Insulation

## 2 PRODUCTS

### 2.1 General Requirements

.1 Insulation, adhesives, coatings, finish coverings, lagging, sealers, and tapes:

- .1 maximum flame spread rating of 25 to CAN/ULC-S102/102.2 or ASTM 84.
- .2 maximum smoke developed rating of 50 to CAN/ULC-S102/102.2 or ASTM 84.
- .3 exception: vapor barrier mastics on mechanical services located outside of the building

### 2.2 Pipe Insulation

.1 Type P-1 (molded glass-fibre):

- .1 factory molded rigid glass-fibre to ASTM C547,
- .2 nominal pipe size: NPS 24 and smaller,
- .3 service temperature, jacketed: -18°C (0°F) to 65°C (150°F),
- .4 all-service-jacket ("ASJ") of white kraft paper bonded to aluminum foil, reinforced with glass fibre yarn, and laminated to an interior kraft paper face,
- .5 vapor transmission: maximum 0.02 perms to ASTM E96,
- .6 listed to CAN/ULC-S102/S102.2 or ASTM E84,
- .7 reduced environmental impact feature of either: bio-based binders, 25% minimum recycled glass content, and/or paper-free ASJ jacket material,
- .8 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

| Mean Temperature °C | Conductivity W/(m·°C) | Mean Temperature °C | Conductivity W/(m·°C) |
|---|---|---|---|
| 24 | 0.034 | 93 | 0.040 |

*Standard of Acceptance*
- Johns Manville - Micro-Lok HP (25% recycled content)
- Owens Corning - Fiberglas Evolution (paper-free ASJ)

- Knauf Fiberglass - Earthwool 1000 Ecose (bio-based binders)

.2 Type P-2 (semi-rigid glass-fibre roll):

.1 glass fibre semi-rigid roll insulation for tanks and pipes, to ASTM C1393 or ASTM C177,

.2 glass-fibre oriented to maintain uniform thickness when installed on round surfaces,

.3 density: 400 kg/m$^3$ (2.5 lb/ft$^3$),

.4 nominal pipe size: NPS 14 and larger,

.5 service temperature with jacket: up to 65°C (150°F),

.6 all-service-jacket ("ASJ") of white kraft paper bonded to aluminum foil, reinforced with glass fibre yarn, and laminated to an interior kraft paper face,

.7 vapor transmission: maximum 0.02 perms to ASTM E96,

.8 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.9 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

| Mean Temperature °C | Conductivity W/(m·°C) | Mean Temperature °C | Conductivity W/(m·°C) |
|---|---|---|---|
| 24 | 0.035 | 93 | 0.046 |

*Standard of Acceptance*

- Johns Manville - Micro-Flex Pipe and Tank Wrap
- Owens Corning - Fiberglas Pipe and Tank
- Knauf Fibreglass - KwikFlex Pipe and Tank

.3 Type P-3 (molded mineral fibre):

.1 factory molded mineral fibre to ASTM C547,

.2 density: 128 kg/m$^3$ (8.0 lb/ft$^3$),

.3 nominal pipe size: NPS 30 and smaller,

.4 service temperature: up to 650°C (1200°F),

.5 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.6 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

| Mean Temperature °C | Conductivity W/(m·°C) | Mean Temperature °C | Conductivity W/(m·°C) |
|---|---|---|---|
| 38 | 0.036 | 149 | 0.049 |

*Standard of Acceptance*

- Roxul - ProRox PS 960
- Johns Manville - MinWool-1200
- Industrial Fiber-Tek - IFT 1200 Pipe

.4 Type P-4 (molded mineral fibre, high temperature):

.1 factory molded mineral fibre, high temperature, to ASTM C547,

.2 density: 145 kg/m$^3$ (9.1 lb/ft$^3$),

.3 nominal pipe size: NPS 6 and larger,

.4 service temperature: up to 730°C (1350°F),

.5 compressive strength: 53 kPa (8 psi) at 10% compression,

.6 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.7 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

| Mean Temperature °C | Conductivity W/(m·°C) | Mean Temperature °C | Conductivity W/(m·°C) |
|---|---|---|---|
| 38 | 0.039 | 149 | 0.049 |

*Standard of Acceptance*
° Roxul ProRox PS 980

.5 Type P-5 (cellular glass):

.1 fabricated pipe and fitting shapes, cellular glass to ASTM C552,

.2 density: 120 kg/m3 (7.5 lb/cu ft),

.3 nominal pipe size: NPS 16 and smaller,

.4 service temperature: -268°C (-450°F) to 480°C (900°F),

.5 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.6 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

| Mean Temperature °C | Conductivity W/(m·°C) | Mean Temperature °C | Conductivity W/(m·°C) |
|---|---|---|---|
| 10 | 0.040 | 24 | 0.042 |

*Standard of Acceptance*
° Owens Corning - fig. Foamglas

.6 Type P-6 (elastomeric foam plastic):

.1 flexible elastomeric closed cell foam, tubular with self-sealing seams, to ASTM C534,

.2 nominal pipe size: NPS 2 and smaller,

.3 service temperature: -183°C (-297°F) to 82°C (183°F),

.4 manufacturer specific sealer/adhesive,

.5 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.6 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

| Mean Temperature °C | Conductivity W/(m·°C) | Mean Temperature °C | Conductivity W/(m·°C) |
|---|---|---|---|
| 24 | 0.035 | 32 | 0.037 |

*Standard of Acceptance*
° Armacell - AP Armaflex SS Pipe Insulation
° KFlex USA - Insul-Tube

.7 Type P-7 (calcium silicate):

.1 fabricated pipe and fitting shapes, calcium silicate, asbestos-free, to ASTM C533 Type I,

.2 density: 232 kg/m3 (14.5 lb/cu ft),

.3 integral corrosion inhibitor to reduce under insulation corrosion,

.4 nominal pipe size: NPS 4 to NPS 24,

.5 service temperature: 20 to 649°C (70 to 1200°F).

.6 listed to CAN/ULC-S102/S102.2 or ASTM E84,

.7 not to exceed a maximum thermal conductivity at the following meant insulation temperatures:

| Mean Temperature °C | Conductivity W/(m·°C) | Mean Temperature °C | Conductivity W/(m·°C) |
|---|---|---|---|
| 38 | 0.050 | 93 | 0.056 |

*Standard of Acceptance*
° Johns Manville - Thermo-12 Gold

.8 Type P-8 (removable high-temperature insulated jackets):

.1 custom fabricated, removable/reusable high temperature insulated jackets for hot surfaces,

.2 suitable for indoor and outdoor use,

.3 process surface temperature: as shown in Table 1,

.4 maximum outer jacket touch-safe temperature protection: 95°C (203°F),

.5 outer jacket: silicone impregnated glass-fibre, for temperatures up to 260°C (500°F),

.6 insulation: mineral or fibreglass insulation suitable for system operating temperature,

.7 internal liner: silicone impregnated fibreglass fabric, or stainless steel knitted wire mesh,

.8 fasteners:

(a) stainless steel laced wire, for pipe sections,
(b) stainless steel mesh straps with buckle rings, for valves, strainers, meters and similar pipeline accessories,

.9 metal identification tag, referenced equipment served.

*Standard of Acceptance*
° Firwin Corporation
° Thermohelp Canada Inc.

## 2.3 Pipe Support Inserts

.1 General:

.1 molded or fabricated high-density molded insulation inserts for pipe supports.

.2 Type P-21 (polyisocyanurate):

.1 polyurethane modified polyisocyanurate, to ASTM C591, Gr.2, Type IV,

.2 nominal pipe size: NPS 1-1/2 to NPS 4,

.3 density: nominal 32 kg/m$^3$ (2 lb/ft$^3$),

.4 minimum compressive strength perpendicular to pipe surface: 165 kPa (24 psi),

.5 service temperature: -73ºC to +121ºC (-100ºF to 250ºF),

.6 listed to CAN/ULC-S102/S102.2 or ASTM E84.

*Standard of Acceptance*
° Trymer - 24-50 PIR

.3 Type P-22 (cellular glass):

.1 cellular glass to ASTM C552,

.2 nominal pipe size: NPS 1-1/2 to NPS 24,

.3 density: nominal 120 kg/m$^3$ (7.5 lb/ft$^3$),

.4 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),

.5 service temperature: -73ºC to+121ºC (-100ºF to 250ºF),

.6 listed to CAN/ULC-S102/S102.2 or ASTM E84.

*Standard of Acceptance*
° Owens Corning - Foamglas

.4 Type P-23 (calcium silicate):

.1 calcium silicate to ASTM C533 Type I, with integral corrosion inhibitor to reduce under insulation corrosion, asbestos-free,

.2 nominal pipe size: NPS 1-1/2 to NPS 24,

.3 density: nominal 232 kg/m$^3$ (14.5 lb/cu ft),

.4 minimum compressive strength perpendicular to pipe surface: 620 kPa (90 psi),

.5 service temperature: 20 to 649°C (70 to 1200°F),

.6 thermal performance: 0.058 W/m/C @ 149°C (0.40 btu/hr/in/sq ft/F @ 300°F).

*Standard of Acceptance*
° Johns Manville - Thermo-12 Gold

### 2.4 PVC Jackets

## 3 EXECUTION

### 3.1 General

.1 Where repairs are made to existing insulated piping due to connections of new piping work, the insulation thickness for the existing piping is permitted to match the existing insulation nominal thickness, provided the extent of new insulation does not exceed a length of 1000 mm (39 in).

### 3.2 Applicable Systems – Hot piping

.1 Insulate Hot piping systems including pipe, valves, fittings, and pipeline accessories in accordance with Table 1 at the end of this specification section.

.2 Insulate condensate piping in accordance with the same criteria as its associated steam system.

.3 Insulate piping for safety valves or safety relief valves that is located;

.1 less than 2.4 m (8 ft) above a floor or work surface, or

.2 within 1 m (39 in) horizontally of, and less than 2.4 m (8 ft) above, an elevated work surface.

### 3.3 Applicable Systems - Cold and Dual Temperature Piping

.1 Insulate Cold and Dual temperature piping systems including pipe, valves, fittings, and pipeline accessories in accordance with Table 2 at the end of this specification section.

.2 Insulate the following drainage services or equipment:

.1 storm water drainage systems in the following locations:

(a) roof drain bodies,
(b) rainwater leaders (storm water piping) from roof drain bodies to the floor level below the drain body,
(c) rainwater leaders in or above data and telecommunication rooms,
(d) rainwater leaders in or immediately above wet areas.

.2 sanitary piping in the following locations:

(a) horizontal sanitary drainage piping NPS 3 and larger in ceiling spaces,
(b) sanitary drainage piping in or above wet areas,
(c) sanitary drainage piping in or above data and telecommunication rooms,
(d) exposed sanitary drainage piping in service tunnels,
(e) exposed sanitary drainage piping serving spaces located in a parking garage,
(f) and where shown on drawings].

.3

## 3.4 Insulating Hot Piping

.1 Secure insulation for domestic hot water piping, domestic hot water and recirculation piping, non-potable hot water piping and non-potable hot water recirculation piping in accordance with the requirements for insulating Cold and Dual Temperature piping.

.2 Insulate straight pipe sections by staggering adjacent longitudinal seams 1/4 turn for each butt joint.

.3 Secure insulation with integral ASJ jackets by stapling the lap flap on 75 mm (3 in) centers or by use of self-sealing lap adhesive strip.

.4 Secure insulation that does not have an integral ASJ jacket by use of stainless steel wire at not less than 300 mm (12 in) centers, or by a continuous wire helix on the same center spacing.

.5 For type P-2 and P-4 insulation, or where the required pipe insulation thickness is greater than 50 mm (2 in);

.1 provide two layers of approximately equal thickness such that the total thickness is as specified,

.2 install straight pipe sections by staggering adjacent section longitudinal seams 1/4 turn for each section, and stagger butt joints between the first layer and second layer by at least 1/4 of the insulation section length, and

.3 secure the first layer of insulation with stainless steel wire on 300 mm (12 in.) centers, and secure the second layer with band straps on 300 mm (12 in) centers.

.6 Secure butt joints with vapour barrier tape or insulation butt strips.

## 3.5 Insulating Cold and Dual Temperature Piping

.1 Insulate straight pipe sections by staggering adjacent longitudinal seams 1/4 turn for each butt joint.

.2 Secure insulation with integral ASJ jackets by;

.1 sealing all lap flaps and butt strips with vapour barrier adhesive, or

.2 securing insulation with staples on 75 mm (3 in) centers and covering longitudinal seams with vapour barrier tape, or

.3 use of integral self-sealing vapour barrier jacket with lap flaps and butt strips.

.3 Except for type P-6 insulation, secure insulation that does not have an integral ASJ jacket by:

.1 use of 12 mm (1/2 in.) wide reinforced filament tape on approximately 150 mm (6 in.) centers for piping NPS 4 and smaller, and use stainless steel banding on 225 mm (9 in.) centers for piping NPS 6 and larger, and

(a) apply an all-service-jacket with 100% coverage of adhesive suitable for the insulation material, with longitudinal and butt seams having a 50 mm (2 in) overlap, and seal the laps with vapour barrier adhesive/ coating, or
(b) apply a heavy brush coat of vapour barrier coating at the rate of 1.2 L/m$^2$ (2.5 Imp.gallon per 100 ft$^2$), embed a layer of reinforcing membrane, and then applying a second heavy brush coat of vapour barrier coating at the rate of 1.0 L/m$^2$ (2.1 Imp.gallon per 100 ft$^2$).

.4 For type P-2 insulation, or where the required pipe insulation thickness is greater than 50 mm (2 in);

.1 provide two layers of approximately equal thickness such that the total thickness is as specified,

.2 install straight pipe sections by staggering adjacent section longitudinal seams 1/4 turn for each section, and stagger butt joints between the first layer and second layer by at least 1/4 of the insulation section length, and

.3 secure the first layer of insulation with stainless steel wire on 300 mm (12 in.) centers, and secure the second layer with stainless steel banding on 225 mm (9 in) centers.

.5 Secure type P-6 insulation with field-applied adhesive or self-adhesive longitudinal edge seams, and apply vapour barrier adhesive/sealant to butt joints.

.6 Secure butt joints with vapour barrier tape, unless otherwise sealed using vapour barrier adhesives and coatings.

.7 For straight pipe runs greater than 15 m (50 ft) and at every 15 m (50 ft) length thereafter, provide an insulation expansion joint consisting of 50 mm (2 in) wide flexible glass-fibre insulation for full depth of pipe insulation. Seal adjacent pipe insulation ends with vapour barrier coating.

.8 Where pipe anchors are attached to chilled water piping;

.1 insulate the pipe anchor to a distance equal to 10 times the largest outside dimension of the anchor structure element, but not less than 150 mm (6 in) beyond pipe insulation outer surface,

.2 insulate with sheet form of type P-3 insulation and seal the seams with insulation manufacturer's sealant. Seal the joint between the pipe insulation and anchor insulation, and between the anchor insulation and the anchor structure where the insulation terminates.

### 3.6 Insulation of Fittings, Flanges, and Couplings – Hot, Cold and Dual Temperature Piping

.1 Insulate fittings including elbows and tees, other than flanges and grooved-couplings:

.1 NPS 1½ and smaller:

(a) miter cut insulation to create tight fit,
(b) where PVC covers are used, trim backside of insulation on elbows to suit cover but do not reduce total thickness less than that of adjacent pipe insulation.

.2 NPS 2 and larger:

(a) use matching preformed insulation inserts, or fabricate tightly-fitting mitered insulation segments made from the same material as pipe insulation,
(b) number of mitered segments to be sufficient to maintain thickness of insulation around throat of elbow or tee,

.2 Insulate flanges and grooved-joint couplings:

.1 insulate with preformed inserts or build-up insulation with same material as on adjacent pipe:

(a) butt pipe insulation to each side of flange or grooved-joint coupling,
(b) build up rigid insulation blocking on each side of flange or grooved-joint coupling, with a width dimension same as pipe insulation thickness,

(c) apply insulation layer over the top of the flange or coupling to a thickness equal to pipe insulation thickness.

.3 Where type P-5 or P-7 insulation is used;

.1 insulate as described above except use factory made insulation inserts, or fabricate inserts to suit the pipe fitting, flange or coupling.

.4 Where type P-6 insulation is used;

.1 insulation as described above except adhere insulation to fitting, flange, or coupling with 100% coverage of adhesive,

.2 do not adhere insulation across bolted connections - insulate on each side of connection and add additional insulation layer across connection and fix in place with bands and seal joints.

.5 Secure insulation with stainless steel wire (Hot piping), or vapour barrier tape (all piping), prior to application of coatings and finishes.

## 3.7 Insulation of Pipeline Accessories – Hot, Cold and Dual Temperature Piping

.1 Insulate pipeline accessories depending on service temperature:

.1 valves,

.2 strainers,

.3 pressure reducing valves,

.4 control valves,

.5 meters,

.6 steam separators.

.2 Insulate pipeline accessories for Hot piping systems with sevice temperatures greater than 93°C (200°F) as follows:

.1 insulated with type P-8 removable/reusable fitted insulation covers, designed to allow free movement of valve actuator,

.2 insulation is not required at this service temperature range for drain valves, blowoff/blowdown valves, and drip caps or plugs.

.3 Insulate pipeline accessories for Hot piping systems with service temperature greater than 60°C (140°F) and up to 93°C (200°F) or less, as follows:

.1 insulated with:

(a) type P-8 removable/reusable fitted insulation covers designed to allow free movement of valve actuator, or
(b) insulated with fitted pipe insulation segments, or oversized sections of insulation arranged to permit its removal and reinstallation, or
(c) tightly placed flexible insulation and covered with PVC fitting covers.]

.2 insulation is not required at this service temperature range for drain valves, drain caps/plubs, and for pipeline accessories NPS 1 and smaller.

.4 Insulation of pipeline accessories is not required for Hot piping with service temperatures less than 60°C (104°F).

.5 Insulate pipeline accessories for chilled water, liquid refrigerant, and dual temperature heating/cooling systems as follows:

.1 detachable insulated box type with embossed aluminum or stainless steel jacket, with vapor barrier tape applied to seams when installed, and lined with one layer of 25 mm (1 in) P6 elastomeric blanket with no voids at corners or joints,

.2 alternatively, for accessories NPS 8 and larger, install one layer of 25 mm (1 in) type P-6 elastomeric blanket insulation adhered to pipeline accessories with 100% adhesive coverage, and all joints sealed with manufacturers sealant, including the joint between P-6 insulation and adjacent piping insulation,

(a) at locations requiring access, extend insulation to create a collar around bolted connection, and install a compression fit piece of insulation to cover equipment.

.3 alternatively, for accessories NPS 4 and smaller, insulate with fitted pipe insulation or mitered blocks with all joints sealed with two coats of vapour barrier coating complete with reinforcing membrane.

.6 Insulate accessories for all other Cold and Dual Temperature Piping systems as follows:

.1 insulate with flexible blanket insulation, fitted pipe insulation or mitered block of same material and thickness of adjacent piping and seal all joints with two coats of vapour barrier coating complete with reinforcing membrane or vapour barrier tape.

.7 At locations requiring access including valve handles, valve actuators, drain valves, etc. cut-back insulation and seal exposed edges.

## 3.8 Insulation of Drainage Systems - Additional Requirements

.1 In addition to the above requirements for Cold and Dual Temperature piping, insulate the underside of roof drain hoppers with flexible blanket insulation of same type as pipe insulation, and seal all joints with two coats of vapour barrier coating complete with reinforcing membrane or vapour barrier tape.

## 3.9 Insulation at Pipe Supports

.1 Provide insulation protection at pipe supports in accordance with Table 3 at the end of this section, based on pipe size and service process temperature.

.2 Installation of pipe insulation saddle protection for Hot piping:

.1 pipe saddles provided under specification section 20 05 29,

.2 insulate the interior void spaces of pipe saddles, using the same material as adjacent pipe insulation,

.3 butt insulation up to sides and end of pipe saddle, and leave bottom surface of saddle exposed for direct contact with pipe support.

.3 Installation of pipe insulation shield protection for hot and cold piping:

.1 pipe insulation shields are provided under specification section 20 05 29,

.2 provide high-density insulation inserts at the pipe support location;

(a) insert length: at least 50 mm (2 in) longer than the shield length to allow application of vapour barrier sealant or tape, but not less than the following:

| Pipe Size NPS | Insert Length mm (in) |
|---|---|
| 1 ½ to 2 | 250 (10) |
| 2 ½ - 6 | 300 (12) |
| 8 - 10 | 400 (16) |
| ≥ 12 | 560 (22) |

(b) arc width: one-half of the pipe diameter for type P-21 insets, and one-third of the pipe diameter for types P-22 and P-24 inserts,

.3 fabricate the high-density inserts so their thickness is the same as the adjacent installed pipe-run insulation, with finished surface thickness within +3 mm/-0 mm (+1/8 in / -0 in) of adjacent pipe insulation thickness,

.4 for cold water piping, apply insulation cover and vapour barrier sealant to fully cover and seal the high-density insert, and to overlap the adjacent pipe-run insulation by at least 50 mm (2 in) on all edges,

.5 install the insulation shield between the finished insulation and the support pipe; the pipe support is sized for the outside dimension of pipe and insulation.

.4 Insulation of type “T” slide supports for Cold and Dual Temperature piping

.1 insulate the exposed surfaces of the pipe slide with 12 mm (1/2 in.) thick type P-6 insulation, neatly cut and adhered to the slide steel surfaces,

.2 apply vapour barrier sealant dam at the juncture with the pipe-run insulation, and at the termination of the insulation.

.5 Insulation of type “H” slide supports for Cold and Dual Temperature piping:

.1 provide sheet metal caps to cover the open ends of the slide and secure caps with stainless steel banding, and fill the two voids in the H-slide support with polyurethane expansion foam insulation,

.2 apply 12 mm (1/2 in) thick type P-3 insulation to the exterior surfaces of the H-slide support,

.3 apply vapour barrier sealant dam at the juncture with the pipe-run insulation, and at the termination of the insulation.

## 3.10 Insulation at Floor and Wall Openings

.1 Extend pipe insulation at full required thickness through floor and wall openings, including vapour barrier jackets for Cold and Dual Temperature piping. Finish coverings for Hot piping may terminate on each side of the opening.

.2 Reduction in insulation thickness through floor or wall openings is not permitted except by prior approved by the Consultant on specific exceptional case basis.

.1 exception: thickness reduction for Hot piping as shown in Table 1 for partitions is permitted.

.3 For penetrations through fire rated separations, provide finishes in accordance with fire stopping manufacturer’s listing requirements.

.4 For outdoor piping passing through exterior walls or roof, terminate mastic lagging at outside face of sleeve and provide storm flashing to protect insulation, caulked to lagging and to building structure.

## 3.11 Sealing of Insulation – Hot Piping

.1 Seal hot piping insulation in accordance with specification section 20 07 11 and/except as specified herein.

.2 Indoor installation (except wet areas):

.1 except where a separate protective finishing jacket is used, apply vapour barrier tape to butt joints, overlapping by at least 50 mm (2 in) each side,

.2 do not tape lap joints except as required to secure the insulation,

.3 where a separate protective finishing jacket is provided, no additional sealing of the insulation is required.

.3 Indoor installations – wet areas:

.1 regardless of how insulation is secured, apply vapour barrier tape to:

(a) all longitudinal lap seams and butt edges,

(b) 100% coverage of insulation at pipe joints, fittings, couplings, etc.

.4 Outdoor installation:

.1 apply two coats of breather mastic complete with reinforcing membrane to all lap edges and butt edges, overlapping joint by minimum 50 mm (2 in) each side, and to all insulation that does not have a factory installed jacket.

### 3.12 Sealing of Insulation – Cold and Dual Temperature Piping

.1 Seal cold and dual temperature piping insulation in accordance with specification section 20 07 11 and/except as specified herein.

.2 Indoor installation (except wet locations):

.1 except for chilled water and dual temperature piping, tightly seal insulation ASJ jacket longitudinal seams and butt joints;

(a) using factory or field fabricated lap seams and butt joint strips with adhesive, or
(b) by applying colour matched vapour barrier tape to all edges, overlapping joint by minimum 50 mm (2 in) each side,
(c) where factory lap seams are damaged, apply colour matched vapor barrier tape along the damaged edges,

.2 for chilled water and dual temperature piping insulation with ASJ jackets, tightly seal longitudinal seams and butt joints;

(a) with two coats of vapor barrier coating complete with reinforcing membrane, or for pipe size NPS 6 and smaller then colour matched vapour barrier tape depending on location of piping in accordance with the following table may be used.

| Piping Location | Vapour Barrier Tape | Vapour Barrier Coating with Membrane |
|---|---|---|
| Mechanical Service Rooms | No | Required |
| Vertical Service Spaces (shafts) | No | Required |
| Tunnels and trenches | No | Required |
| Unconditioned spaces | No | Required |
| Conditioned Spaces | Permitted [Note 1] | Permitted |
| Ceiling spaces over Conditioned Spaces | Permitted [Note 1] | Permitted |
| IT rooms | No | Required |

***Notes:***
*[1] Pipe size NPS 6 and smaller only.*

(a) overlap insulation edges and butt joint by minimum 50 mm (2 in) each side,
(b) seal the butt end of the insulation with vapour barrier coating, overlapping onto the piping, at every fourth length of piping, but not to exceed 4 m (13 ft) in pipe run length.

.3 cover mechanical fastener penetrations including staples with colour matched vapour barrier tape, overlapping the fasteners by a minimum of 50 mm (2 in) in all directions.

.4 seal insulation on pipe elbows, tees, flanges, joints, couplings, and other fittings;

(a) with two coats of vapor barrier coating complete with reinforcing membrane,
(b) for pipe sizes NPS 6 and smaller, colour matched vapour barrier tape may be used in locations as described in the above table for piping.

.3 Indoor installations – wet areas:

.1 tightly seal piping located within wet areas in accordance with the requirements for outdoor installation except use vapour barrier coatings.

.4 Outdoor installation:

.1 tightly seal insulation with two coats of vapour barrier mastic complete with reinforcing membrane;

(a) at all lap edges and butt joints,
(b) 100% coverage of insulation of pipe elbows, tees, flanges, joints, couplings, and other fittings,
(c) to cover mechanical fastener penetrations including staples,
(d) in all cases overlapping the joint, fitting or fastener by a minimum 50 mm (2 in) each side.

.5 In all locations;

.1 seal insulation that does not have a factory applied ASJ jacket with 100% coverage of two coats of vapor barrier coating/mastic complete with reinforcing membrane,

.2 seal high-density inserts for pipe supports with two coats of vapour barrier coating/mastic complete with reinforcing membrane, overlapping adjacent insulation a minimum of 50 mm (2 in).

**3.13 Insulation Finish Covering (Jacket)**

.1 Provide insulation protective finish coverings selected in accordance with Table 4 at the end of this specification section and installed in accordance with specification section 20 07 11 and/except as specified herein.

.2 Self-adhesive weather barrier (SAWB) coverings;

.1 apply SAWB in accordance with manufacturer's instructions,

.2 do not place an overlap within one-eighth duct diameter on each side of the duct top centerline,

.3 overlap higher layers over lower layers with an overlap not less than 100 mm (4 in).

**3.14 Mechanical Damage Protection - Indoors**

.1 Protect visible pipe insulation extending up through a floor sleeve at the floor line with 1.2 mm (18 ga) stainless steel jacket approximately 200 mm (8 in) high, secured with rivets and mechanically fastened to the floor with countersunk stainless steel screws.

.2 Where waterproof floor sleeves are required, the floor sleeve may be combined with this requirement.

.3 For piping systems using protective finish covering, this mechanical damage protection cover is in addition to the specified pipe finish cover.

**3.15 Painted Piping**

.1 Not applicable

**3.16 Standard Details**

.1 Refer to specification section 20 05 29 for illustration of coordination of insulation with pipe supports, unless otherwise shown on drawings.

**3.17 Insulating, Support Inserts and Finishes Tables**

.1 The insulating and finishing tables follow:

.1 Table 1 - Hot piping Systems, Insulation Type and Thickness

.2 Table 2 - Cold and Dual Temperature Piping Systems, Insulation Type and Thickness

.3 Table 3 - Insulation Hanger Protection

.4 Table 4 - Piping Insulation Protective Finishes.

**Table 1:**
**Hot Piping Insulation Type and Thickness**

| System | Fluid Nominal Temp. °C (°F) | Insulation Type | Nominal Pipe Size (NPS) | | | | |
|---|---|---|---|---|---|---|---|
| | | | < 1 | 1 to 1¼ | 1½ to 3 | 4 to <8 | ≥ 8 |
| | | | Insulation Thickness, mm (in) | | | | |
| Steam and Condensate > 860 kPa (125 psi) | 177 to 315°C (351 to 600°F) | P-3 | 115 (4.5) [Note 3] | 125 (5) [Note 3] | 125 (5) | 125 (5) | 125 (5) |
| | | P-4 | --- | --- | --- | --- | 125 (5) [Note 1, 2] |
| | | P-7 | 200 (8) [Note 3] | 200 (8) [Note 3] | 200 (8) | 175 (7) | 175 (7) |
| Steam and Condensate > 100 kPa (15 psi) and ≤ 860 kPa (125 psi)<br><br>Boiler Feed Water<br><br>Safety relief piping | 122 to 176 (251 to 350) | P-1 P-3 | 80 (3 ) [Note 3] | 100 (4) [Note 3] | 115 (4.5) | 115 (4.5) | 115 (4.5) |
| | | P-2 P-4 | --- | --- | --- | --- | 150 (6) [Note 1, 2] |
| | | P-7 | 125 (5) [Note 3] | 175 (7) [Note 3] | 175 (7) | 175 (7) | 150 (6) |
| Steam and Condensate ≤ 100 kPa (15 psi)<br><br>High temperature hot water heating | 94 to 121 (201 to 250) | P-1 P-3 | 65 (2.5) [Note 3] | 65 (2.5) [Note 3] | 80 (3) | 80 (3) | 90 (3½ ) |
| | | P-2 P-4 | --- | --- | --- | --- | 100 (4) [Note 1, 2] |
| | | P-7 | 125 (5) [Note 3] | 100 (4) [Note 3] | 125 (5) | 125 (5) | 125 (5) |
| Hot Water Heating<br><br>Glycol Heating<br><br>Pumped Condensate | 61 to 93 (141 to 200) | P-1 P-3 | 40 (1½ ) [Note 3] | 40 (1½ ) [Note 3] | 50 (2) | 50 (2) | 50 (2) |
| | | P-2 P-4 | --- | --- | --- | --- | 65 (2½) [Note 1, 2] |
| | | P-7 | 65 (2½) [Note 3] | 65 (2½) [Note 3] | 65 (2½) | 65 (2½) | 65 (2½) |
| Hot Water Heating (Buried) | 61 to 93 (141 to 200) | P-5 | 50 (2) [Note 3] | 50 (2) [Note 3] | 65 (2.5) | 65 (2.5) | 65 (2.5) |

…continued on next page

**Table 1: (Continued)**
**Hot Piping Insulation Type and Thickness**

| System | Fluid Nominal Temp. °C (F) | Insulation Type | Nominal Pipe Size (NPS) | | | | |
|---|---|---|---|---|---|---|---|
| | | | < 1 | 1 to 1¼ | 1½ to 3 | 4 to <8 | ≥ 8 |
| | | | Insulation Thickness, mm (in) | | | | |
| Pure Water (with heat sanitization) | 25 to 93 (77 to 200) | P-1 P-3 | 25 (1) | 25 (1) | 25 (1) | 25 (1) | 25 (1) |
| Low Temperature Hot Water Heating<br>Low Temperature Glycol Heating | 41 to 60 (105 to 140) | P-1 P-3 | 25 (1) | 25 (1) | 40 (1½) | 40 (1½) | 40 (1½) |
| Domestic Hot Water<br>Domestic Hot Water Recirculation<br>Not-Potable Hot Water<br>Non-Portable Hot Water Recirculation | 41 to 60 (105 to 140) | P-1 P-3 | 25 (1) | 25 (1) | 40 (1 ½ ) | 40 (1 ½ ) | 40 (1 ½ ) |
| Condenser Water (outdoors) | 16.5 to 39 (61 to 104) | P-3 P-4 P-5 | 40 (1½ ) | 40 (1½ ) | 40 (1½ ) | 40 (1½ ) | 40 (1½ ) |

***Notes:***
*[1] For NPS 14 and larger.*
*[2] Install in two layers of insulation to make up total thickness.*
*[3] For piping NPS 1-1/4 and smaller located in partitions within conditioned spaces, insulation thickness may be reduced by up to 25 mm, but final thickness shall not be less than 25 mm.*

**Table 2:**
**Cold and Dual Temperature Piping Insulation Type and Thickness**

| System | Fluid Nominal Temp. °C (°F) | Insulation Type | Nominal Pipe Size (NPS) | | | | |
|---|---|---|---|---|---|---|---|
| | | | < 1 | 1 to 1¼ | 1½ to 3 | 4 to <8 | ≥ 8 |
| | | | Insulation Thickness, mm (in) | | | | |
| Dual Temperature Heating/Cooling | 4 to 93 (39 to 200) | P-1 P-3 | 40 (1½ ) | 40 (1½ ) | 50 (2) | 50 (2) | 50 (2) |
| | | P-2 | --- | --- | --- | --- | 65 (2½) [Note 1, 2] |
| Domestic Cold Water<br>Non-potable Water | 4 to 16 (39 to 61) | P-1 P-3 | 25 (1) | 25 (1) | 40 (1 ½ ) | 40 (1 ½ ) | 50 (2) |
| Storm and Sanitary Drainage | 4 to 16 (39 to 61) | P-1 | 25 (1) | 25 (1) | 25 (1) | 25 (1) | 25 (1) |
| | | P-6 | 15 (1/2) | 20 (3/4) | 25 (1) [Note 3] | --- | --- |
| Equipment Drains | 4 to 16 (39 to 61) | P-6 | 15 (1/2) | 20 (3/4) | 25 (1) [Note 3 | --- | --- |
| Chilled Water, Glycol Heat Recovery | 4 to 16 (39 to 61) | P-1 P-3 P-5 | 25 (1) | 25 (1) | 40 (1 ½ ) | 40 (1 ½ ) | 50 (2) |
| Chilled Water (Outdoors) | 4 to 16 (39 to 61) | P-3 | 50 (2) | 50 (2) | 50 (2) | 75 (3) | 75 (3) |
| Chilled Water (Buried) | 4 to 16 (39 to 61) | P-5 | 25 (1) | 25 (1) | 40 (1 ½ ) | 40 (1 ½ ) | 40 (1 ½ ) |
| Refrigerant Suction | < 4 (< 39) | P-6 | 25 (1) | 25 (1 ) | 25 (1 ) [Note 3] | --- | --- |

***Notes:***
*[1] For NPS 14 and larger.*
*[2] Install in two layers of insulation to make up total thickness.*
*[3] Do not use on pipe size NPS 2-1/2 to 3.*

**Table 3:**
**Insulation Hanger Protection**

| Service Temperature °C (F) | Pipe Size NPS | Pipe Saddle | Insulation Shield | High-Density Insert |
|---|---|---|---|---|
| ≥ 93 to 205 (≥ 200 - 400) | ≥ 1-1/2 | Yes | --- | --- |
| | ≤ 1-1/4 | --- | Yes | P-23 |
| 61 to 93 (141 to 200) | > 6 | Yes | --- | --- |
| | ≥ 1-1/2 and ≤ 6 | --- | Yes | P-22, P-23 |
| | ≤ 1-1/4 | --- | Yes | --- |
| 26 to 60 (80 to 140) | ≥ 1-1/2 | --- | Yes | P-22, P-23 |
| | ≤ 1-1/4 | --- | Yes | --- |
| Cold & Dual Temp | ≥ 1-1/2 | --- | Yes | P-22 |
| | ≤ 1-1/4 | --- | Yes | P-21, P-22 |

**Table 4:**
**Piping Insulation Protective Finish Coverings**

| Exposed/ Concealed | Location | Piping System | Protective Finish Covering |
|---|---|---|---|
| Concealed | Indoors | All | None |
| Exposed | Indoors | All except steam 345 kPa (50 psi) and over | PVC |
| | | Wet Areas | PVC |
| | | Painted Pipe | Fabric |
| | Outdoors | All | Stainless Steel |

**End of Section**

# TESTING ADJUSTING AND BALANCING
# 20 08 05

## 1 GENERAL

### 1.1 Scope

.1 Test, adjust, and balance (TAB) air handling systems and hydronic systems installed, modified or extended as part of this work.

.2 Rechecking of testing and balancing during alternate heating/cooling season.

### 1.2 Qualifications and performance standards

.1 Balancing to be performed under supervision of recognized expert with an established reputation in this field.

- .1 TAB contractor to be a member of AABC or NEBB.

.2 Perform testing and balancing in accordance with:

- .1 SMACNA Testing, Adjusting and Balancing guidelines,
- .2 Associated Air Balancing Council standards for Total System Balance.

### 1.3 Preparatory work

.1 Review design drawings and specifications, shop drawings, interference drawings and other related documentation to become familiar with their intended performance.

.2 Carry out site visits during later stages of construction to ensure that arrangements for TAB are incorporated.

.3 Confirm proper placement of thermometer wells, test ports, pressure gauge cocks, balancing valves, balancing dampers and splitter dampers, and access doors.

.4 Submit TAB schedule, with descriptive data outlining procedures and sample forms showing method of data presentation, three months before start of TAB work on site.

.5 Provide details of specific procedures to be used for determining test parameters from test measurements and criteria proposed to establish compliance with specification requirements.

.6 List instruments to be used, method of instrument application (by sketch) and correction factors.

.7 Calibrate instruments in accordance with recognized standards, and submit calibration curves not more than three months before commencement of TAB.

.8 TAB measurements to commence when building is “closed in” and work is sufficiently advanced to include;

- .1 Installation of ceilings, doors and windows.
- .2 Application of sealing, caulking, and weather stripping.
- .3 Normal operation of mechanical systems.

### 1.4 Systems, equipment and related controls requiring TAB

.1 Air handling systems.

.2 Hydronic systems including

- .1 Heating and cooling equipment and piping systems.
- .2 Domestic water equipment and cold, hot and recirculation hot water piping systems.

## 2 AIR MOVING SYSTEMS

### 2.1 Parameters

.1 Listed below is an outline of the information to be established in the TAB process:

- .1 Air flow related;
  - (a) Air velocity
  - (b) Flow cross sectional area.
  - (c) Static pressure.
  - (d) Velocity pressure.
- .2 Temperature related;
  - (a) Wet bulb.
  - (b) Dry bulb.
- .3 Equipment related;
  - (a) rotational speed (rpm)
  - (b) Electrical power,
  - (c) Voltage.
  - (d) Current draw.

.2 Measurement are required at and around equipment to establish air side performance of;

- .1 Fans.
- .2 Coils.
- .3 Filters.
- .4 Dampers.(fresh, return and relief)
- .5 Humidifiers.
- .6 Terminal units

.3 Measurement are required to characterize system performance;

- .1 at main ducts.
- .2 at branch ducts.
- .3 at sub-branch ducts.
- .4 at each supply, exhaust and return air inlet and outlet.
- .5 in each thermostatically controlled zone.

### 2.2 General criteria

.1 Balance systems so that fans operate at lowest possible speed and static pressure consistent with delivery of specified air quantity at most remote terminal point.

.2 Set-up supply fans with sufficient speed to deliver required air quantity when filters are loaded to manufacturers recommended maximum pressure drop. Temporarily block filters to achieve maximum pressure drop at design air flow.

.3 Air quantities at each exhaust system inlet and supply system outlet are to be measured and throw and pattern is to be adjusted at each supply outlet.

**2.3 Fan performance assessment**

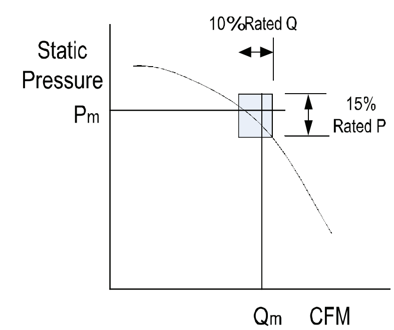
.1 Measure air quantity by taking anemometer traverses across a coil or at a filter bank or by pitot tube traverse in a straight section of duct at fan suction or discharge.

.2 Measure static pressure difference between fan inlet and discharge, motor amperage and fan speed in rpm. Determine motor input power from a curve showing power output as a function of motor amperage for the particular motor.

.3 Plot results of measurements on fan characteristic curve supplied by fan manufacturer and the air volume, static pressure and fan speed lines should form a triangle enclosed by a rectangle with a dimension of not more than 15% of the rated static pressure by a dimension of not more than 10% of the specified air quantity. Input power taken from the fan characteristic should be within 10% of the power determined from the motor amperage readings.

.4 If required precision is not obtained, readings to be repeated. If subsequent testing shows that the required precision is unobtainable then fan manufacturer is to submit written report explaining actual fan performance and provide new characteristic curve showing actual performance for fan “as installed”.

.5 Measure static pressure loss across cooling coils, heating coils and individual filter banks and tabulate readings with manufacturers published pressure loss figures for the actual measured air volume.




**2.4 Variable volume system balancing procedure**

.1 Obtain from Consultant the expected diversity value. Open sufficient boxes to 100%, and close a random selection of boxes, equally distributed throughout the system, to obtain the design fan flow rates.

.2 Set system to operate with 100% return air, set room thermostats at design indoor temperature, set fan discharge temperature at design point.

.3 Set thermostat in most remote zone to full cooling and adjust fan inlet guide vane, or AFD speed, static pressure control to supply specified air quantity at most remote zone volume damper, pneumavalve or terminal box.

.4 Reset most remote zone thermostat to design room temperature and set next most remote zone thermostat to full cooling and adjust branch splitter damper ahead of zone volume damper, pneumavalve or terminal box, to provide design air quantity at outlets.

.5 If zone air quantity is less than design, increase fan inlet guide vane, or AFD speed, static pressure control setting to achieve design air quantity and rebalance previously checked zones.

.6 Repeat as required for each zone.

## 2.5 Mixed constant volume and variable volume balancing procedure

.1 Same procedure as for all VAV system except as follows:

  .1 Boxes which are constant volume are to be selected and set for 100% design airflow.

  .2 Balance the constant volume boxes first, then the VAV boxes are per the procedure described above.

## 2.6 Induction primary air supply system balancing procedure

.1 Set system to operate with 100% return or supply air and measure plenum pressure at each induction unit on floor most remote from unit.

.2 Adjust fan inlet guide vane static pressure controller to provide design static pressure at most remote unit.

.3 Check and adjust individual unit dampers to obtain design static pressure at each air plenum of each induction unit supplied by fan on test.

.4 If nozzle plenum static pressure at an intermediate flow is less that for design air quantity, reset fan inlet guide vane static pressure controller to achieve value and re-balance more remote units.

## 2.7 Terminal box supply system balancing procedure

.1 Set system to operate with 100% return air, set room thermostats at indoor design temperature and set fan discharge temperature at design value.

.2 Set thermostat in most remote zone to full cooling and adjust fan inlet guide vane static pressure controller to maintain manufacturer's specified minimum static pressure at box inlet.

.3 Check air quantity delivered by box and adjust volume regulators to obtain design value.

.4 Reset room thermostat to full heating and check performance of regulator.

.5 Reset thermostat to design temperature and repeat procedure for remaining terminal boxes.

.6 If inlet static pressure at a subsequent box is less than manufacturer's specified minimum, reset inlet guide vane static pressure controller to suit.

.7 Open balancing dampers and adjust fan inlet static pressure controllers, or fan speed to obtain design air quantity at most remote outlet.

.8 Balance remaining outlets by adjusting dampers.

.9 If air quantity at some outlet other than the most remote outlet is less than design, re-adjust fan and rebalance previously adjusted outlets.

.10 Measure fan performance and adjust fan speeds and inlet guide vane controllers so that return air quantity is equal to supply air quantity less fixed exhaust air quantities, with a 10 percent allowance for pressurization.

### 2.8 Fresh air adjustment procedure

.1 After adjustment of supply, return and related exhaust fans, adjust minimum fresh air damper position to obtain design fresh air quantity.

.2 Damper position to be determined by measurement of outside return and mixed air temperatures and confirming calculations to be included in balance report.

.3 Where duct space permits, include airflow measurement of supply, and recirculation or outdoor air, to verify results.

### 2.9 Branch air quantity measurement procedure

.1 Branch air quantities to be determined using pitot tube traverses in accordance with the procedures outlined in "Testing, Balancing and Adjusting of Environmental Systems" by William G. Eads, P.E., issued by SMACNA.

.2 Measurements to be taken at each riser as it is connected to fan discharge or suction header and at each floor where branches are taken from the riser. Measurement to be repeated until sum of branch air quantities is within 10% of fan delivery.

## 3 HYDRONIC SYSTEMS

### 3.1 Parameters

.1 Listed below is an outline of the information to be established in the TAB process;

- .1 Flow.
- .2 Pressure.
- .3 Temperature.
- .4 Specific gravity.
- .5 Rotational speed (rpm).
- .6 Electrical
  - (a) power
  - (b) Voltage.
  - (c) Current draw.

.2 Measurement are required at and around equipment to establish fluid side performance of;

- .1 Heat exchangers (primary and secondary sides).
- .2 Coils.
- .3 Boilers.
- .4 Pumps.
- .5 PRVs.
- .6 Makeup (water) systems.
- .7 Domestic hot water heaters.
- .8 Humidifiers.

### 3.2 General criteria

.1 Use calibrated venturi tubes, orifices or other metered fittings and pressure gauges in conjunction with permanent and portable type flow meters to determine flow rates for system balance.

.2 Effect system balancing with automatic control valves open to heat transfer elements and bypasses closed.

.3 Base flow balance on (in order of preference):

- .1 double regulating valves, or globe valves associated with flow measuring elements (flow meters),
- .2 temporary non-invasive flow meters,
- .3 differential pressure measurement across heat transfer elements, and checked against manufacturer's literature, or
- .4 temperature difference across various heat transfer elements in the system where flow metering devices are not installed. This method may only be used at design heat transfer conditions.

.4 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing.

.5 Perform balancing by measurement of temperature differential in conjunction with air balancing.

.6 Adjust water distribution systems by means of double regulating valves, globe valves, balancing cocks, valves and fittings. Do not use shut-off valves for balancing unless indexed.

- .1 Butterfly valves on discharge side of pumps may be used if they are one trade size smaller than system pipe size. Include Cv values and flow vs valve position curve with balancing report.

.7 Where available pump capacity is less than total flow requirements of individual system parts, full flow in any part may be simulated by temporary restriction of flow to other parts.

## 4 EQUIPMENT TESTING

### 4.1 Performance data

.1 Submit the following data as a minimum. If contractor's standard forms provide for additional data, also submit such additional data.

- .1 Some equipment tests may need to be performed during the alternate season testing.
- .2 Include nameplate data and as-tested results.
- .3

.2 Heat Transfer Equipment:

- .1 manufacturer and type,
- .2 inlet and outlet temperatures,
- .3 pressure drop,
- .4 flow rate.][]

### 4.2 ALTERNATE SEASON TESTING

.1 Requirements

.1 Re-check testing and balancing of the heating, ventilating and air conditioning systems and water flow conditions at flow meter locations at approximately six months after initial testing and balancing has been performed and accepted, as advised by the Consultant.

.2 Include items which, because of their seasonal character could not be adequately completed during the initial balancing

.3 Include the reading and recording of temperatures and pressures at all gauges, as well as outdoor and indoor conditions.

.4 Measure and record the motor amperages and drive RPM of all fans and pumps during re-checking.

.2 Report

.1 Provide an addendum report to the original balancing report.

## 5 REPORT PRESENTATION AND VERIFICATION

### 5.1 Required reports

.1 Provide the following reports:

.1 Air and water balancing report

.2 Alternate season test report.

### 5.2 Report format

.1 Reports to incorporate approved standard forms, with values expressed in SI and (Imperial) units.

.2 Include "as-built" system schematics showing flow quantities and measurement points. Use as-built drawings and ventilating line diagrams for references.

.3 Submit two hard copies of TAB reports, with index tabs, in "D" ring binders, for verification.

.4 Submit two soft copies of TAB reports in Adobe Acrobat V7 PDF format.

### 5.3 Accuracy

.1 Adjust systems until operating values within plus or minus 5% of design values are achieved.

.2 Measurements to be accurate to within plus or minus 2% of actual values.

### 5.4 Spot checks

.1 After review of the Draft Report by the Consultant and at the Consultants direction, retest up to 10% of all measurements in locations as directed by the Consultant, at no cost extra to the contract.

.2 If results indicate unusual testing inaccuracy, omissions, or incomplete balancing/adjustment, in the opinion of the Consultant, re-balance entire affected system(s) at no increase in Contract Price.

### 5.5 Balance position marking

.1 Mark the balance position of dampers and valves at the completion of the final testing:

.1 Ductwork: indicate with arrow using paint or permanent marker,

.2 Exposed ductwork in public areas: self adhesive label, placed adjacent to balancing damper, neatly filled in with % open or degree open value.

.3 Valves: self-adhesive label, placed on piping (insulated or not) adjacent to valve, neatly filled in with either % valve open, or number of valve turns to open.

.2 Additional requirements for Double Regulating Valves:

.1 Remove valve handle or other protective device, and set memory stop to limit valve open travel. Replace valve handle or protective cover.

**5.6 Record keeping**

.1 Keep records of trial and final balance and submit preliminary report as each system is completed.

.2 Make spot checks as requested and repeat balancing of system if actual spot check quantities do not agree with preliminary report figures.

**5.7 Verification**

.1 Reported measurements will be verified.

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

.3 Number and location of verification measurements to be at discretion of Engineer.

.4 Where discrepancies are encountered repeat TAB, and resubmit reports.

**5.8 Completion**

.1 Continue TAB until reports are approved.

.2 The Substantial Performance of the Mechanical Work will be considered reached when the initial Start-Up and Performance Testing report is accepted by the Consultant and in the opinion of the Consultant all systems have been satisfactorily installed, operated tested, balanced, and adjusted to meet the specified and intended performance.

.3 The substantial performance is not dependent upon alternate season testing.

.4 The total performance of the Mechanical Subcontract (Contract) will not be considered reached until the alternate season testing and balancing is completed and the final report submitted and accepted by the Consultant.

**END OF SECTION**

# PROJECT CLOSE-OUT MECHANICAL
# 20 08 19

## 1 GENERAL

### 1.1 Scope

.1 Provide documentation deliverables at completion of the Work.

### 1.2 Occupancy Permit

.1 Submit the reviewed final Life Safety and Fire Protection Commissioning report two weeks prior to application for occupancy permit.

### 1.3 Substantial Performance

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

.2 Where the work is sub-divided into separate scopes of Work, each requiring a separate Substantial Performance application, provide a separate checklist for each application.

.3 Prepare and submit to the Consultant a comprehensive deficiency list of items to be completed or corrected, as part of the application for a review by the Consultant to establish Substantial Performance of the Work, or for each designated portion of the Work in the case of phased Substantial Performance.

- .1 Failure to include an item on the list does not alter the Contractor’s responsibility to complete the Work.

.4 Within five working days of the Consultant’s review report which indicates that Substantial Performance of the Work has been achieved, provide a detailed schedule for completion and/or correction of the Work of all items described in the Contractors’ and the Consultants’ deficiency list.

### 1.4 Total Performance

.1 Submit the following documentation with the application for Total Performance. Application for Total Performance cannot be submitted any earlier than the date of Alternate Season testing.

- .1 Where documentation has already been submitted to the Owner, provide a copy of the transmittal.

| **SUBSTANTIAL PERFORMANCE APPLICATION CHECKLIST** | |
|---|---|
| Project Name: | |
| Contract: | |
| Contract Scope: | |
| Application Date: | |
| Signed: | |

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

- ☐ Contractor has compiled and submitted a detailed deficiency list, identifying work still to be completed, incomplete, or requires correction.
- ☐ Equipment start-up reports (Interim).
- ☐ Building department inspection reports.
- ☐ ESA field inspection reports.
- ☐ Sprinkler installation certification report to NFPA 13.
- ☐ Air and Water Balancing reports (Interim).
- ☐ Vibration survey report (if specified).
- ☐ Controls / BMS operation report.
- ☐ Equipment, pipeline, and valve identification completed
- ☐ Clean-up completed.
- ☐ Spare parts and replacement parts turned over to Owner; transmittal attached.
- ☐ Warranty certificates
- ☐ Operating and Maintenance Manuals, draft, submitted.
- ☐ As-built drawings submitted
- ☐ Training completed and attendance logs submitted.

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

| TOTAL PERFORMANCE APPLICATION CHECKLIST | |
|---|---|
| Project Name: | |
| Contract: | |
| Contract Scope: | |
| Application Date: | |
| Signed: | |

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

- ☐ All known deficiencies have been corrected, including latent deficiencies reported by the Owner.
- ☐ Air and water balancing - final versions including alternate season testing completed and submitted.
- ☐ Final commissioning reports submitted and accepted by Owner.
- ☐ Operating and Maintenance manuals - finalized and submitted (if final version was issued at time of Substantial Performance indicate here)
- ☐ As-built drawings final version submitted (if final version was issued at time of Substantial Performance indicate here)

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

**End of Section**

# FIRE PROTECTION - GENERAL
# 21 05 01

## 1.1 GENERAL

## 1.2 Scope

.1 Fire protection work includes;

  .1 Pre-action Sprinkler System

## 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 29 Common Hanger and Support Requirements for Piping

## 1.4 Applicable Codes and Standards

.1 Legislation:

  .1 Fire protection work to conform to standards of the National Fire Prevention Association (NFPA) and relevant sections of the provincial Building Code applicable to the location of the Work.

.2 Product standards:

  .1 ULC/ORD-C203 Pipe Hanger Equipment for Fire Protection Service

  .2 UL 203 Pipe Hanger Equipment for Fire Protection Service

## 1.5 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.

## 1.6 Water Supply Test Results

.1 Provide water flow test on municipal water service in proximity to building connection, in accordance with NFPA 14 and NFPA 291. Flow test must be conducted within one (1) year prior to system design. Submit record of test including static pressure, and residual pressure and flow.

  .1 Obtain municipal approval and pay fees associated with testing.

.2 Water supply flow test data:

| | |
|---|---|
| Static pressure, kPa : | |
| Flow rate, L/s : | |
| Residual pressure, kPa : | |
| Contractor name: | |
| Date of Test: | |
| Street main size, NPS | |
| Location of hydrant | |

# 2 PRODUCTS

## 2.1 Pipe

.1 NPS 2 and smaller, grooved and threaded joints:

.1 to ASTM A53 Grade B, Schedule 40 continuous weld steel,

.2 galvanized where specified.

.2 NPS 2 ½ to NPS 10, welded joints:

.1 to ASTM A53-63R Grade B, Schedule 40 electric resistance weld steel,

.3 NPS 2 ½ and larger, for rolled groove joints:

.1 NPS 2½ and over ASTM A53-72A Schedule 10 thin wall, rolled grooved.

.4 NPS 12 and larger, welded joints:

.1 to ASTM A53-63R Grade B electric resistance weld steel, 9.53 mm (0.375 in) wall thickness.

## 2.2 Fittings, Gaskets, and Valves

.1 For systems with a maximum design pressure up to 1200 kpa (175 psi).

.2 Fittings:

.1 1035 kPa (150 #) black malleable iron screwed up to NPS 2.

.2 Forged steel, butt welding Schedule 40 for NPS 2½ and over.

.3 Unions:

.1 1035 kPa (150 #) black malleable ground joint union, bronze to iron seat up to NPS 2.

.4 Flanges:

.1 1035 kPa (150 #) forged steel, slip-on or weld neck, raised face style.

.5 Gaskets for flanged joints:

.1 Red rubber sheet 1.6 mm (1/16 in) thick.

*Standard of Acceptance*

- Chesterton 100
- Beldam Red Rubber

.6 Valves:

.1 ULC and FM listed for fire protection service.

.2 as specified in Section 20 10 00 Valves.

## 2.3 Fittings for Grooved Pipe

.1 For systems with a maximum design pressure up to 1200 kpa (175 psi).

.2 Couplings:

.1 Malleable or ductile iron NPS 2½ and over.

.3 Fittings:

.1 Malleable iron or ductile iron to NPS 2½ to NPS 12.[][

.2 Fabricated steel NPS 14 and over.

.4 Flanges:

.1 Cast iron, raised face flange with coupling groove NPS 2½ and over.

.5 Gaskets for grooved couplings:

.1 EPDM Grade "E", dry lubricated.

**2.4 Pipe Supports**

.1 Conform to specification section 20 05 29.

.2 Pipe hangers and supports to be listed ULC/ORD-C203 or UL 203 for fire protection service, except where such listing requirement is excluded under applicable NFPA standards.

## 3 EXECUTION

**3.1 Piping Installation**

.1 General layout of mains, risers, run-outs and connection details of piping systems are shown.

.2 Support piping in accordance with the requirements of the NFPA standard applicable to the system type, subject to and in accordance with the requirements of specification section 20 05 29.

.3 Provide bends, expansion loops, hoses or joints to compensate for pipe seismic movement.

.4 Anchor, guide and laterally support vertical and horizontal piping to support filled weight and absorb thrust under operating conditions.

.5 Erect piping so that gravity forces and thrust from changes in direction do not stress connections to apparatus.

.6 Separate copper pipe and fitting materials from contact with ferrous material with di-electric couplings.

.7 Install drain valves at low points in water piping systems and in valved run-outs from risers so that system or isolated parts of system can be drained.

.8 Do not use galvanized materials in contact with glycols.

**END OF SECTION**

# WET PIPE SPRINKLER SYSTEM
# 21 13 13

## 1 GENERAL

### 1.1 Scope

.1 Provide wet pipe automatic sprinkler systems.

.2 Provide installation drawings and hydraulic calculations, designed and sealed by a professional engineer licensed in the province of British Columbia.

### 1.2 Qualified Subcontractors

.1 Sprinkler work to be undertaken by specialist automatic sprinkler installation firm with an established reputation in this field.

### 1.3 Applicable codes and standards

.1 National Fire Protection Association (NFPA) 13 - Standard for the Installation of Sprinkler Systems

.2 NFPA 25 - Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems

.3 FC 403

.4 Canadian Industrial Risks Insurers (CIRI), Interpretive Guide.

.5 Risk Management Services (RMS)

.6 M & M Protection Consultants (M & M)

.7 British Columbia Building Code

.8 British Columbia Fire Code

.9 National Building Code

.10 National Fire Code

.11 ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-dipped, Zinc-coated, Welded and Seamless

### 1.4 Shop drawings and product data

.1 Prepare shop drawings and forward three copies with hydraulic calculations to Owners Insurers for review and acceptance.

.2 After shop drawings are accepted by reviewing Authority submit copies of these stamped shop drawings and product data sheets for review in accordance with Division 1 procedures.

### 1.5 Samples

.1 Submit samples of;

.1 sprinkler heads,

.2 signs.

## 1.6 Design criteria

.1 System is designed to NFPA 13 using pipe schedule sizing method for hazard classification shown with design densities and design areas for each zone as detailed

.2 Changes to pipe sizes or head layouts accompanied with modified hydraulic calculations, may be submitted for approval.

# 2 PRODUCTS

## 2.1 Pipe, hangers and gaskets

.1 To section 21 05 01.

## 2.2 Sprinkler heads

.1 Ratings:

.1 ULC and FM listed for fire service.

.2 standard temperature rating 57°C to 74°C (135°F to 165°F) with intermediate or high temperature rating to suit local conditions.

.3 thermal sensitivity:

(a) Quick Response type for Light and Ordinary hazard applications
(b) Standard response type for Extra hazard applications.

.2 Selection:

.1 indicated by type in accordance with following:
(a) TYPE To match existing in L0 area of work

*Standard of Acceptance*
- Viking
- Tyco
- Reliable
- Victaulic

## 2.3 Alarm check valves

.1 Construction:

.1 ULC and FM listed for fire service,

.2 resilient seat swing check valve,

.2 Trim:

.1 include valves, gauges, fittings and nipples for;

(a) drain connections,
(b) alarm connection,
(c) alarm test,
(d) pressure switch to indicate low pressure in system, wired to sprinkler trouble annunciator.
(e) excess pressure pump connections

(f) alarm pressure switch wired to sprinkler annunciator.
(g) pressure gauges to show water and air pressures with combined SI and Imperial scales.

*Standard of Acceptance*
° As listed above for sprinkler heads

## 2.4 Ancillary devices

.1 Supervisory switches:

.1 ULC and FM listed for fire service,

.2 mechanically secured, with N.O. and N.C. contacts and supervisory capability,

.3 for OS & Y gate valves.

*Standard of Acceptance*
° Potter Electric - Model OSYSU - for post indicator and butterfly valves

*Standard of Acceptance*
° Potter Electric - Model PCVS

.2 Pressure switches on alarm check valves:

.1 for loss of normal water pressure on wet sprinkler system,

.2 for monitoring of low water pressure on wet sprinkler system with excess pressure pump.

*Standard of Acceptance*
° Potter Electric - Model PS100-21: for detecting water flow alarm condition

*Standard of Acceptance*
° Potter Electric - Model PS120A: for monitoring low water pressure

.3 Flow indicators:

.1 For mounting in zone piping.

.2 Fitted with;

(a) sealed retard,
(b) visual indication of switch activation,
(c) mechanical delay adjustment

*Standard of Acceptance*
° Grinnell - F-620
° Potter Electric - VS
° System Sensor - WFD

.4 Water gong:

.1 Water operated outside alarm bell, weather protected.

*Standard of Acceptance*
° As listed above for sprinkler heads

## 2.5 Signs

.1 Type:

.1 fitted on control valves, shut-off valves, drain valves and test valves,

.2 150 mm x 150 mm (6 in x 6 in) for automatic control valves and alarm valves,

.3 50 mm x 150 mm (2 in x 6 in) for other valves, and

.4 made of enameled steel with fire department red enamel background, white letters, inscription in accordance with [NFPA][FM] Standards.

# 3 EXECUTION

## 3.1 General

.1 Provide headers, alarm check valve assemblies, valves, and fire department connections.

.2 Provide supervisory switches on valves.

.3 Provide water flow alarm switches, and two low water pressure monitoring switches.

.1 one low water pressure switch to operate excess pressure pump

.2 one low water pressure switch to annunciate trouble condition to fire alarm system, set at 70 kPa (10 psig) below excess pressure pump start setpoint - field verified.

.4 Provide signs at each valve identifying portion of system controlled. Fasten signs to pipe in immediate vicinity of valve.

.5 Install excess pressure pump across alarm valve.

.6 Extend piping and connect to sprinklers.

.7 Provide drain valves at trapped low points in piping system.

.8 Provide small hose assemblies connected where shown.

.9 Provide additional sprinkler heads with associated piping for sprinkler protection under ducts, under obstructions, and in blind spaces. Identify additional sprinkler heads on shop drawings with capital letter "A" and resubmit drawings to permit inclusion of these sprinkler heads in hydraulic calculations.

.10 Combination drains or hub drains will be provided at headers and control cabinets under Division 22.

.11 Run NPS 2 drain through wall to outside for Inspectors water flow testing in locations shown.

.12 Personnel involved in installation of grooved joint piping and fittings to be conversant with;

.1 pipe end preparation and special tools,

(a) pipe ends to be clean and free from indentations, projections and roll marks in area from pipe end to groove.

(b) dimensions to be according to standard cut groove or roll groove Specification (Victaulic TS-215/78).

.2 coupling and fitting selection.

.3 joint assembly to accommodate expansion, contraction, and flexibility,

.4 specifications and/or recommendations with respect to support, anchorage and guiding of pipe systems.

## 3.2 Freeze protection piping

.1 Provide antifreeze loops, with shut off and test valves and filling arrangements and charge with 40% water and 60% propylene glycol.

.2 Provide a reduced pressure principle backflow preventer to isolate the antifreeze loop from the remainder of the sprinkler piping system.

  .1 Gravity loops are not acceptable for backflow protection.

## 3.3 Testing and approvals

.1 Test sprinkler systems in accordance with requirements of NFPA.

**END OF SECTION**

# PRE-ACTION SPRINKLER SYSTEM
# 21 13 19

## 1 GENERAL

### 1.1 Scope

.1 Provide dry pipe pre-action sprinkler systems as shown.

.2 Provide installation drawings and hydraulic calculations, designed and sealed by a professional engineer licensed in the province of British Columbia.

### 1.2 Qualified Subcontractors

.1 Work to be undertaken by same specialist automatic sprinkler installation firm providing wet pipe sprinkler systems for this project.

### 1.3 Applicable codes and standards

.1 National Fire Protection Association (NFPA) 13 - Standard for the Installation of Sprinkler Systems

.2 NFPA 25 - Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems

### 1.4 Shop drawings and product data

.1 Prepare shop drawings and forward three copies with hydraulic calculations to Owners Insurers for review and acceptance.

.2 After shop drawings are accepted by reviewing Authority submit copies of these stamped shop drawings and product data sheets for review in conformity with Division 1 procedures.

### 1.5 Samples

.1 Submit samples of;

  .1 sprinkler heads,

  .2 signs,

  .3 heat detectors.

### 1.6 Design criteria

.1 System is designed to NFPA 13 using hydraulic method for hazard classification shown with design densities and design areas for each zone as detailed.

.2 Hydraulic calculations are based on water supply test results, down-rated in accordance with requirements of Authorities having jurisdiction as shown. Hydraulic calculations establishing pipe sizing as shown on drawings are available.

.3 Changes to pipe sizes or head layouts accompanied with modified hydraulic calculations, may be submitted for approval.

### 1.7 Maintenance materials

.1 Provide cabinet, containing special sprinkler wrench, and spare stock of sprinklers. Include at least one head of each type and temperature rating installed in system.

## 2 PRODUCTS

### 2.1 Pipe, hangers, gaskets, valves and fittings:

.1 To section 21 05 01, and:

  .1 all carbon steel piping, fittings, unions, and flanges to be galvanized.

### 2.2 Sprinkler heads

.1 Sprinkler heads to be listed Dry-pendant heads.

*Standard of Acceptance*
- Viking
- Tyco
- Reliable

## 3 EXECUTION

### 3.1 Sprinkler installation

.1 Provide headers, alarm valve assemblies, valves, and fire department connections.

.2

.3 Provide double-valved auxiliary drains at trapped low points in piping system. Insulate and electrically heat trace the auxiliary drain between the outlet valve and 50mm (2 in) above the inlet valve.

  .1 Power will be provided by Division 26 up to and including a junction box in the area served by the dry-pipe system. Extend 120 VAC wiring from this junction box to each auxiliary drain.

  .2 Insulation and heat tracing are not required where auxiliary drains are located in heated areas.

.4 Locate sprinklers in symmetrical pattern to suit reflected ceiling plans and to avoid speakers, fire alarm components, lighting fixtures, ductwork and diffusers. In general, centre heads in ceiling tiles.

.5 Provide additional sprinkler heads with associated piping for sprinkler protection under ducts, under obstructions, and in blind spaces. Identify additional sprinkler heads on shop drawings with capital letter "A" and resubmit drawings to permit Inclusion of these sprinkler heads in hydraulic calculations.

.6 Isolate automatic sprinkler system from potable water supply to comply with The British Columbia Building Code.

.7 Combination drains or hub drains will be provided at headers and control cabinets under Plumbing.

### 3.2 Installation of pre-action system detectors

.1 Provision of detection system and connection to pre-action system control panel will be done under this Section.

.2

### 3.3 Testing and approvals

.1 Test sprinkler systems in accordance with requirements of NFPA.

.2 Schedule testing to give at least two weeks' notice to following authorities

  .1 Local Fire Department.

  .2 Insurer's Representative.

  .3 Owner.

  .4 Consultant.

.3 Prior to testing, ensure that flow switches, pressure switches, supervisory switches and other devices are functioning.

.4 Obtain Contractor's Material and Test Certificate for above ground piping.

.5 Copies of Certificates to be distributed as per shop drawing requirements.

.6 On completion of project obtain Certificate of Approval showing that work is in accordance with rules and regulations of National Fire Protection Association.

**END OF SECTION**

# PLUMBING PIPING SYSTEMS – GENERAL REQUIREMENTS
# 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 including:

(a) sanitary drainage and vent systems,

### 1.2 Applicable Codes and Standards

.1 Legislation:

.1 Plumbing Code

.2 Municipal bylaws regarding potable water and sewage systems.

.2 Installation standards and codes:

.1 AWWA C651 Disinfecting Water Mains.

### 1.3 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.

### 1.4 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)

## 2 PRODUCTS

### 2.1 Dielectric Unions

.1 Construction:

.1 Bronze or brass body with non-metallic fitting or coating the FNPT tailpiece.

.2 FNPT x Copper sweat connection.

.3 Pressure rating; ASME Class 3000 at 121°C (250°F)

*Standard of Acceptance*

° Hart Industrial Unions - fig. D-3136 or Polymer Compsit Coating

### 2.2 Dielectric Flanges

.1 Construction:

.1 ASME Class 150 or 300 carbon steel flange, Van-stone style with copper tube adapter tailpiece.

.2 Flange provided with a powder coated finish, and an EPDM insulator to isolate the copper tailpiece form contact with the flange.

.3 Minimum MCPR:

(a) Class 150: 1400 kPa (200 psi) at 121°C (250°F)

(b) Class 300: 2800 kPa (400 psi) at 121°C (250°F)

*Standard of Acceptance*

° CTS Flange Canada - fig. BF / WBG

## 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.

.2 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

.1 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 check valve on supply and valved drain at bottom of tank. Drill check valve disc with 1.6 mm (1/16 in) hole in its centre.

.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 Install recirculation piping as shown.

**3.5 Dissimilar Metals Galvanic Isolation**

.1 Provide dielectric unions or flanges to separate copper and copper alloy tube and fitting materials from contact with carbon (plain and galvanized) steel material.

.1 For clarity, dielectric unions or flanges are not required when connecting copper to T304 or T316 stainless steel pipe or tubing.

.2 Refer to specification section 23 05 01 for exemptions when connecting domestic water copper piping or stainless steel piping to HVAC piping systems.

**3.6 Drainage**

.1 Provide waste and vent connections to plumbing fixtures and equipment.

.2 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 gasketted 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 Special Water and Waste Connections**

.1 Provide hot and cold water, waste and vent connections to equipment.

.2 Provide vacuum breakers and backflow preventers on equipment connections, and hose bibbs, 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 apparatus and brass trap 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.

.6 Provide similarly sized connections for items marked N.I.M.C. (Not in Mechanical Contract) and S.B.O. (Supplied by Owner).

.7 For these items:

.1 N.I.M.C. Do not make final connections but provide services.

.2 S.B.O. Make final connections including traps, screwdriver stops and accessories.

### 3.8 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 major leaks, but not less than 2 hours. Repair major leaks.

.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 conduct a pressure test at 150% of the design pressure for 10 minutes, then reduce pressure to design pressure.

  (a) maintain pressure and examine each joint with commercial leak detector solution.

   *Standard of Acceptance*

   - Snoop
   - Leak-tec

  (b) repair leaks and retest using leak detector solution with piping under pressure specified.

 .3 As an alternative to leak testing of each joint, 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 Record ambient air temperature at the same time,

  (c) maximum pressure loss over 24 hours: not more than 1% of test pressure, corrected for ambient temperature.

 .4 Repair leaks and retest until satisfactory.

  (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.

 .5 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.

### 3.9 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 |

### 3.10 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.[][

### 3.11 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

### 1.1 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.

### 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-Annes G or NSF/ANSI 372.

### 1.4 Submittals

.1 Refer to section 20 05 23.

### 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 3 and under, copper alloy body:

.1 To MSS SP-110, 600 CWP, two-piece bronze or DZF 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 [1].

*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 [2], [3].

*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 3 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 (type GTV-1)

.1 NPS 2 and under (type GTV-1):

.1 To: MSS SP-80, Class 125; or MSS SP-139, 300 CWP. Bonze body, solid wedge bronze disc, non-rising stem, screw in or union bonnet, 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. 808
- Apollo - fig. 102SLF
- Crane (GGC) - fig. LF1320
- Nibco - fig. S-111-LF

.5 Threaded ends:

*Standard of Acceptance*

- Kitz - fig. 807
- Apollo - fig. 102TLF

- Crane (GGC) fig. LF438
- Nibco - fig. T-113-LF

## 2.6 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

## 2.7 Butterfly Valves – Groove Ends

.1 NPS 2 to NPS 12, ductile iron (type BFV-3).

.1 To MSS SP-67, ductile iron body with coated flow passage, and grooved ends to CSA B242.

.2 Required MCPR: 2000 kPa (290 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 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 761
- Gruvlok - fig. AN7700 series
- MAS - fig. W50-A-ED-66-S-LL

.2 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 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 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

.3 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 fluorelastomer 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

## 2.8 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 Ductile iron body with spring-assisted twin stainless steel discs, and EPDM disc coating and O-rings.

.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, 716, 716H.

## 2.9 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

## 2.10 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

.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

## 2.11 Automatic Flow Balancing Valve

.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 Anderson - fig. 76X
° Griswald Controls - fig. K Valve

# 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<br>Domestic Hot Water<br>Domestic Recirculating Water<br>Domestic Tempered Water | Copper | BV-1<br>GLV-1<br>GTV-1<br>BFV-1, BFV-2, BFV-5 |
| | Stainless Steel | BV-2<br>BFV-2, BFV-4 |
| | Ductile Iron | BFV-1, BFV-2 |
| Domestic Cold Water<br>(Industrial Occupancies only) | Galvanized steel | BV-1<br>GTV-2<br>BFV-1, BFV-3 |
| Non-potable water | Copper | BV-1<br>GLV-1<br>GTV-1<br>BFV-1, BFV-2, BFV-5 |
| | Stainless Steel | BV-2<br>BFV-2, BFV-4 |
| | Galvanized Steel | BV-1, BV-2<br>GLV-1<br>GTV-1, GTVNP-1<br>BFV-1, BFV-2, BFV-3, BFV-4 |
| Pumped Sanitary Drainage<br>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<br>Clear waste sump pump discharge | Inline silent check<br>or<br>non-slam swing check |
| Sanitary sump pump discharge<br>Storm sump pump discharge | Non-slam swing check valve |

### 3.5 Automatic Flow Balancing Valves

.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 Pluming 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 | ASTM B88 | Standard Specification for Seamless Copper Water Tube |
| .2 | ASME B16.15 | Cast Bronze Threaded Fittings, Classes 125 and 250 |
| .3 | ASME B16.18 | Cast Copper Alloy Solder Joint Pressure Fittings |
| .4 | ASME B16.22 | Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| .5 | ASME B16.24 | Cast Copper Alloy Pipe Flanges and Flanged Fittings; Class 150, 300, 400, 600, 900, 1500, & 2500. |
| .6 | ASME B16.50 | Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings |
| .7 | ASTM B828 | Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings. |
| .8 | ASTM A193 | Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature |
| .9 | ASTM A194 | Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both |
| .10 | ASTM B-32 | Specification for Solder Metal |
| .11 | AWS A5.8 | Brazing Filler Metal. |
| .12 | CSA B242 | Groove and Shouldered Type Mechanical Couplings |

.13 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.

### 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

# 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:
Horizonal Pipe Support Spacing for
Copper Tube

| Pipe Size NPS | Rod Diameter | Maximum Spacing |
|---|---|---|
| ½ | M10 (3/8 in) | 1.5 m (5 ft) |
| 3/4 to 1¼ | M10 (3/8 in) | 1.8 m (6 ft) |
| 1½ | M10 (3/8 in) | 2.4 m (8 ft) |
| 2 | M10 (3/8 in) | 2.4 m (8 ft) |
| 2½ | M12 (½ in) | 3.0 m (10 ft) |
| 3 | M12 (½ in) | 3.0 m (10 ft) |
| 4 | M16 (5/8 in) | 3.0 m (10 ft) |

.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:<br>Pressure and Temperature Limits for Class Rated Fittings | | |
|---|---|---|
| Class | Maximum<br>Design Pressure | Maximum<br>Coincident<br>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 3 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:<br>Flange Gasket Selection | | | | |
|---|---|---|---|---|
| Gasket Temperature Limit | Gasket Pressure Limit | Gasket Material | Gasket Thickness | Figure |
| 95°C<br>(203°F) | 1720 kPa<br>(250 psig) | EPDM | 1.5 m<br>(1/6 in) | A-B<br>AB-576 |
| | 2750 kPa<br>(400 psig) | NBR | 1.5 m<br>(1/6 in) | Durlon<br>7910 |

### 3.5 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.

## 3.6 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.

## 3.7 Pressure Testing, Flushing and Balancing

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

**END OF SECTION**

# 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 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 below grade:

.1 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 worm gears

.4 Joints above ground:

.1 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.

**2.3 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 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.

.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 tor 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: Horizonal Pipe Support Spacing for Copper Tube | | |
|---|---|---|
| Pipe Size NPS | Rod Diameter | Maximum Spacing |
| ½ | M10 (3/8 in) | 1.5 m (5 ft) |
| 3/4 to 1¼ | M10 (3/8 in) | 1.8 m (6 ft) |
| 1½ | M10 (3/8 in) | 2.4 m (8 ft) |
| 2 | M10 (3/8 in) | 2.4 m (8 ft) |
| 2½ | M12 (½ in) | 3.0 m (10 ft) |
| 3 | M12 (½ in) | 3.0 m (10 ft) |
| 4 | M16 (5/8 in) | 3.0 m (10 ft) |

.3 Support horizontal cast iron DWV piping in accordance with Table 1B and as follows;

.1 at least one pipe support for each length of 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 | Rod Diameter | Maximum Spacing |
| 3 | M12 (½ in) | 3 m (9.8 ft) |
| 4 | M16 (5/8 in) | 3 m (9.8 ft) |
| 6 to 12 | M20 (3/4 in) | 3 m (9.8 ft) |
| 15 | M25 (1) | 3 m (9.8 ft) |

.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 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**

# RAINWATER LEADERS – CAST IRON AND COPPER
# 22 14 16.13

## 1 GENERAL

### 1.1 Scope

.1 Provide cast iron pipe and fittings and/or copper tube and fittings for rain water leaders (storm drainage piping) for aboveground services.

### 1.2 Definitions

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

*.1* ***Rainwater leader:*** means the piping located inside of a building which conveys rainwater/snow melt water from a roof drain, patio drain or similar collection device, to the building storm sewer and includes the building storm drain (storm drainage piping has the same meaning.)

### 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 29 | Common Hanger and Support Requirements for Piping |

### 1.4 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.

.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.

.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:

.1 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.

## 3 EXECUTION

### 3.1 Installation General

.1 Install rainwater leader drainage piping in accordance with the requirements of the plumbing code applicable at the project location.

.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 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.

.3 For suspended piping, provide hangers within 450 mm (18 in.) of each joint, at each change of direction, and within 450 mm (18 in.) of the terminal end of each pipe run.

.4 Assemble and tighten mechanical sleeve joints to coupling manufacturers recommended torque value with torque wrench.

.5 Install cast iron hub-and-spigot joints with neoprene compression gasket and lubrication in accordance with manufacturer requirements.

.6 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.

.7 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 tor 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:
Horizonal Pipe Support Spacing for
Copper Tube

| Pipe Size NPS | Rod Diameter | Maximum Spacing |
|---|---|---|
| ½ | M10 (3/8 in) | 1.5 m (5 ft) |
| 3/4 to 1¼ | M10 (3/8 in) | 1.8 m (6 ft) |
| 1½ | M10 (3/8 in) | 2.4 m (8 ft) |
| 2 | M10 (3/8 in) | 2.4 m (8 ft) |
| 2½ | M12 (½ in) | 3.0 m (10 ft) |
| 3 | M12 (½ in) | 3.0 m (10 ft) |
| 4 | M16 (5/8 in) | 3.0 m (10 ft) |

.3 Support horizontal cast iron DWV piping in accordance with Table 1B and as follows;

.1 at least one pipe support for each length of 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 | Rod Diameter | Maximum Spacing |
| 3 | M12 (½ in) | 3 m (9.8 ft) |
| 4 | M16 (5/8 in) | 3 m (9.8 ft) |
| 6 to 12 | M20 (3/4 in) | 3 m (9.8 ft) |
| 15 | M25 (1) | 3 m (9.8 ft) |

.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 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**

# HVAC PIPING SYSTEMS GENERAL REQUIREMENTS
# 23 05 01

## 1 GENERAL

### 1.1 Scope

.1 Provide heating and cooling piping systems in accordance with the referenced piping materials, standards, specifications and piping codes described herein.

.2 This specification applies to;

- .1 water based piping systems, including glycol/water mixtures, for building hydronic heating and cooling systems,

### 1.2 Related Sections

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

- .1 20 05 24 Welding and Brazing.

### 1.3 Applicable Codes and Standards

.1 Legislation:

- .1 British Columbia Regulation 104/2004 Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation

.2 Installation standards and codes (as adopted and amended by the AHJ for pressure vessels):

- .1 CSA B51 Boiler, pressure vessels, and pressure piping code
- .2 ASME B31.1 Power Piping
- .3 ASME B31.3 Process Piping
- .4 ASME B31.9 Building Services Piping

### 1.4 Qualified Tradesmen

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

### 1.5 Registration and Inspection

.1 Before commencing work, make arrangements and pay for registration and inspection by the AHJ responsible for boiler and pressure vessel safety for the following pressure piping systems:

- .1 , including condensate piping, at pressures greater than 100 kPa (15 psig), except piping NPS 3 and smaller.
- .2 Service water piping for heating a building, at design temperatures greater than 121°C (250°F) or at design pressures greater than 1100 kPa (160 psig),

.2 At the start of the Work, obtain existing pressure piping system registration numbers, if available, from the Owner and/or the AHJ.

### 1.6 Design Criteria – General

.1 Pressure piping design conditions and applicable codes are specified herein. Where different operating and design pressures are shown on drawings, the drawings govern.

.2 Where a “Class” is indicated on drawings, this refers to Class as defined in the applicable ASME B16 series of product standards. Notwithstanding the maximum allowable pressure-temperature ratings defined for each ASME Class designation, the applicable Class designation by floor level shown on the drawings may identify lower maximum design pressures.

.3 Where a “Class” is indicated on drawings, this Class designation is applicable to Class rated components other than valves. Refer to valve specification sections for the Minimum Component Pressure Rating for each valve type and selection criteria based on system design pressure.

### 1.7 Design Criteria - Hot Water Heating Systems

.1 Piping design and installation code:

.1 To ASME B31.9 for piping system not subject to boiler and pressure vessel regulations.

.2 To ASME B31.1 for piping systems which are subject to boiler and pressure vessel regulations.

.2 System includes but is not limited to;

.1 Heating coils,

.2 Controls,

.3 System design criteria:

.1 Design temperatures and pressures:

| System Type | Supply Temp. °C (°F) | Return Temp. °C (°F) | Design Temp. °C (°F) | Maximum Operating Pressure kPa (psig) | Design Pressure kPa (psig) |
|---|---|---|---|---|---|
| Terminal Reheat System | 30 (86) | 21.1 (70) | 77 (170) | 900 (125) | - |

## 2 PRODUCTSA

### 2.1 Dielectric Unions

.1 Construction:

.1 Bronze or brass body with non-metallic fitting or coating the FNPT tailpiece.

.2 FNPT x Copper sweat connection.

.3 Pressure rating; ASME Class 3000 at 121°C (250°F)

*Standard of Acceptance*

- Hart Industrial Unions - fig. D-3136 or Polymer Compsit Coating

### 2.2 Dielectric Flanges

.1 Construction:

.1 ASME Class 150 or 300 carbon steel flange, Van-stone style with copper tube adapter tailpiece.

.2 Flange provided with a powder coated finish, and an EPDM insulator to isolate the copper tailpiece form contact with the flange.

.3 Minimum MCPR:

(a) Class 150: 1400 kPa (200 psi) at 121°C (250°F)

(b) Class 300: 28oo kPa (400 psi) at 121°C (250°F)

*Standard of Acceptance*

° CTS Flange Canada - fig. BF / WBG

## 3 EXECUTION

### 3.1 Pipe Installation General Requirements

.1 General layout of mains, risers, run-outs and connection details of piping systems are shown.

.2 Install concealed pipes close to building structure to keep furring spaces to minimum and minimize obstruction to other services in ceiling spaces.

.3 Run exposed piping parallel to walls and conserve headroom and space. Group piping wherever practical.

.4 Ream pipe after cutting to length and clean off scale and dirt inside and outside of pipe before threading, grooving or welding.

.5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and special fittings such as expansion joints.

.6 Cap ends during construction to prevent entry of foreign matter.

.7 Provide bends, expansion loops, hoses or joints to compensate for pipe expansion and contraction.

.8 Anchor, guide and laterally support vertical and horizontal piping to support filled weight and absorb thrust under operating conditions.

.1 For steam, gas and vapour piping, provide temporary intermediate supports when hydrostatically piping so that pipe support spans are not greater than that required for liquid piping service.

.9 Erect piping so that expansion forces, gravity forces and thrust from changes in direction do not stress connections to apparatus.

.10 Do not use galvanized materials in contact with glycols.

.11 Refer to piping system specifications for additional requirements.

### 3.2 Drainage Piping, Drain Valves and Air Vents

.1 Provide drain valves at low points in water piping systems and in valved run-outs from risers so that system or isolated parts of system can be drained. Locate piping system drain valves as close to the system pipe as possible.

.2 Provide an additional drain valve at the drain termination point where;

.1 the drain valve is not accessible from a floor with or without the use of a 2.4 m (8 ft) high ladder, or from an elevated work platform,

.2 and as otherwise specified herein.

.3 Provide drain valves on equipment drains, including but not limited to refrigeration equipment, boilers, heat exchangers and water treatment and filtration equipment.

.4 For copper tube drains, connect coper drain tubing to the outlet side of equipment drain valves or piping system drain valves; do not make connections of copper drain tubes directly to carbon or stainless steel HVAC liquid piping.

.5 Drain sizes:

.1 NPS 2 for large water-filled equipment including refrigeration equipment, boilers, and heat exchangers.

.2 NPS ¾ for other equipment drains, including integral or field installed condensate and drip pans.

.3 NPS 2 for piping system drains, unless otherwise shown.

.6 Run large equipment drains to floor trenches unless otherwise shown to terminate in a specific location.

.7 Run other equipment drains to nearest floor drain unless otherwise shown to terminate in a specific location. Where NPS ¾ drains terminate at a floor drain, provide a funnel of at least 200 mm x 100 mm (8 in x 4 in) on the floor drain cover.

.8 Install piping system drains as follows;

.1 In mechanical service rooms and permanently accessible service spaces, extend drains down along a wall or column and terminate approximately 1000 mm (40 in) above the floor level in the service room, or above the lowest accessible level in a vertical service space.

.2 In other service rooms including non-accessible service spaces, electrical rooms, telecom rooms or data rooms, extend drains to a location outside of these service room to a location agreed with by the Engineer unless otherwise shown and provide a drain valve at the termination point.

.3 Where piping system drains are located in finished areas above accessible ceilings that are not more than 3 m (10 ft) high, terminate the drains approximately 200 mm (8 in) above the top of the ceiling and provide a drain valve at this termination point.

.4 Where piping system drains are located above non-accessible ceilings, or where an accessible ceiling is more than 3 m (10 ft) high, extend the drain tubing to a location agreed with by the Engineer unless otherwise shown and provide a drain valve at this termination point.

.9 Terminate drain ends with a 45° elbow and a brass body, male-end, cam-and-groove (Camlock) coupling fitting with dust cap. Supply the matching hose-end female connector and turn over to the owner.

.10 Provide air vents with isolation ball valves at high points to allow effective drainage of the system and to facilitate removal of air from the system.

### 3.3 Dissimilar Metals Galvanic Isolation

.1 Provide dielectric unions or flanges to separate copper and copper alloy tube and fitting materials from contact with carbon steel material. This includes equipment such as coils with copper header connections.

.2 Dielectric unions or flanges are not required when all of the following conditions are met:

.1 the hydronic water treatment program (existing or new) includes a cathodic and/or anodic filming chemistry for mixed metals,

.2 copper tubing is not used in the piping system, except for the final 1 m (40 in) length connection to terminal equipment and in which the tubing is isolated from the carbon steel piping by a bronze body or carbon steel body valve (no brass) , and

.3 terminal equipment which contains copper or copper alloy tubing is connected to carbon steel piping with a flexible connector having an internal non-metallic hose.

.3 For clarity, where copper tubing is installed in a part of a carbon steel piping system, dielectric unions or flanges are required.

### 3.4 Pressure and Leak Testing - Liquid Service Piping

.1 This test procedure applies to piping normally containing water, including HVAC water piping and condensate piping.

.2 Pressure test liquid HVAV piping systems unless otherwise specified in other sections of Division 23.

.3 Initial pneumatic leak test:

.1 Conduct an initial pneumatic leak test to locate and repair major leaks.

(a) ASME B31.1 systems: 175 kPa (25 psig)

(b) ASME B31.9 systems: 70 kPa (10 psig)

.2 Remove compressed air source and maintain this pressure for the time necessary to inspect for major leaks, but not less than 2 hours. Repair major leaks.

.3 During pneumatic pressure tests, comply with the site safety requirements for notification and guarding during testing with compressed gasses.

.4 Final hydrostatic pressure test:

.1 Use the system design pressure for the entire installation, unless different design pressures are indicated for each floor.

.2 Pressure test condensate piping to the same test conditions as the steam system to which they are connected.

.3 Fill the system with water and conduct a pressure test at 150% of the design pressure for 10 minutes, then reduce pressure to design pressure.

(a) Maintain pressure and examine each joint with commercial leak detector solution.

*Standard of Acceptance*

- Snoop
- Leak-tec

(b) Repair leaks and retest using leak detector solution with piping under pressure specified.

.4 As an alternative to leak testing of each joint, 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 Record ambient air temperature at the same time.

(c) Maximum pressure loss over 24 hours: not more than 1% of test pressure, corrected for ambient temperature.

(d) Repair leaks and retest until satisfactory.

## 3.5 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.

## 3.6 Piping Material Selection Schedule

.1 Provide piping material in accordance with schedule Table 1 at the end of this specification section.

DW

| Table 1: Piping and Valve Material and Specification by System Type | | | | |
|---|---|---|---|---|
| Piping System | Abbrev | Pipe Material | Pipe Specification | Valve Specification |
| Hydronic heating and cooling - closed loop (with or without glycol) | HTS/R HS/R LTS/R GHS/R CHS/R GCS/R RV | Carbon Steel | 23 21 13.23 | 23 05 23.13 |
| | | Copper | 23 21 13.33 | 23 05 23.13 |
| Condenser Water - open-loop | CTS/R | Carbon Steel | 23 21 13.23 | 23 05 23.13 |
| | | Stainless Steel | 23 21 13.26 | 23 05 23.16 |
| Cooling Tower Overflow and Drain | DR | Galvanized Steel | 23 21 13.23 | 23 05 23.13 |
| Process Chilled Water | PCHS/R | Carbon Steel | 23 21 13.23 | 23 05 23.13 |
| | | Stainless Steel | 23 21 13.26 | 23 05 23.16 |
| Process Cooling Water (with city water back-up) | PCWS/R | Stainless Steel | 23 21 13.26 | 23 05 23.16 |
| Snow Melting (buried) | SMHS/R | Polyethylene | 23 21 13.37 | 23 05 23.13 |
| Instrumentation Piping | --- | Stainless Steel | 23 21 13.29 | |
| Underground Steam and Condensate Piping | S-xxx PC-xxx GC | Various | 23 22 13.13 | 23 05 23.23 |
| Distribution Steam, Condensate and Boiler Feedwater | S-xxx PC-xxx GC, HD V, RV | Carbon Steel | 23 22 13.23 | 23 05 23.23 |
| Steam Boiler Plant - Steam, Condensate and Feedwater | S-xxx PC-xxx GC, HD BF, BO CBO, HD, V, RV | Carbon Steel | 23 22 13.23 | 23 05 23.26 |

**Table 1: Piping and Valve Material and Specification by System Type**

| Piping System | Abbrev | Pipe Material | Pipe Specification | Valve Specification |
|---|---|---|---|---|
| Clean Steam, Clean Condensate and Clean Feedwater (no chemical treatment) | CS-xxx CPC-xxx CGC CBF BF, BO CBO V, RV | Stainless Steel | 23 22 13.26 | 23 05 23.29 |
| Non-potable make-up water (no pre-treatment, no added chemicals) | NPWH | Copper | 23 21 13.33 | 23 05 23.13 |
| | | Stainless Steel (tube or pipe) | 22 11 16.16 or 23 21 13.26 | 23 05 23.16 |
| Water Pre-Treatment for HVAC Services (softened water and dealkalized water) | SWH DALK | Copper | 23 21 13.33 | 23 05 23.13 |
| | | Galvanized Steel | 23 21 13.23 | 23 05 23.13 |
| Reverse Osmosis water for HVAC Services | ROS/R | Stainless Steel | 23 21 13.26 | 23 05 23.19 |
| Chemical Feed (chemical water treatment) | CF, CS | Various | 23 25 11 | |
| Equipment and piping system drainage for HVAC liquid systems | DR | Galvanized Steel | 23 21 13.23 | 23 05 23.13 |
| | | Copper | 23 21 13.33 | 23 05 23.13 |
| Equipment and piping system drains for steam and condensate system. | DR | Same as associated steam and condensate system. | | |
| Brine | BRS/R | PVC | 23 21 13.36 | |

**END OF SECTION**

# GENERAL-DUTY VALVES FOR HVAC WATER PIPING
# 23 05 23.13

## 1 GENERAL

### 1.1 Scope

.1 Provide valves for general duty service in HVAC water piping systems, including shut-off valves, check valves, and manual balancing valves, for piping systems with a design pressure of 3500 kPa (507 psig) or less and a design temperature of 121°C (250°F) or less.

.2 This specification applies to hydronic heating and cooling water systems (with or without glycol additives) and other piping systems required to be carbon steel pipe, galvanized steel pipe, and/or coper tubing as specified in section 23 05 01, except as otherwise required for specific duty valve in other specification sections.

### 1.2 Related Sections

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

.1 20 05 23 General Requirements for Valves

.2 23 05 01 Heating and Cooling Piping Systems

### 1.3 Submittals

.1 Refer to section 20 05 23.

### 1.4 Applicable Codes and Standards

.1 Refer to section 20 05 23 and as specified herein.

.2 Where an HVAC liquid piping system is subject to registration as a pressure piping system as identified in specification section 23 05 01, all valves shall have Canadian Registration Numbers in accordance with CSA B51. In the following valve specifications, where the identified model does not have a current CRN, provide a valve of equal or greater performance which has a current CRN from the same manufacturer.

.3 For the purpose of this article, "current CRN" means a registration which does not expire for at least 12 months from the date of submittal of shop drawings.

## 2 PRODUCTS

### 2.1 Ball Valves – bronze/brass body

.1 NPS 2 and under:

.1 To MSS SP-110, 600 CWP/150 SWP, two-piece bronze or DZR brass body, full port, solid stainless steel or chrome plated bronze ball, PTFE seat and seals.

.2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.

.3 Required MCPR: 2300 kPa (335 psig) at 121°C (250°F).

.4 Solder ends:

*Standard of Acceptance*

- Kitz - fig. 59, 69AM-LL
- Apollo - fig. 77-200
- Nibco - fig. S-585-70
- Anvil - fig. 171S

.5 NPT threaded ends.

*Standard of Acceptance*

- Kitz - fig. 58, 68AM-LL
- Apollo - fig. 77-100
- Nibco - fig. T-585-70
- Anvil - fig. 171N

### 2.2 Ball Valves – carbon steel body

.1 NPS 2 and under:

.1 To MSS SP-110, 1500 CWP/150 SWP, carbon steel body, regular port, stainless steel or chrome plated carbon steel ball, PTFE seat and seals.

.2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.

.3 ISO 5211 mounting pad.

.4 Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

.5 Two-piece body style, NPT threaded ends:

*Standard of Acceptance*

- Apollo - fig. 89-100
- MAS - fig. CSCR-2
- Velan - fig. S-M1102-SSGA

.6 Three-piece body style, NPT threaded ends:

*Standard of Acceptance*

- Apollo - fig. 83A-140
- Nibco - fig. TM-590-CS-R-66-FS-LL
- MAS - fig. CSS-F-3N
- Velan - fig. S-K1802-SSGA

.7 Three-piece body style, socket weld ends:

*Standard of Acceptance*

- Apollo - fig. 83A-240
- Nibco - fig. KM-590-CS-R-66-FS-LL
- MAS - fig. CSS-F-3N-SW
- Velan - fig. W-K1802-SSGA

.2 NPS ½ to NPS 4:

.1 To MSS SP-72, ASME Class rated, carbon steel two-piece split body, full port, stainless steel or chrome plated carbon steel ball, PTFE seat and seals, ASME Class 150 flanged ends.

.2 Handle extensions suitable to clear 50 mm (2 in) pipe insulation thickness.

.3 ISO 5211 mounting pad.

.4 Class 150:

(a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 150SCTDZM-N
- Apollo - fig. 88A-200
- Nibco - fig. F-515-CS-F-66-FS
- Velan - fig. SB-150

.5 Class 300:

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 300SCTDZM-N
- Apollo - fig. 88A-900
- Nibco - fig. F-535-CS-F-66-FS
- Velan - fig. SB-300

## 2.3 Globe Valves

.1 NPS 2 and under:

.1 To MSS SP-80, Class 150, bronze body, renewable PTFE composition disc, union bonnet, and lockshield handles where shown.

(a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

(b) Solder ends.

*Standard of Acceptance*

- Kitz - fig. 10
- Crane - fig. 1310 (class 300)
- Jenkins - fig. 106BPJ (class 300)
- Nibco - fig. S-235-Y

(c) NPT threaded ends.

*Standard of Acceptance*

- Kitz - fig. 09
- Crane - fig. 7TF
- Jenkins - fig. 106BJ

- Nibco - fig. T-235-Y

.2 To MSS SP-80, Class 300, bronze body, hardened stainless steel plug, renewable seat and union bonnet, with NPT threaded ends.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 17S
- Crane - fig. 382P
- Jenkins - fig. 592J
- Nibco - fig. T-276-AP

.3 To ASME B16.34, Class 800, forged steel body, bolted bonnet, hard faced disc and seat ring, with NPT threaded ends.

(a) Required MCPR: 12 MPa (1740 psig) at 121°C (250°F).

*Standard of Acceptance*

- Crane - fig. B3644XU-T
- Powell - fig. LG08TA58GB
- Beric - fig. 502-T-X-8-A-08

.2 NPS 2½ and over, flanged:

.1 To MSS SP-85, Class 125, cast iron body, bronze trim, OS & Y bolted bonnet, bronze disc and seat ring, flat faced flanges,

(a) Required MCPR:

- NPS 2-12: 1200 kPa (174 psig) at 121°C (250°F).
- NPS 14-24: 860 kPa (125 psi) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 76
- Crane - fig. 351
- Jenkins - fig. 2342J
- Nibco - fig. F-718-B

.2 To ASME B16.34, Class 300, ASTM A216 Gr WCB cast steel body, 13% chrome stellite trim, OS & Y, bolted bonnet, and raised face flanges.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 300SCJS
- Crane - fig. 151XU
- Jenkins - fig. J1042B2
- Powell - fig. 3031-FC8G
- Beric - fig. 203-RF-EA08-H

**2.4 Gate Valves**

.1 NPS 2 and under:

.1 To MSS SP-80, Class 150 with bronze body, OS&Y rising stem, bronze wedge disc and union or screw-in bonnet, and NPT threaded ends.

(a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 42
- Crane - fig. 431UB
- Nibco - fig. T-131

.2 To MSS SP-80, Class 300, bronze body, OS&Y rising stem, copper nickel alloy or stainless steel trim, solid wedge disc, union bonnet, and NPT threaded ends.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 37
- Crane - fig. 622E
- Jenkins - fig. 2280UJ
- Nibco - fig. T-174-A

.3 To ASME B16.34, Class 800, forged steel body, standard port, OS&Y rising stem, solid wedge disc, bolted bonnet, and NPT threaded ends.

(a) Required MCPR: 12 MPa (1740 psig) at 121°C (250°F).

*Standard of Acceptance*

- Bonney Forge - fig. HL-11-T
- Crane - fig. B-3604XU-T
- Powell - fig. GA08TA58GB
- Beric - fig. 501-T-X-8-A-02

.2 NPS 2½ and over, flanged:

.1 To MSS SP-70, Class 125, cast iron body, OS&Y rising stem, flat faced flanges, bronze trim, and bolted bonnet, and flat-faced flanges.

(a) Required MCPR:

- NPS 2-12: 1200 kPa (174 psig) at 121°C (250°F).
- NPS 14-24: 860 kPa (125 psi) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 72
- Crane - fig. 465½
- Jenkins - fig. 454J
- Nibco - fig. F-617-O

.2 To ASME B16.34, Class 300, ASTM A216 Gr WCB cast steel body, OS&Y rising stem, flexible disc, 13% chrome stellite trim, bolted bonnet, and raised face flanges.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 300SCLS
- Crane - fig. 33XU-F
- Jenkins - fig. J1010B8F
- Powell - fig. 3003-FC8G
- Beric - fig. 103-RF-AA08-H

## 2.5 Butterfly Valves – Low Pressure (type "LP")

.1 NPS 2½ to NPS 24, for flange installation:

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

.2 Stainless steel shaft, bronze or ductile iron disc with nickel chrome seating edge and replaceable EPDM resilient seat to provide bubble tight shut-off under system pressure from either side with flange removed from un-pressurized side.

.3 ISO 5211 mounting pad.

.4 Locking handles up to NPS 4, and gear operators for NPS 6 and over.

.5 Required MCPR:

(a) NPS 2 to 12: 1380 kPa (200 psig) at 107°C (225°F).

(b) NPS 14 to 24: 1030 kPa (150 psig) at 107°C (225°F).

*Standard of Acceptance*

- Nibco - fig. LD-2000
- Crane - fig. Center Line RS-200
- Kitz - fig. 6100 series
- DeZurik - fig. BOS-US
- Bray - fig. 31H
- Watts - fig. BF-03-M2
- MAS - fig. D series

.2 NPS 2½ to 12, for grooved end pipe:

.1 To CSA B242, malleable or ductile iron body with corrosion inhibiter finish, with grooved ends.

.2 Stainless steel shaft, aluminum-bronze or nickel plated ductile iron or EPDM encapsulated ductile iron disc, and replaceable EPDM resilient seat for bi-directional flow and bubble tight shut-off under system pressure.

.3 ISO mounting pad.

.4 Locking handles up to NPS 4, and gear operators for NPS 6 and over.

.5 Required MCPR: 1380 kPa (300 psig) at 107°C (225°F).

*Standard of Acceptance*

- Victaulic - fig. 761 Vic-300
- Gruvlok - fig. 7700 series
- MAS - fig. W50-A-ED-GG-S-LL

.3 NPS 14 to NPS 24, for grooved end pipe:

.1 To CSA B242, ductile iron body with corrosion inhibiter finish, with grooved ends.

.2 Stainless steel shaft, corrosion-inhibiter encapsulated ductile iron disc with offset design, and replaceable EPDM resilient sealt for bi-directional flow and bubble tight shut-off under system pressure.

.3 ISO mounting pad.

.4 Gear operator.

.5 Required MCPR: 2065 kPa (300 psig) at 107°C (225°F).

*Standard of Acceptance*

- Victaulic - fig. AGS Vic-300 W709

## 2.6 Butterfly Valve - High Pressure (type "HP")

.1 NPS 2½ to NPS 36:

.1 To MSS SP-68, high pressure offset-disc type, carbon steel lug body with flange bolt holes drilled and tapped, suitable for single flange connection to ASME/ANSI B16.5 flanges (NPS 24 and under) and ASME/ANSI B16.47 Series A flanges (NPS 30 to NPS 48).

.2 316 or 17-4 stainless steel disc and shaft, PTFE seat complete with titanium or 316 stainless steel spiral wound back-up ring, bi-directional bubble tight shut-off under system pressure for dead-end service with flange removed from one side.

.3 ISO 5211 mounting pad.

.4 Locking handles up to NPS 4, and gear operators for NPS 6 and over.

.5 Class 150 valve (NPS 2½ to 36):

(a) Required MCPR: 1600 kPa (230 psig) at 121°C (250°F).

*Standard of Acceptance*

- DeZurik - fig. BHP
- Crane - fig. Flowseal 3LA series
- Apollo - fig. 230L
- WKM - fig. DynaCentric
- Nibco - fig. LCS-6822
- Keystone - fig. K-Lok 36
- Nibco SureSeal - fig. G1L
- Bray - fig. McCannalok

.6 Class 300 valve (NPS 2½ to NPS 24)

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- DeZurik - fig. BHP
- Crane - fig. Flowseal 3LA series
- Apollo - fig. 230L
- WKM - fig. DynaCentric
- Nibco - fig. LCS-7822
- Keystone - fig. K-Lok 37
- Bray - fig. McCannalok

## 2.7 Inline Silent Check Valves

.1 NPS 2 and under, bronze, threaded:

.1 To MSS SP-80, Class 125, bronze body, spring-controlled inline style (non flapper), body guided disc, resilient EPDM or PTFE seat or disc; bronze, Inconel or stainless steel spring; with NPT threaded ends.

.2 Required MCPR: 1200 kPa (174 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 36
- Nibco - fig. T-480-Y

- Apollo - fig. CVBB 61-500
- Valmatic - fig. 1400THR

.2 NPS 2 ½ to NPS 12, wafer style:

.1 To MSS SP-125, Class 125 or 150, cast or ductile iron body, stainless steel trim and spring-controlled inline globe-style (non flapper), body guided disc, resilient BUNA-N seat, wafer body style for installation between flat-faced flanges.

.2 Valve design provides both a metal-to-metal and metal-to-resilient seat for zero leakage sealing.

.3 Required MCPR: 1200 kPa (174 psig) at 65°C (150°F).

*Standard of Acceptance*

- Dezurik - fig. APCO 300 Series
- Valmatic - fig. 1400A series
- Mueller - fig. 101MAT
- Nibco - fig. W-910

.3 NPS 2½ to NPS 24, flanged ends:

.1 To MSS SP-125, Class 125 or 150, cast or ductile iron body, stainless steel trim and spring-controlled inline globe-style (non flapper), body guided disc, resilient BUNA-N seat, with Class 125/150 flanges.

.2 Valve design provides both a metal-to-metal and metal-to-resilient seat for zero leakage sealing.

.3 Required MCPR:

- NPS 2-12: 1200 kPa (174 psig) at 65°C (150°F).
- NPS 14-24: 860 kPa (125 psi) at 65°C (150°F).

*Standard of Acceptance*

- Dezurik - fig. APCO 600 Series
- Valmatic - fig. 1800 series
- Mueller - fig. 107MAT
- Nibco - fig. F-960

.4 NPS 2½ to NPS 24, carbon steel, flanged:

.1 To MSS SP-126, Class 150 and 300, ASTM A216 WCB carbon steel body, stainless steel trim and spring-controlled inline globe-style (non flapper), body guided disc, stainless steel seat, with Class 150 / 300 flanges.

.2 Valve design provides both a metal-to-metal and metal-to-resilient seat for zero leakage sealing.

.3 Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Dezurik - fig. APCO 600 Series
- Durabla - fig. GLC
- Mueller - fig. 109MDT

## 2.8 Swing Check Valves

.1 NPS 2 and under:

.1 To MSS SP-80, Class 125, bronze body, bronze swing disc, screw in cap, regrindable seat.

(a) Required MCPR: 1200 kPa (174 psig) at 121°C (250°F).

(b) Soldered ends

*Standard of Acceptance*

- Kitz - fig. 23
- Crane - fig. 1342
- Jenkins - fig. 4093J
- Nibco - fig. S-413-B

(c) NPT threaded ends:

*Standard of Acceptance*

- Kitz - fig. 22
- Crane - fig. 37
- Jenkins - fig. 4037J
- Nibco - fig. T-413-B

.2 To MSS SP-80, Class 300, bronze body, bronze swing disc, screw in cap, regrindable seat, with NPT threaded ends.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 19
- Crane - fig. 76E
- Jenkins - fig. 4962J
- Nibco - fig. T-473-B

.2 NPS 2½ to NPS 10, cast iron, flanged

.1 To MSS SP-71, Class 125, cast iron body, flat faced flange, renewable bronze seat ring, bronze disc, bolted cap, with ASME Class 125 flanged ends.

(a) Required MCPR: 1200 kPa (174 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 78
- Crane - fig. 373
- Jenkins - fig. 587J
- Nibco - fig. F-918-B

.3 NPS 2 to NPS 30, carbon steel, flanged:

.1 To ASME B16.34, Class 300, ASTM A216 Gr WCB cast steel body, renewable stainless steel seat ring, stainless steel or 13% Cr overlay disc, bolted cap.

(a) Required MCPR: 3500 kPa (507 psig) at 121°C (250°F).

*Standard of Acceptance*

- Kitz - fig. 300SCOS
- Crane - fig. 159XU
- Beric - fig. 303-RF-EA08

.4 NPS 2 to NPS 12, for grooved end pipe

.1 Ductile iron body, ductile iron or bronze disc, nickel seat, EPDM liner, stainless steel spring, with grooved ends.

.2 Required MCPR: 2000 kPa (290 psig) at 110°C (230°F)

*Standard of Acceptance*

- Victaulic - fig. 716H/716
- Gruvlok - fig. 7800

## 2.9 Double Regulating Valves ("DRV")

.1 NPS 3 and under:

.1 Bronze or DZR brass body, plug type stem with flow measurement ports and tamper-proof setting.

.2 NPT threaded or soldered ends.

.3 Required MCPR: 1500 kPa (215 psig) at 121°C (250°F) water temperature.

*Standard of Acceptance*

- S.A. Armstong - fig. CBV
- Victaulic - fig. 787
- Bell and Gossett - fig. Circuit Setter Plus
- Preso - fig. B-Plus
- Nexus - fig. UltraMB(NL)
- Red White - fig. 9517

.2 NPS 2½ to NPS 12:

.1 Cast or ductile iron body, copper alloy trim, with flow measurement ports, tamper-proof setting, with groove or Class 250/300 flanges.

.2 Required MCPR: 1720 kPa (250 psig) at 110°C (230°F)

*Standard of Acceptance*

- S.A. Armstrong - fig. CBV II
- Victaulic - fig. 788/789
- Preso - fig. B-PLUS
- Nexus- fig. UltraMB
- Red White - fig. 9519

.3 Flow meter for DRVs

.1 Differential pressure gauge with calibrated chartes or direct digital flow meter type.

.2 Hose and fittings to suit manual double regulating valves.

.3 In addition to equipment and materials used during start-up and testing, supply one complete set of clean un-used calibrated flow charts or one (1) digial flow meter, to the owner at the completion of the project.

## 2.10 Plug Valves with Flow Balancing Ports

.1 NPS 6 to 24, flanged:

.1 To MSS SP-78, cast or dutile iron body, lubricated bronze or nickel plated cast iron plug, lubrication assembly, short pattern, with Class 125 flat-face flange ends.

.2 Two pressure test ports with pet cocks for differential pressure measurement, and calibrated flow charts.

.3 Worm gear operator with memory stop.

.4 Class 125:

(a) Required MCPR:

- NPS 2-12: 1200 kPa (174 psi) at 121°C (250°F)
- NPS 14-24: 1000 kPa (145 psi) at 121°C (250°F)

*Standard of Acceptance*

- Hattersley - fig. 611
- DeZurik - fig. Hilton Balancing Valve

.5 Class 250:

(a) Required MCPR:

- NPS 2-12: 2700 kPa (390 psi) at 121°C (250°F)
- NPS 14-24: 1700 kPa (245 psi) at 121°C (250°F)

*Standard of Acceptance*

- Hattersley - fig. 602
- DeZurik - fig. Hilton Balancing Valve

### 2.11 Triple Duty Valves

.1 Combination discharge non-slam check valve, isolation valve and balancing valve ("triple-duty").

.2 NPS 1-1/4 to NPS 2:

.1 Ductile iron body, Class 125, non-slam bronze disc with stainless steel spring, EPDM seat ring, plug type stem, flow measurement ports, tamper-proof setting, with NPT threaded ends.

.2 Required MCPR: 900 kPa (130 psig) at 110°C (230°F)

*Standard of Acceptance*

- S.A. Armstrong - fig. FLO-TREX FTV-T
- ITT Bell & Gossett

.3 NPS 2 to NPS 12:

.1 Cast or ductile iron body, non-slam bronze disc with stainless steel spring, EPDM seat ring, plug type stem, flow measurement ports, tamper-proof setting, with flanged or groove pipe ends.

.2 Class 125 required MCPR: 900 kPa (130 psig) at 110°C (230°F)

.3 Class 250 required MCPR: 2070 kPa (300 psig) at 110°C (230°F)

*Standard of Acceptance*

- S.A. Armstrong - fig. FLO-TREX FTV series
- ITT Bell & Gossett

## 3 EXECUTION

### 3.1 General

.1 Refer to section 20 05 23 and as required herein.

### 3.2 Valve Selection Based on Pressure Rating

.1 Unless otherwise specified herein or shown, select valves that have a Minimum Component Pressure Rating (MCPR) which exceed the applicable piping system Design Pressure and Design Temperature specified in section 23 05 01.

.2 Where drawings indicate either: (a) a pressure rating; or (b) a pressure rating and Class rating, by floor level then select valves as follows:

  .1 For all valves, select a valve with a MCPR rating equal to or greater than the pressure rating indicated on the drawings for each floor level.

  .2 For clarity, even if a valve has an ASME Class rating, do not select a valve based on its Class to match any Class rating shown on the drawings.

## 3.3 Butterfly valves

.1 Where butterfly valves are used, provide high pressure HP type butterfly valves as follows:

  .1 at hot water boiler inlet and outlet connections,

  .2 at refrigeration equipment evaporator and condenser water inlet and outlet connections,

  .3 where valves are installed in pipe risers in vertical service shafts,

  .4 where valves are used to isolate piping service to a building,

  .5 as required based on valve size and pressure ratings, or

  .6 at other locations as shown on drawings.

.2 For butterfly valves with automatic control actuators, select RS or HP type valves as required so that valve torque requirements do not exceed 75% of installed valve actuator torque rating.

## 3.4 Check Valves

.1 Provide an inline silent check valve on the pump discharge under any of the following conditions:

  .1 multi-parallel pump installation,

  .2 where the pump discharge piping rises to more than 5 m (15 ft) above the pump discharge, and

  .3 at other locations as shown on drawings.

.2 Provide an inline silent check valve where a check-valve is shown on drawings other than at a pump discharge.

.3 Provide swing check or silent check valves at other locations.

**End of Section**

# HYDRONIC PIPING – CARBON STEEL
# 23 21 13.23

## 1 GENERAL

### 1.1 Scope

.1 Provide carbon steel pipe and fittings for HVAC liquid piping systems. Refer to section 23 05 01 for piping system applicability.

.2 This specification applies to liquid piping systems with design pressures not exceeding 2750 kPa (400 psig) at temperatures not exceeding 121°C (250°F, except as otherwise specified.

### 1.2 Related Sections

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

.1 20 05 24 Welding and Brazing

.2 23 05 01 HVAC Piping Systems General Requirements

### 1.3 Applicable Codes and Standards

.1 Legislation:

.1 Refer to section 23 05 01.

.2 Installation standards and codes:

.1 Refer to section 23 05 01.

.3 Product standards:

| | | |
|---|---|---|
| .1 | ANSI A21.11 | Rubber Gasket joints for Ductile-Iron Pressure Pipe and Fittings |
| .2 | ANSI B1.20.1 | Pipe Threads, General Purpose (inch) |
| .3 | ASME B16.1 | Cast Iron Pipe Flanges And Flanged Fittings |
| .4 | ASME B16.3 | Malleable Iron Threaded Fittings. |
| .5 | ASME B16.5 | Pipe Flanges and Flanged Fittings |
| .6 | ASME B16.9 | Factory Made Wrought Steel Buttwelding Fittings |
| .7 | ASME B16.11 | Forged Steel Fittings, Socket-Welding and Threaded |
| .8 | ASME B16.20 | Metallic Gaskets for Pipe Flanges: Ring Joint Spiral Wound and Jacketed. |
| .9 | ASME B16.21 | Nonmetallic Flat Gaskets for Pipe Flanges. |
| .10 | ASME B18.2.1 | Square and Hex Bolts and Screws, |
| .11 | ASME B18.2.2 | Square and Hex Nuts |
| .12 | ASME B16.39 | Malleable Iron Threaded Pipe Unions: Classes 150, 250 and 300. |
| .13 | ASTM A47 | Standard Specificatin for Ferritic Malleable Iron Castings. |
| .14 | ASTM A53 | Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| .15 | ASTM A105 | Standard Specification for Carbon Steel Forgings for Piping Applications |

| | |
|---|---|
| .16 ASTM A106 | Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service |
| .17 ASTM A194 | Standard Specification for Carbon and Alloy Steel Nuts and Bolts for High-Pressure or High-Temperature Service, or Both. |
| .18 ASTM A536 | Standard Specification for Ductile Iron Castings. |
| .19 CSA B242 | Groove and Shoulder Type Mechanical Pipe Couplings |

## 2 PRODUCTS

### 2.1 Pipe

.1 Carbon steel:

.1 NPS 2 and under:

(a) ASTM A106 Gr B, schedule 40 seamless, or
(b) ASTM A53 Gr B, schedule 40 Electric Resistance Weld (ERW).

.2 NPS 2-1/2 to 10:

(a) ASTM A53 Gr B, schedule 40 Electric Resistance Weld (ERW).

.3 NPS 12 to NPS 18:

(a) ASTM A53 Gr B, schedule Standard (0.375 in. wall thickness) ERW.

.4 NPS 20 to NPS 24:

(a) ASTM A53 Gr B, schedule 30 ERW.

### 2.2 Pipe Joints and Fittings

.1 Threaded fittings:

.1 End connections: NPT thread to ANSI B1.20.1.

.2 Fittings: Class 150 and Class 300, malleable iron to ASME B16.3..

.3 Unions: Class 150 and Class 300, malleable iron body with ground joint and bronze face to ASME B16.39.

.4 Threaded joint compound: pulverized lead paste or Teflon pipe tape sealant.

*Standard of Acceptance*

- Masters Pro-Dope
- Masters Orange or White Tape.

.2 Welding fittings:

.1 Butt weld fittings:

(a) Forged to ASME B16.9,
(b) wall thickness to match pipe,
(c) long radius elbows.

.2 Welding outlet fittings:

(a) forged to ASTM A105,
(b) dimensions and pressure ratings to MSS SP-97, Standard Class for buttwelding branch connection and Class 3000 for threaded or socket welded branch connection,
(c) NPT ends to ASME B1.20.1.

.3 Socket welded fittings:

(a) forged to ASTM A105,
(b) dimensions and pressure ratings to ASME B16.11, Class 3000.

.4 Half couplings:

(a) forged carbon steel to ASTM A105,
(b) dimensions and pressure rating to ASME B16.11, Class 3000 socket weld or threaded ends,
(c) NPT ends to ASME B1.20.1.

.3 Flanges:

.1 Flat-faced cast iron to ANSI B16.1, Class 125.

.2 Raised-face forged carbon steel to ASME B16.5, Class 150 and Class 300, weld neck with wall thickness to match pipe, or slip on type.

.3 Studs, bolts and nuts to ANSI B18.2.1, ANSI 18.2.2 and ASTM A194, “high strength” type.

.4 Gaskets to ANSI B16.21, ANSI B16.20 or ANSI A21.11.

*Standard of Acceptance*

° Chesterton - fig. 100, 195 and 450
° Beldam

## 3 EXECUTION

### 3.1 Piping Installation

.1 Refer to section 23 05 01 for piping design criteria and general requirements for piping installation.

.2 Slope main piping horizontal or up in direction of flow nominally at a slope of 1:500 (0.2%);

.1 branch piping to have greater slope,

.2 slope piping up in direction of terminal heating and cooling devices,

.3 where supply and return piping are grouped together and flow is in opposite directions, arrange piping horizontal.

.3 Use eccentric reducers at pipe size changes arranged flat-on-top to assist venting.

.4 Cap ends during construction to prevent entry of foreign matter.

### 3.2 Class Rated Fittings and Flanges

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

| Class | Maximum Design Pressure | Maximum Coincident Design Temperature |
|---|---|---|
| 125 Note [1] | 900 kPa (130 psi) | ≤ 65°C (150°F) |
| 125 Note [1] | 700 kPa (100 psi) | ≤ 121°C (250°F) |
| 150 | 1720 (250 psi) | ≤ 38°C (100°F) |
| 150 | 1400 kPa (200 psi) | ≤ 121°C (250°F) |

| Class | Maximum Design Pressure | Maximum Coincident Design Temperature |
|---|---|---|
| 300 | 3700 kPa (535 psi) | ≤ 38°C (100°F) |
| 300 | 3100 kPa (450 psi) | ≤ 121°C (250°F) |

***Notes:***

[1] For flanges only.

## 3.3 Pipe Joints and Fittings

.1 Make pipe joints as follows.

.1 Piping NPS 2-1/2 and under:

(a) NPT threaded joint to ANSI B1.20.1 and made with Teflon tape or pipe dope, or
(b) socket weld joints.

.2 Piping NPS 2-1/2 and larger:

(a) welded,
(b) flanged.

.3 For clarity, pipe size of NPS 2-1/2 may be either type of joint specified.

.2 For flange joints, select gasket materials in accordance with the following table so that gasket pressure and temperature both exceed the piping system design pressure and design temperature.

| Gasket Temperature Limit | Gasket Pressure Limit | Gasket Material | Gasket Thickness | Chesterton Figure |
|---|---|---|---|---|
| 80°C (180°F) | 1720 kPa (250 psig) | Red rubber | 1.6 m (1/6 in) | 100 |
| 200°C (390°F) | 2400 kPa (350 psig) | Synthetic fiber with nitrile binder | 1.6 m (1/6 in) | 450 |
| 400°C (750°F) | 3700 kPa (535 psig) | Synthetic fiber with nitrile binder | 1.6 m (1/6 in) | 195 |

## 3.4 Equipment connections

.1 Make pipe connections to equipment as follows:

.1 NPS 2 and smaller: threaded fittings.

.2 NPS 2 ½ and larger:

(a) flanged connections,
(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.

## 3.5 Welding

.1 Comply with section 20 05 24 and as specified herein.

## 3.6 Branch Connections

.1 Make branch connections to mains in accordance with Table 2a and 2b.

.1 These tables are valid for design pressures up to 2070 kPa (300 psig), without adding reinforcement material where branch pipe is directly welded to the main. For welded branch connections at higher design pressures, use buttweld, socket weld, or integrally reinforced outlet fittings only.

.2 In these tables, the following abbreviations apply.

***Abbreviations:***

| | |
|---|---|
| TH | Threaded fitting to ASME B16.3 |
| SW | Socket weld fittings to ASME B16.11 |
| HC | Half coupling to ASME B16.11 |
| BW | Buttweld fitting to ASME B16.9 |
| OF | Reinforced Outlet Fittings to MSS SP-97 |
| DP | Direct welding of Branch Pipe to Main without added reinforcement. |

**Table 2a – Allowable Branch to Main Connections (NPS 1 to NPS 10)**

| Branch NPS | Mains Pipe, NPS 1 | 1-1/4 | 1-1/2 | 2 | 2-1/2 | 3 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 3/ 4 | TH SW | TH SW | TH SW | TH SW | BW SW | BW, OF SW HC DP | BW, OF SW HC DP | BW, OF HC DP | BW, OF HC DP | BW, OF HC DP |
| 1 | TH SW | TH SW | TH SW | TH SW | BW SW | BW, OF SW DP | BW, OF SW HC DP | BW, OF HC DP | BW, OF HC DP | BW, OF HC DP |
| 1-1/4 | --- | TH SW | TH SW | TH SW | BW SW | BW, OF SW DP | BW, OF SW DP | BW, OF HC DP | BW, OF HC DP | BW, OF HC DP |
| 1-1/2 | --- | --- | TH SW | TH SW | BW SW | BW, OF SW DP | BW, OF SW DP | BW, OF HC DP | BW, OF HC DP | BW, OF HC DP |
| 2 | --- | --- | --- | TH SW | BW SW | BW, OF SW | BW OF SW DP | BW, OF DP | BW, OF HC DP | BW, OF HC DP |
| 2-1/2 | --- | --- | --- | --- | BW SW | BW, OF SW | BW, OF SW | BW, OF DP | BW, OF DP | BW, OF DP |
| 3 | --- | --- | --- | --- | --- | BW | BW, OF SW | BW, OF DP | BW, OF DP | BW, OF DP |
| 4 | --- | --- | --- | --- | --- | --- | BW | BW, OF | BW, OF DP | BW, OF DP |
| 6 | --- | --- | --- | --- | --- | --- | --- | BW | BW, OF | BW, OF DP |
| 8 | --- | --- | --- | --- | --- | --- | --- | --- | BW | BW, OF |
| 10 | --- | --- | --- | --- | --- | --- | --- | --- | --- | BW |

| Table 2b – Allowable Branch to Main Connections (NPS 12 to NPS 30) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Branch | Mains Pipe, NPS | | | | | | | |
| NPS | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 30 |
| ¾ to 2 | OF HC DP | OF HC DP | OF HC | OF HC | OF HC | OF HC | OF HC | OF HC |
| 2-1/2 | OF DP | OF DP | OF | OF | OF | OF | OF | OF |
| 3 | OF DP | OF DP | OF | OF | OF | OF | OF | OF |
| 4 | BW OF DP | OF DP | OF | OF | OF | OF | OF | OF |
| 6 | BW OF DP | BW OF DP | BW OF | OF | OF | OF | OF | OF |
| 8 | BW OF DP | BW OF DP | BW OF | BW OF | BW OF | OF | OF | OF |
| 10 | BW OF DP | BW OF DP | BW OF | BW OF | BW OF | BW OF | BW OF | OF |
| 12 | BW | BW OF DP | BW OF | BW OF | BW OF | BW OF | BW OF | OF |
| 14 | --- | BW | BW OF | BW OF | BW OF | BW OF | BW OF | BW OF |
| 16 | --- | --- | BW | BW OF | BW OF | BW OF | BW OF | BW OF |
| 18 | --- | --- | --- | BW | BW OF | BW OF | BW OF | BW OF |
| 20 | --- | --- | --- | --- | BW | BW OF | BW OF | BW OF |
| 22 | --- | --- | --- | --- | --- | BW | BW OF | BW OF |
| 24 | --- | --- | --- | --- | --- | --- | BW | BW OF |
| 30 | --- | --- | --- | --- | --- | --- | --- | BW |

.2 Use of Class 3000 half-couplings as a branch connector (“HC”), and direct welding of branch piping to main piping (”DP”), is permitted in accordance with the following requirements:

.1 half-coupling or branch pipe sits-on mains pipe, and does not insert into the main pipe,

.2 the opening size in the main pipe to closely follow the inside diameter of the half-coupling or branch pipe,

.3 half-coupling or branch pipe attachment end is shaped and beveled to closely following the surface of the main pipe, suitable for a pull-penetration weld,

.4 the half-coupling or direct branch pipe is attached with a groove weld and covered with a smooth finishing fillet weld in accordance with the requirements of the applicable piping code.

.3 Where integrally reinforced outlet fittings, half-couplings or direct welding of branch pipe is used, hole saw or drill and ream mains pipe to maintain full inside diameter of branch line prior to welding.

.4 Where multiple branch pipes are to connect to the main pipe in close proximity to each other, provide a minimum separation between the centerlines of adjacent branch pipes equal to or greater than the sum of the OD dimensions of the adjacent branch pipes.

.5 If threaded fittings have been installed where the specification requires welded fittings, either cut-out and replace the fitting, or fully seal-weld the exposed threads.

.6 Where saddle type branch welding fittings are used on mains, hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding.

## 3.7 Pressure Testing

.1 Conduct pressure and leak tests in accordance with section 23 05 01.

## 3.8 Flushing and Cleaning

.1 After pressure testing, clean piping in accordance with Section 23 25 05.

.2 For piping changes to existing systems, which consist of NPS 2 and smaller branch piping to terminal heating or cooling equipment, the following abbreviated cleaning and flushing procedure may be used:

.1 After cutting of threads and de-burring, and before installation of piping, manually clean the interior of the pipe with wire-brush on an extended rod, while washing the inside of the pipe with a solution of non-foaming, phosphate free detergent, 3% by weight, followed by a hose rinse flushed to drain until water runs clear.

.2 After installation of piping, check strainers are clean, and open isolation valves to use service water for pressure testing and final flush.

.3 After pressure testing, isolate new piping from existing piping, fully open control valves (where installed) and flush service water to drain. Use compressed air at not more than 70 kPa (10 psig) to assist in flushing the water.

.4 Refill system with service water and circulate for two hours. Inspect strainers, and repeat drain, fill and recirculate routine until strainers are free of debris.

**END OF SECTION**

# HYDRONIC PIPING - COPPER
# 23 21 13.33

## 1 GENERAL

### 1.1 Scope

.1 Provide copper tube and fittings for HVAC liquid piping systems for aboveground and underground installations for the following applications:

- .1 (as an alternative to steel piping) final connections not exceeding 1 m (39 in) in length to terminal heating units which have copper tube coils, copper tube heating elements, and copper tube radiant panels,
- .2 tubing located in slabs or under slab-on-grade floors to connect to terminal heating or cooling units,
- .3 drain and vent piping for equipment and piping systems (except cooling tower drainage piping).
- .4 non-potable make-up water piping for HVAC services, or
- .5 where otherwise shown.

.2 This specification applies to liquid piping systems with design pressures not exceeding 2000 kPa (290 psig) at temperatures not exceeding 121°C (250°F, except as otherwise specified. Refer to section 23 05 01 for piping system applicability.

.3 The use of copper tube is limited to nominal tube sizes NPS 3 and under.

### 1.2 Related Sections

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

| | | |
|---|---|---|
| .1 | 20 05 24 | Welding and Brazing |
| .2 | 23 05 01 | Heating and Cooling Piping Systems General Requirements |

### 1.3 Applicable codes and standards

.1 Legislation:

- .1 Refer to section 23 05 01.

.2 Installation standards and codes:

- .1 Refer to section 23 05 01.

.3 Product standards:

| | | |
|---|---|---|
| .1 | ASME B16.15 | Cast Bronze Threaded Fittings, Classes 125 and 250 |
| .2 | ASME B16.18 | Cast Copper Alloy Solder Joint Pressure Fittings |
| .3 | ASME B16.21 | Nonmetallic Flat Gaskets for Pipe Flanges |
| .4 | ASME B16.22 | Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| .5 | ASME B16.24 | Cast Copper Alloy Pipe Flanges and Flanged Fittings; Class 150, 300, 400, 600, 900, 1500, & 2500. |
| .6 | ASME B16.50 | Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings |

| | | |
|---|---|---|
| .7 | ASTM A307 | Standard Specification for Carbon Steel Bolts and Studs 60,000PSI Tensile Strength |
| .8 | ASTM A563 | Standard Specification for Carbon and Alloy Steel Nuts |
| .9 | ASTM B32 | Specification for Solder Metal |
| .10 | ASTM B88 | Standard Specification for Seamless Copper Water Tube |
| .11 | ASTM B828 | Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings. |
| .12 | AWS A5.8 | Specification for Filler Metals for Brazing and Braze Welding |
| .13 | AWS A5.31 | Specification for Fluxes for Brazing and Braze Welding |
| .14 | AWS C3.4 | Specification for Torch Brazing |

# 2 PRODUCTS

## 2.1 Tube

.1 Aboveground:

.1 NPS ½ to 2: to ASTM B88, type "L" hard-drawn copper tube.

.2 NPS 2-1/2 to NPS 3: to ASTM B88, type "K" hard-drawn copper tube.

.2 Underground or in-slab:

.1 NPS ½ to NPS 3: to ASTM B88, type “K” hard-drawn or annealed copper tube.

.3 Copper tube to be listed to the applicable standard and bear the green marking (type “K”) or blue marking (type “L”) stripe for type K tubing, and bear the markings of the testing agency accredited by Standards Council of Canada.

## 2.2 Tube Joints and Fittings

.1 Fittings:

.1 Cast bronze fittings to ASME B16.18.

.2 Wrought copper and bronze fittings to ASME B16.22.

.3 Brazed joints only: Wrought copper and copper alloy to ASME B16.50.

.4 Threaded fittings including unions to ASME B16.15, Class 250.

.2 Flanges:

.1 Brass or bronze to ANSI B16.24.

.2 Gaskets to ANSI B16.21.

*Standard of Acceptance*

- Chesterton - fig. 100, 195 and 450
- Beldam

.3 Solder:

.1 95:5 tin/antimony solder to ASTM B32.

.4 Braze filler:

.1 Silver brazing alloy: classification BCuP-5 to AWS A5.8.

# 3 EXECUTION

## 3.1 Tubing Installation

.1 Refer to section 23 05 01 for piping design criteria and general requirements for piping installation.

.2 Maximum tube size: NPS 3.

.3 Slope main piping horizontal or up in direction of flow nominally at a slope of 1:1000 (⊂ in in 10 ft).

  .1 branch piping to have greater slope,

  .2 slope piping up in direction of terminal heating and cooling devices.

  .3 where supply and return piping are grouped together and flow is in opposite directions, arrange piping horizontal.

.4 Use eccentric reducers at tube size changes arranged flat on bottom to assist venting.

.5 Where tubing is installed to run inside of concrete slabs, support tubing to maintain tube centerline at the center of the floor slab unless otherwise shown. Where tubing is supported by ferrous metals or where it might come into contact with reinforceing steel bar, provide two layers of Denso Tape around the tubing at the point of contact.

.6 Use copper tubing for equipment drains (pressure and non-pressure)

.7 Provide di-electric unions or flanges in accordance with section 23 05 01.

## 3.2 Tube Joints and Fittings

.1 Prepare and install tube and fittings;

  .1 in accordance with ASTM B828 for solder joints,

  .2 in accordance with AWS C3.4 and specification section 20 05

.2 Use of direct butt weld style soldered or brazed joints, including pulled-Tee's, are not permitted.

.3 Before assembling solder or brazed joints, remove working parts of valves.

.4 Make tube joint for above-ground piping as follows:

  .1 NPS 2 and smaller: soldered or brazed joints with socket type fittings.

  .2 NPS 2-1/2 to NPS 3: brazed joints with socket type fittings.

.5 Make tube joints for underground and/or in-slab piping as follows:

  .1 All sizes: brazed joints with sweat fittings.

  .2 Arrange tubing to minimize the number of joints. Use annealed tubing wherever possible, with field-bends made with tube bending dies which provide uniform support of tubing during bending operations.

## 3.3 Equipment Connections

.1 Equipment connections:

  .1 NPS 2 and smaller: unions and threaded fittings,

  .2 NPS 2 ½ to NPS 3: flanged connections.

## 3.4 Pressure and Leak Testing

.1 Conduct pressure and leak tests in accordance with section 20 05 01.

## 3.5 Flushing and cleaning

.1 After pressure testing, clean piping in accordance with Section 23 25 05.

.2 For piping changes to existing systems, which consist of NPS 2 and smaller branch piping to terminal heating or cooling equipment, the following abbreviated cleaning and flushing procedure may be used:

  .1 After cutting of threads and de-burring, and before installation of tubing, manually clean the interior of the tube with wire-brush on an extended rod, while washing the inside of the tubepipingsolution of non-foaming, phosphate free detergent, 3% by weight, followed by a hose rinse flushed to drain until water runs clear,

  .2 After installation of piping, check strainers are clean, and open isolation valves to use service water for pressure testing and final flush.

  .3 After pressure testing, isolate new piing form existing piping, fully open control valves (where installed) and flush service water to drain. Use compressed air at not more than 70 kPa (10 psig) to assist in flushing the water.

  .4 Refill system with service water and circulate for two hours. Inspect strainers, and repeat drain, fill and recirculate routine until strainers are free of debris.

**END OF SECTION**

# AIR DISTRIBUTION - GENERAL
# 23 31 01

## 1 GENERAL

### 1.1 Scope

.1 Provide labour, materials and equipment for installation, testing and putting into operation ventilating and air conditioning systems

### 1.2 Qualified tradesmen

.1 Work to be done by qualified tradesmen holding certificates of competency.

### 1.3 Applicable standards

.1 British Columbia Building Code

.2 Regulations of Province, City, or local authority having jurisdiction.

## 2 PRODUCTS

### 2.1 Not Used

## 3 EXECUTION

### 3.1 Ductwork

.1 Ductwork system routing is shown diagrammatically. Drawings are not considered to be fabrication or installation drawings.

.2 Locate mains, risers and runouts to be concealed behind furrings or above ceilings except in mechanical equipment rooms and access spaces where ductwork is to be exposed.

.3 Determine areas without ceilings from Architectural Drawings and Room Finish Schedules, and in these areas keep ductwork as high as possible.

.4 Anchor, guide and support vertical and horizontal runs of ductwork to resist dead load and absorb thrust.

### 3.2 Air supply equipment

.1 Install and connect air handling units, and air conditioning units, and build casing and plenums.

### 3.3 Air exhaust equipment

.1 Install and connect exhaust fans, roof and wall exhausters and dust and fume collectors.

### 3.4 Terminals devices

.1 Locate and install terminal boxes, registers, diffusers, and grilles

## 3.5 Life safety

.1 Install fire dampers, smoke dampers, and combination smoke and fire dampers to protect openings in fire separations.

.2 Provide smoke stopping around unprotected ducts passing through smoke separations.

## 3.6 Air balancing

.1 Co-operate with air balancing agency; install supplementary dampers, access openings and access doors to facilitate testing and adjustment.

**END OF SECTION**

# DUCTWORK
# 23 31 13

## 1 GENERAL

### 1.1 Scope

.1 Provide metal ductwork systems as shown.

### 1.2 Applicable Codes and Standards

.1 Installation standards and codes

| | | |
|---|---|---|
| .1 | NFPA 90A | Installation of air conditioning and ventilating systems. |
| .2 | NFPA 90B | Installation of warm air heating and air conditioning systems. |
| .3 | ASHRAE | Letter and number designations, shown as “CR3-16" etc., are taken from ASHRAE Duct Fitting Data Base.(DFDB) |
| .4 | ANSI/SMACNA | HVAC Duct Construction Standards - Metal and Flexible (2005 edition) |

.2 Product standards:

| | | |
|---|---|---|
| .1 | ASTM A90/M | Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings |
| .2 | ASTM A653/M | Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process |
| .3 | ASTM A924/M | Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| .4 | ASTM A1011/M | Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength |
| .5 | ASTM A283/M | Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates |
| .6 | ASTM A36/M | Standard Specification for Carbon Structural Steel |
| .7 | ASTM A480/M | Specification for General requirements for Flat Rolled Plate, Sheet, and Strip |
| .8 | ASTM A463/M | Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process |
| .9 | ASTM B209 | Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |

### 1.3 Shop Drawings and Application Details

.1 Submit manufacturer's catalogue literature for;

- .1 Proprietary joints,
- .2 Hardware.

.2 Submit field/fabrication drawings at 1:50 (¼ inch=1 foot) or larger scale, with piping, ductwork, and fittings in double line format, to show;

- .1 arrangements in congested areas,
- .2 where installation proposed deviates substantially from layout shown, and

.3 where installation requires joints for field assembly in welded duct construction.

.3 For greater clarity, do not submit field/fabrication drawings for other areas of the Work.

.4 Submit schedules and details to show;

.1 fabrication details of

(a) connections to risers in duct shafts
(b) balancing damper construction,
(c) fittings where geometry contemplated is different from that specified.

.2 in chart form

(a) duct system pressure class,
(b) duct sheet gauges,
(c) joint types and application criteria,
(d) location criteria and dimensions for bracing, stiffeners and balancing dampers
(e) duct leakage class, and
(f) extent of sealing.

### 1.4 Record Drawings

.1 As work progresses, mark-up field drawings and submit as part of record of “As-Built” conditions.

### 1.5 Qualifications

.1 Ductwork systems to be provided by firm having an established reputation in this field.

## 2 PRODUCTS

### 2.1 Basic material

.1 Galvanized steel:

.1 Ducts and connectors: lock forming quality to ASTM A653 or ASTM A924,

(a) Z275(G90) for indoor ductwork,
(b) Z275 (G90) zinc coating for outdoor ductwork.

.2 Miscellaneous pipe, angles, strips and threaded rod in contact with ductwork: galvanized with a minimum thickness equal to ASTM A653 - Z180 (G60).

.2 Stainless steel:

.1 To ASTM A480, Type 304L

.3 Aluminum:

.1 To ASTM B209;

(a) alloy 3003-H14 or 5052-H32 for sheet material.
(b) alloy 6061-T6 for plate material
(c) alloy 6061-T4 or T6 for shapes material.

.4 Plain mild carbon steel:

.1 To ASTM A1011, A283, A572 and A36 as applicable.

## 2.2 Joints

.1 Flanged duct joints:

 .1 proprietary roll-formed flanges, corner pieces, integral edge seals, gaskets and cleats.

 .2 material to match that of ductwork being joined.

*Standard of Acceptance*
° Ductmate – System 25/35/45
° Carlisle Canada - Nexus

## 2.3 Sealant and tape

.1 To section 23 33 05 Duct Accessories.

## 2.4 Hangers and supports

.1 Upper hanger attachments;

 .1 in new concrete: manufactured concrete inserts.

*Standard of Acceptance*
° Myatt Fig. 485

 .2 for steel joist: galvanized joist clamps or steel plate washer.

*Standard of Acceptance*
° Anvil Fig. 61 or 86
° Anvil Fig. 60 for plate washer

 .3 for steel beams: galvanized beam clamps.

*Standard of Acceptance*
° Anvil Fig. 60

.2 Seismic supports and restraints to Section 20 05 49 Seismic Restraint

## 2.5 Duct access doors

 .1 To section 23 33 05 Duct Accessories.

# 3 EXECUTION

## 3.1 Construction

.1 Construction details, sheet gauges, reinforcing, and bracing to be taken from SMACNA HVAC Duct Construction Standards - Metal and Flexible except as otherwise shown.

.2 Rectangular ductwork:

 .1 longitudinal seams: Pittsburgh Lock, with specified sealant applied prior to hammering of joint,

 .2 transverse joints: to SMACNA HVAC standards based on pressure class and reinforcement used and sealing requirements.

.3 Round ductwork, 500 Pa (2 in wg) pressure class and higher:

 .1 spiral flat type longitudinal seam, button punched.

## 3.2 Pressure classification and seal class

.1 Low pressure ductwork construction classification:

**Table 1: Duct Pressure Classification**

| Pressure class Pa (in wg) | Operating pressure Pa (in wg) | Velocity m/s (fpm) | Leakage Test Pressure Pa (in wg) |
|---|---|---|---|
| 125 (½) | up to 125 (½) | 10.0 (2000) | 125 (½) |
| 250 (1) | 125 to 250 (½ to 1) | 12.5 (2500) | 250 (1) |
| 500 (2) | 250 to 500 (1 to 2) | 12.5 (2500) | 500 (2) |
| 750 (3) | 500 to 750 (2 to 3) | 15.0 (3000) | 750 (3) |
| Greater than 750 (3) | High Pressure Ductwork | | Not less than 1000 (4) |

.2 Assemble ductwork seams and joints with joint sealant as shown in table 2.

.3 Sealant application:

.1 store duct sealant at room temperature for 24 hours before use,

.2 apply sealant on seams as noted in table 1, and brush or extrude sealant to cover fasteners,

.3 on bell and spigot style joints apply sealant on male section with caulking gun and spread sealant evenly on mating surface with brush,

(a) insert fitting and secure with sheet metal screws

(b) brush sealant onto outside of assembled joint in 50 mm (2 in) wide band covering fastener heads,

.4 allow 40 hours curing time before pressure testing.

**Table 2: Duct System Pressure and Seal Class**

| No. | Ductwork System | Static pressure construction class Pa (in.wg.) | Seal class | Sealing requirements (1)(2)(3)(4) |
|---|---|---|---|---|
| 1 | Induction unit supply from fan discharge to unit plenum box inlet. | +1000 (4) and up | A | Transverse joints, longitudinal seams, ductwall penetrations, and other connections |
| 2 | Supply risers in vertical service space (duct shafts). | +1000 (4) | B | Transverse joints, longitudinal seams, and other connections |
| 3 | Supply air ductwork from discharge side of fan to inlet of terminal box or reheat coil in healthcare and laboratory facilities. | +1000 (4) | | |

| **Table 2: Duct System Pressure and Seal Class** | | | | |
|---|---|---|---|---|
| No. | Ductwork System | Static pressure construction class Pa (in.wg.) | Seal class | Sealing requirements (1)(2)(3)(4) |
| 4 | Return/exhaust air ductwork between HEPA filters and suction side of fan. | -1000 (4) | | |
| 5 | Return/exhaust air ductwork between a Heat Recovery Wheel and suction side of fan. | -1000 (4) | | |
| 6 | Autopsy exhaust ductwork. | -1000 (4) | | |
| 7 | Supply air ductwork from discharge side of fan to inlet of terminal box or reheat coil;<br><br>Return air ductwork on discharge side of fan. | +750 (3) | | |
| 8 | Return/Exhaust risers in mechanical rooms and vertical service spaces (duct shafts). | -750 (3) | | |
| 9 | Supply air ductwork upstream of HEPA filters, including diffusers with integral HEPA filters.(5) | +750 (3) | | |
| 10 | Return and/or exhaust air ductwork on suction side of fans other than in mechanical rooms and vertical service spaces. | -500 (2) | C | Transverse joints and other connections |
| 11 | Supply air ductwork on downstream side of terminal units or reheat coil;<br><br>Exhaust air ductwork on discharge side of fan;<br><br>Fan coil units, suction and discharge. | 250 (1) | C | Transverse joints only |
| 12 | Supply air and return air ductwork from roof top air conditioning units, 5 tons or less | 125 (½) | D | No sealing |

**Notes for table 2:**

(1) *Transverse joints* are connections of two duct or fitting elements oriented perpendicular to flow,
(2) *Longitudinal seams* are joints oriented in direction of flow,
(3) *Duct wall penetrations* are openings made by screws, non-self-sealing fasteners, pipe, tubing, rod and wire,
(4) *Other connections* such as spin-ins taps and other branch fittings inserted into cut openings in duct, access door frames, insertion type control elements and duct joints at equipment are to be treated as *transverse joints.*
(5) *This pressure class also applies to supply ductwork downstream of a terminal box or reheat coil which serve diffusers with integral HEPA filters.*

## 3.3 Fittings - Rectangular Ductwork

.1 Refer to Annex A at the end of this Section for illustrations of referenced fitting types.

.2 Elbows:

.1 Elbows are to be installed as shown, or if not shown, in descending order as listed in table 3.

(a) for clarity, elbows types are to be selected based on the highest order number (where 1 is the highest) which will fit the available space.

**Table 3: Rectangular Duct, Elbows**

| Order No. | ASHRAE Fitting No. | Description | Throat Radius Ratio R/W | Duct Width Limit mm (in) | Minimum Throat Radius mm (in) | Remarks |
|---|---|---|---|---|---|---|
| 1 | CR3-1 | Smooth radius Unvaned elbow | 1.5 | ≤ 300 (12) | --- | Default |
| | | | 1.0 | > 300 (12) | --- | |
| 2 | CR3-3 | Smooth radius Vaned elbow | 0.75 | ≤ 900 (36) | 150 (6) | One full radius single thickness splitter vane |
| | CR3-4 | Smooth radius Vaned elbow | 0.75 | > 900 (36)<br>≤ 1500 (60) | 150 (6) | Two full radius single thickness splitter vane |
| | CR3-5 | Smooth radius Vaned elbow | 0.75 | > 1500 (60) | 150 (6) | Three full radius single thickness splitter vane |
| 3 | CR3-15 | Square Mitred Vaned elbow | Square throat; Square heel. | -- | --- | Double thickness turning vanes;<br>50 (2) heel radius vane;<br>54 mm (2.125 in) vane spacing. |
| 4 | CR3-2 | Radius Heel Sharp Throat | 0.5 | --- | --- | Double thickness turning vanes as per CR3-3, 4 or 5 depending on duct width |

.2 First elbow on discharge side of fan:

(a) fitting CR3-1, unvaned elbow with throat radius 1.0 times duct width, with the required upstream effective length $L_e$ of straight length of duct in accordance with fitting type SR7-5 or SR7-9 as applicable.

.3 Wye and tee branch fittings - Supply air systems:

.1 Wye and tee branch fittings are to be installed as shown, or if not shown, as selected from table 4.

**Table 4 : Rectangular Duct, Wye and Tee Branch Fittings - Supply Air Systems**

| Ref. No. | Supply Ductwork System | Fitting Type | ASHRAE Fitting No |
|---|---|---|---|
| 1 | For 750 Pa (3 in.w.g) pressure class and above: branch take-off from ducts in shafts, and ducts upstream of terminal boxes, filters and reheat coils | Smooth radius wye; diverging | SR5-1 |
| | | Dovetail wye | SR5-14 |
| | | Divided flow fittings | (SMACNA) 4A or 4B |
| | | 45° entry branch diverging | SR5-13 |
| 2 | Supply ducts downstream of terminal boxes, fan coil units, reheat coils or heat pumps | Tee, rectangular main to round conical tap | SR5-12 |
| | | Tee, 45° entry branch diverging | SR5-13 |
| | | Smooth radius wye; diverging | SR5-1 |

.4 Wye and tee branches - Return/Exhaust air systems:

.1 Wye and tee branch fittings are to be installed as shown, or if not shown, as selected from table 5.

**Table 5 : Rectangular Duct, Wye and Tee Branch Fittings - Return/Exhaust Air Systems**

| Ref. No. | Return/Exhaust Ductwork System | Fitting Type | ASHRAE Fitting No |
|---|---|---|---|
| 1 | All pressure classes including branch connections at duct shafts | Smooth radius wye; converging | ER5-1 |
| | | Dovetail wye | ER5-4 |
| | | Divided flow fittings | (SMACNA) 4A or 4B |
| | | 45° entry branch diverging, where shown on drawings | ER5-3 |

.5 Transitions (Rectangular and Round):

.1 converging: maximum 20° angle between ductside and direction of flow,

.2 diverging: maximum 15° angle between ductside and direction of flow.

.6 Fabricate duct offsets using elbows selected in accordance with table 2 and as follows:

.1 single offset in single plane, less than duct height: made up with two 45° elbows,

.2 single offset, of greater displacement, made up with 90° elbows,

.3 double offset in single plane, less than duct height, made up with four 45° elbows,

.4 double offset in single plane, of greater displacement than duct height, made up with 90° elbows.

.7 Obstructions passing through duct:

.1 covered by round nosed streamline enclosure where free area of duct is reduced by less than 15%,

.2 fitted in round nosed streamline enclosure with duct width increase, SMACNA HVAC FIG 2-10, Detail E , with converging and diverging transition angle requirements as specified above.

## 3.4 Fittings - Round Ductwork

.1 Refer to Annex A at the end of this Section for illustrations of referenced fitting types.

.2 Elbows:

.1 Elbows are to be installed as shown, or if not shown, in order of available space as listed in table 6.

| **Table 6 : Round Duct, Elbows** | | | | | |
|---|---|---|---|---|---|
| Ref. No. | Description | ASHRAE Fitting No. | Throat Radius Ratio R/W | Duct Width Limit mm (in) | Remarks |
| 1 | 30° elbow | CD3-3* | 1.5 | ≤ 300 (12) | Die stamped |
| | | CD3-14* | 1.5 | > 300 (12) | 2-Gore |
| 2 | 45° elbow | CD3-3 | 1.5 | ≤ 300 (12) | Die stamped |
| | | CD3-14 | 1.5 | > 300 (12) | 3-Gore |
| 3 | 60° elbow | CD3-3* | 1.5 | ≤ 300 (12) | Die stamped |
| | | CD3-14* | 1.5 | > 300 (12) | 4-Gore |
| 4 | 90° elbow | CD3-1 | 1.5 | ≤ 200 (8) | Die stamped |
| | | CD3-9 | 1.5 | >200 (8) and ≤ 350 (14) | 5-Gore |
| | | CD3-10 | 1.5 | >350 (14) and ≤ 900 (36) | 7-Gore |
| | | | 2.5 | > 900 (36) | 7-Gore |

.3 Wye branches:

.1 Wye and tee branch fittings are to be installed as shown, or if not shown, as selected from table 7.

| **Table 7 : Round Duct, Wye and Tee Branch Fittings** | | | |
|---|---|---|---|
| Ref. No. | Supply Ductwork System | Fitting Type | ASHRAE Fitting No |
| 1 | Downstream of supply fan. | Wye branch plus 45° elbow | SD5-2 |
| | | Tee, tapering | SD5-12 |
| 2 | Downstream of terminal boxes. | Wye branch plus 45° elbow | SD5-1 |
| | | Tee, tapering | SD5-10 |
| 3 | Return or exhaust duct branches. | Wye branch plus 45° elbow | ED5-2 |
| 4 | Return or exhaust duct branches; equal main and branch duct size. | Tee, tapering, with 45° elbow | SD5-2 |

| **Table 7 : Round Duct, Wye and Tee Branch Fittings** | | | |
|---|---|---|---|
| Ref. No. | Supply Ductwork System | Fitting Type | ASHRAE Fitting No |
| 5 | Return or exhaust duct branches; smaller branch size. | Tee, tapering, with 45° elbow | SD5-12 |

### 3.5 Balancing dampers

.1 Provide splitter dampers where branch connections are taken from supply mains.

.2 Provide single blade dampers on each branch of supply air systems downstream of terminal boxes.

.3 Provide Opposed Blade Dampers (OBD) at branch and main connection on exhaust and return air systems.

### 3.6 Finishing, fastening and supports

.1 Hammer edges and slips to leave smooth finished surface inside duct.

.2 Support vertical ducts with angles riveted to duct and bearing on building structure.

.3 Hangers;

  .1 Duct side up to maximum 500 mm (20 in) supported with strap hangers of same material as duct but one sheet metal thickness heavier.

  .2 Extend strap hangers down duct side and turn under 50 mm (2 in) fastening securely to side and underside of duct.

  .3 Duct side greater than 500 mm (20 in) supported with trapeze hangers constructed from galvanized steel angle with steel rods in accordance with table 8;

| **Table 8 : Duct Hangers** | | |
|---|---|---|
| Duct size mm (in) | Angle size mm (in) | Rod size mm (in) |
| up to 750 (up to 30) | 25x25x3 (1x1x⅛) | 6 (¼) |
| 750 to 1050 (30 to 40) | 40x40x3 (1½x1½x⅛) | 6 (¼) |
| 1050 to 1500 (40 to 60) | 40x40x3 (1½x1½x⅛) | 10 (⅜) |
| 1500 to 2400 (60 to 90) | 50x50x3 (2x2x⅛) | 10 (⅜) |
| 2400 and over (90 and over) | 50x50x6 (2x2x¼) | 10 (⅜) |

  .4 Maximum hanger spacing: 2.4 m (8 ft) on centre.

  .5 Seismic restraints: to Section 20 05 49 *Seismic Restraints*.

## 3.7 Sheet metal plenums:

.1 50 mm (2 in) thick thermally insulated double wall construction,

.2 inner (cold side) wall of galvanized steel,

.3 outer (room side) wall of galvanized steel,

.4 50 mm (2 in) thick, 72 kg/m$^3$ (4 lb/ft$^3$) density, glass fibre insulation, foil backed with vapour barrier on inner wall side,

.5 watertight, welded stainless steel type 304 floor panels, with upturned 50 mm (2 in) perimeter lip,

.6 thermal break; between adjacent wall panels, between wall panels and plenum roof panels, and between wall/roof panels and building structure.

## 3.8 Protection of duct openings

.1 Cap off ends of unfinished ducts while plastering, drywall and other finishing operations are in progress,

.2 Cover open ends or registers of active exhaust/return ducts with 25 mm (1 in) thick filter media secured with tape. Maintain media until dust producing finishing operations are completed.

## 3.9 Duct access doors

.1 Provide for inspection and servicing of duct mounted components and cleaning of duct system;
   .1 located such that any section of duct is not more than 15 m (50 ft) from point of access,
   .2 at not more than 6 m (20 ft) intervals on supply air ductwork installed after HEPA filter,
   .3 at base of each accessible duct riser,
   .4 in front of and behind duct mounted coils,
   .5 at activation side of fire, smoke, and combination fire/smoke dampers,
   .6 and motorized dampers where damper actuator is located inside of duct or plenum.

.2 Door size:
   .1 Select access door sizes based on smallest duct dimension in accordance with table 9.

| **Table 9 : Access Door Sizes** | | | |
|---|---|---|---|
| Smallest Duct Dimension mm (in) | Bottom of duct height above floor m (ft) | Location | Door Size mm (in) |
| ≤ 350 (14) | Any | Side or bottom | 300 x 150 (12x6) |
| >350 and ≤500 (>14 and ≤20) | Any | Side or bottom | 450 x 250 (18x10) |
| >500 (>20) | ≤3.6 (12) | Side or bottom | 530x350 (21x14) |

| | | | |
|---|---|---|---|
| | >3.6 (12) | Bottom | 635x430 (25x17) |

### 3.10 Leak testing

.1 Test air duct systems for leaks at 1.00 times pressure specified for class as follows;

.1 between supply air handling units and terminal units

.2 between supply air handling units and air supply outlets on supply systems without terminal units

.3 between inlet grilles and exhaust/return fan inlet, and fan outlet and exhaust or mixing plenum, on return/exhaust systems,

.4 following parts of system are exempt from pressure testing;

(a) short duct runs of 15 metres (45 feet) or less, operating at 37 Pa (1/8 in) SP or less.
(b) ductwork installed downstream of terminal boxes and fan coil units.

.2 Conduct test in accordance with Associated Air Balance Council (AABC) recommended procedures.

.3 Where audible air noise is detected during test, remove test, pressure apply sealant to leaking joints and seams, and retest after 48 hours. Continue testing and sealing until leaks are inaudible.

.4 Allowable ductwork leakage to be lesser of,

.1 1% of system airflow, or

.2 value calculated from following formula;

$$F = K \times C_L \times P^{0.65}$$

$$L = (A \times F) / 100, \text{ or}$$

$$L = (A \times K \times C_L \times P^{0.65}) / 100$$

**Table 10: Flow Measurement Units**

| | Term | Flow Measurement | | |
|---|---|---|---|---|
| | | $m^3/s$ | l/s | CFM |
| F | leakage coefficient | $m^3/s$ per $100m^2$ | l/s per $m^2$ | CFM per 100 $ft^2$ |
| $C_L$ | leakage coefficient | Refer to table 11 below | | |
| P | test pressure | kPa | kPa | in.wc. |
| L | Allowable leakage | $m^3/s$ | L/s | CFM |
| A | Duct surface area | $m^2$ | $m^2$ | $ft^2$ |
| K | unit conversion | $1.24 \times 10^{-2}$ | 1 | 1 |

**Table 11: Leakage Coefficient, $C_L$**

| | Seal Class |
|---|---|

| Duct Type | C | B | A |
|---|---|---|---|
| Rectangular metal | 24 | 12 | 6 |
| Round Metal | 12 | 6 | 3 |
| Unsealed rectangular metal duct | 48 | 48 | 48 |
| Unsealed round or oval metal duct | 30 | 30 | 30 |

.5 Calculate duct surface area for each test section and determine allowable leakage in accordance with formulae above. Test duct at pressure for specified class for 15 minutes. If leakage rate exceeds allowable value, caulk and seal joints, and repeat testing caulking and sealing process until measured leakage rate is less than calculated allowable value for section under test.

.6 Maintain set of drawings on site, coloured each day during testing to indicate extent of duct satisfying leakage criteria under test.

.7 Submit a written report, verified by TAB Agent, identifying each segment of duct system tested, showing calculation of allowable leakage, test pressure and leakage value measured under test, and certifying that leakage testing has been satisfactorily completed.

### 3.11 Duct cleaning

.1 Cleaning to be performed by agent specializing in this field of work, be a member in good standing with National Air Duct Cleaners Association (NADCA), and to comply with NADCA standards.

.2 Clean new horizontal and vertical ducts (supply, return, exhaust, transfer), as well as, existing supply and return ductwork connected to new fan systems.

.3 Clean ductwork using high powered vacuum system, hand tools and mechanical brushing systems such that metal surfaces are visibly clean.

.4 Reset balancing dampers to original settings if moved during work. Have TAB Agent confirm damper settings.

.5 Maintain set of drawings on site, coloured each day during cleaning to indicate extent of duct cleaning completed.

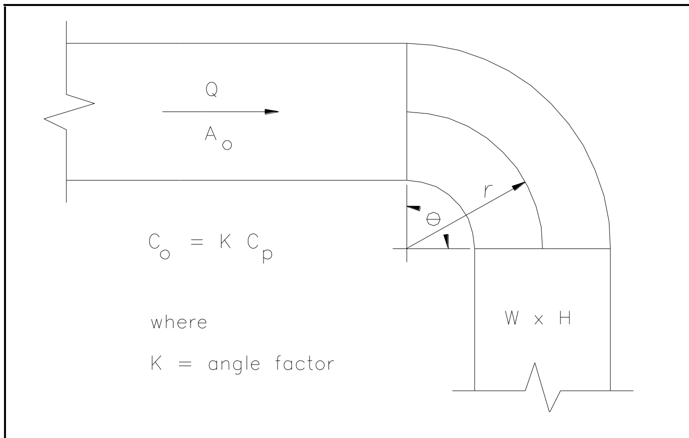
.6 Submit a written report, verified by TAB Agent, identifying extent of duct system cleaning and certifying that NADCA standards have been met.

### 3.12 Fitting Illustrations

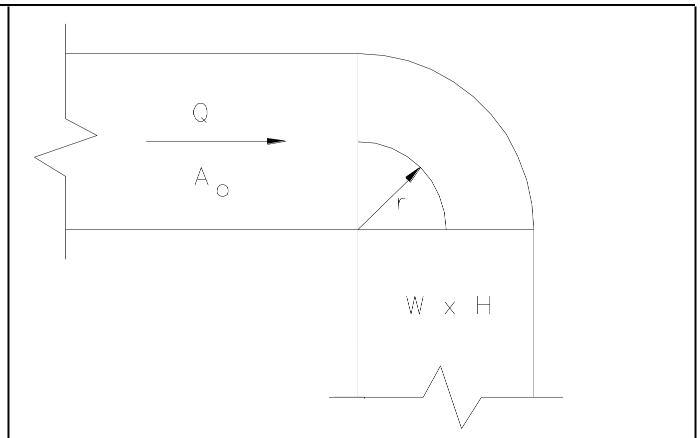
.1 Illustrations of fitting referenced in this specification follows in Annex A.

## Annex A – Illustration of Referenced Fittings

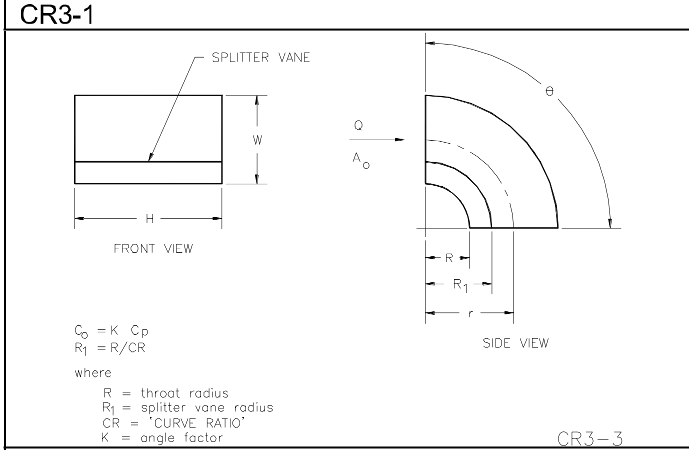
**Rectangular Elbows** (see Table 3)



CR3-1



CR3-2



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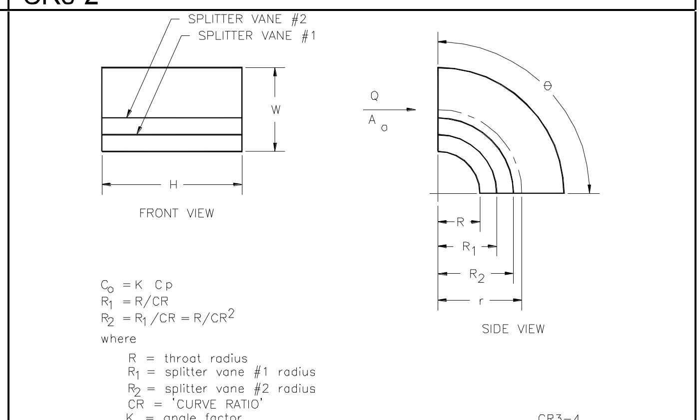

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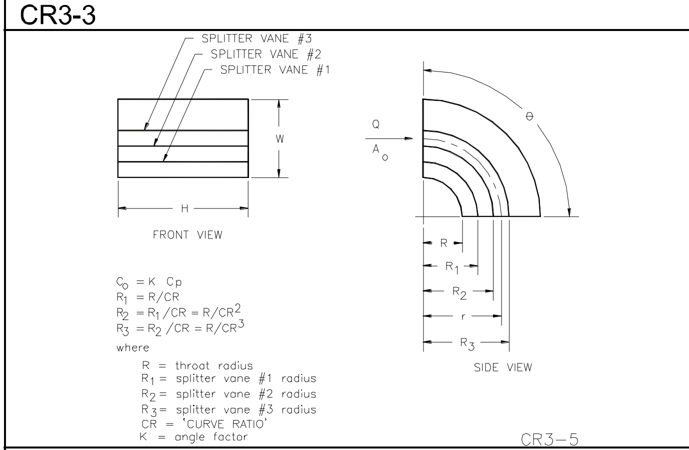

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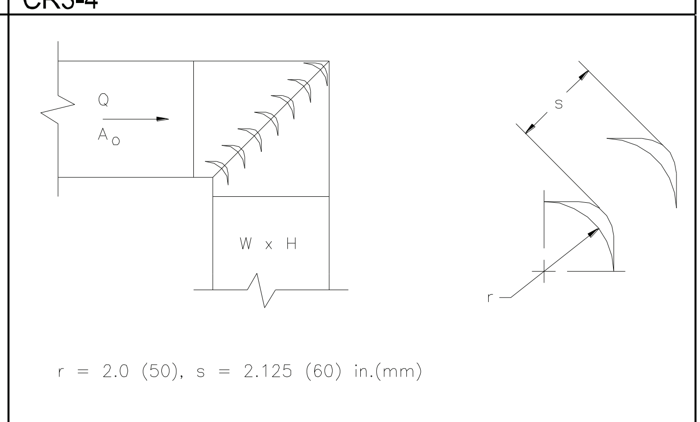
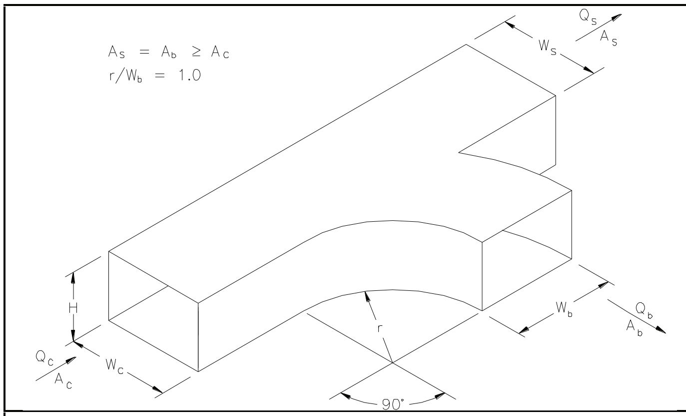
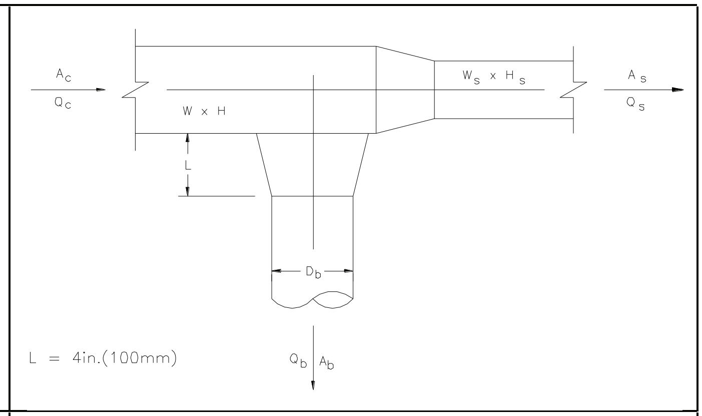


CR3-15

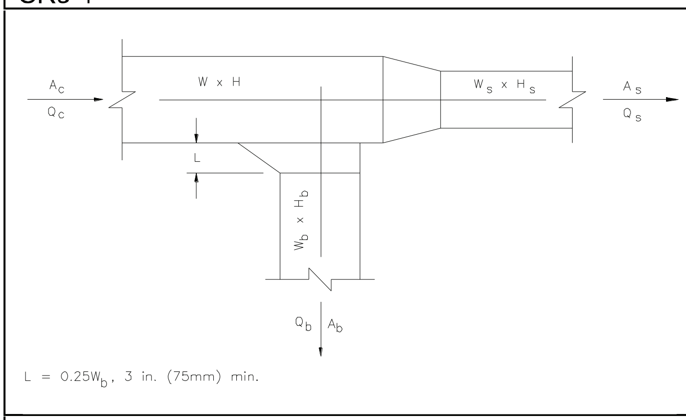
**Rectangular Wyes and Tee's – Supply Ductwork** (see Table 4)



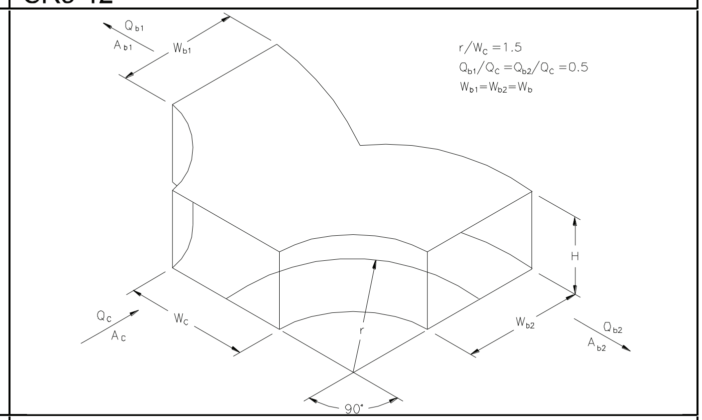

SR5-1



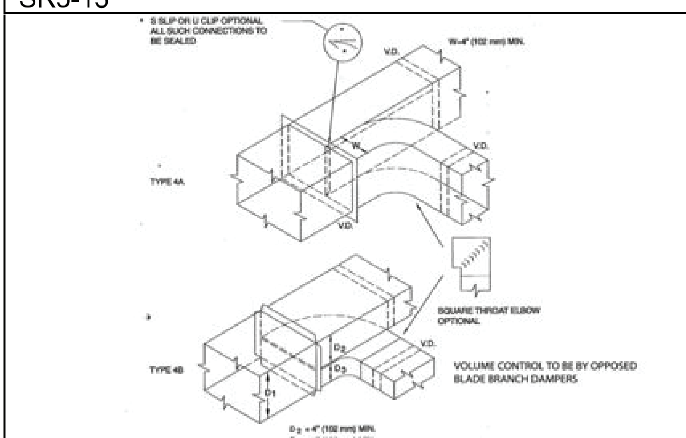

SR5-12




SR5-13

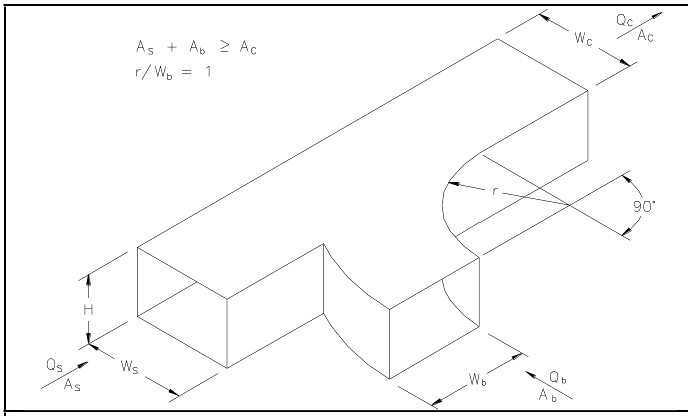



SR5-14

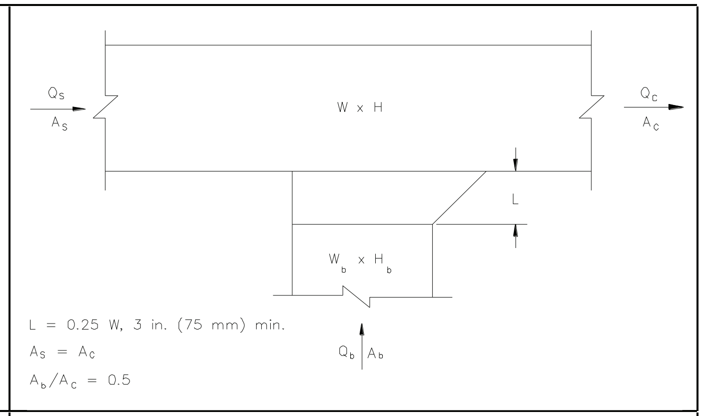



SMACNA Fig. 4A/4B

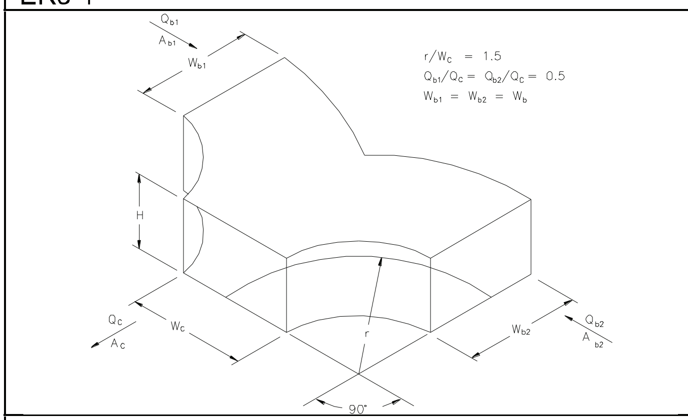
**Rectangular Wyes and Tee's – Return/Exhaust Ductwork** (see Table 5)




ER5-1

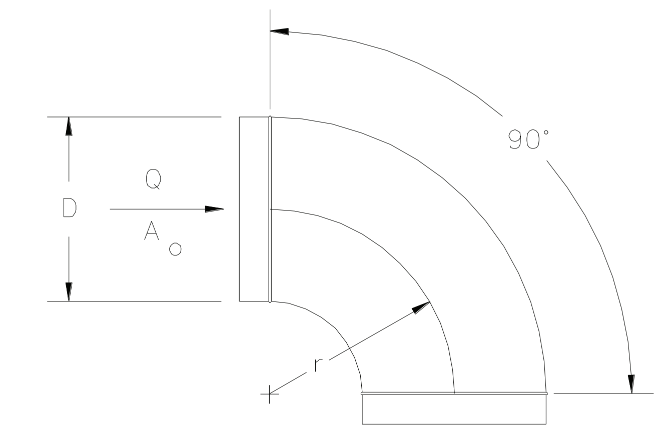



ER5-3

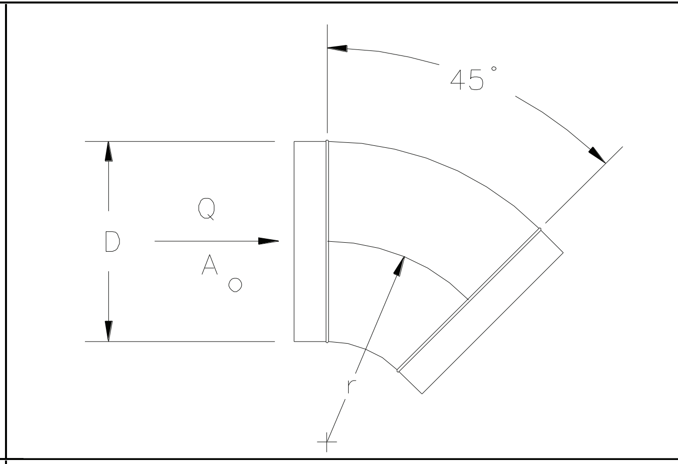



ER5-4

**Round Elbows** (see Table 6)




CD3-1

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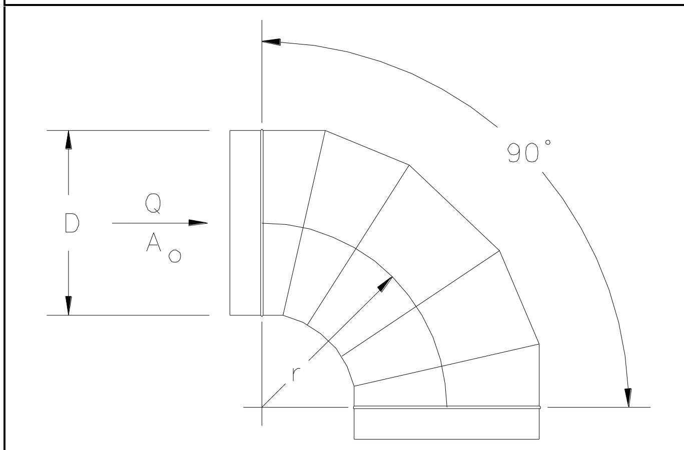
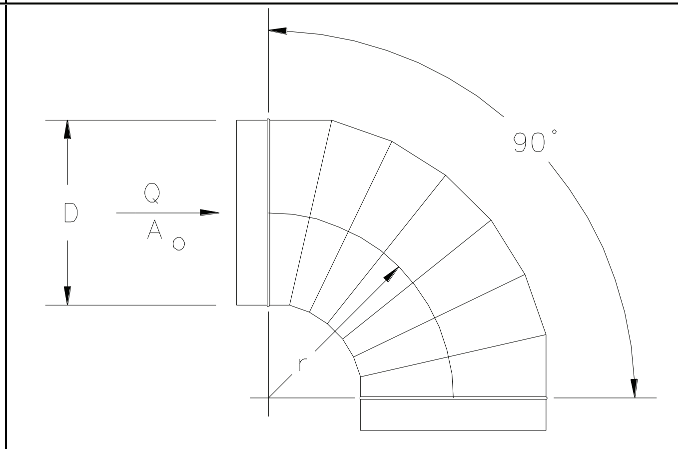
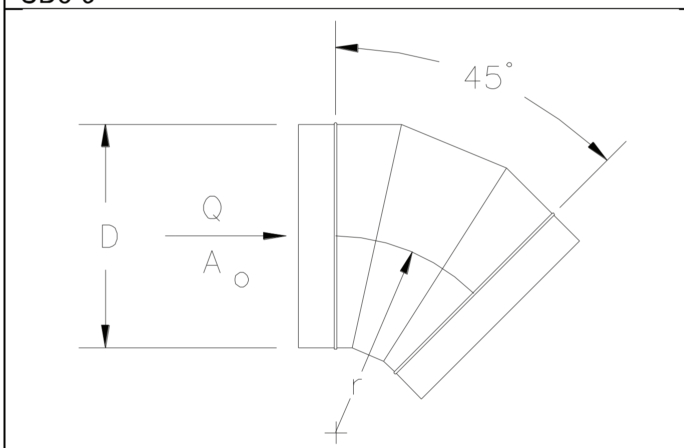



CD3-9

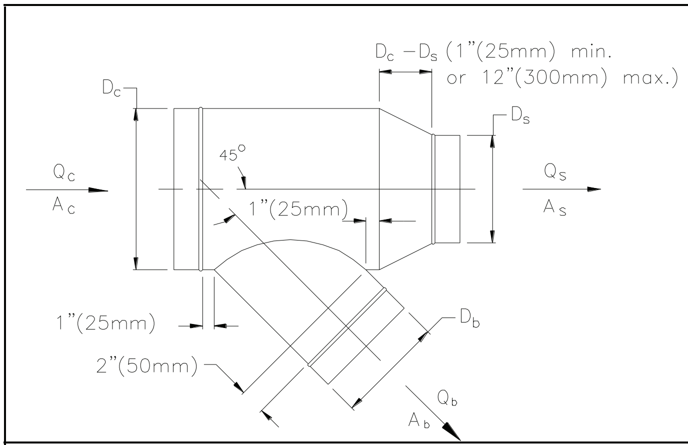



CD3-10

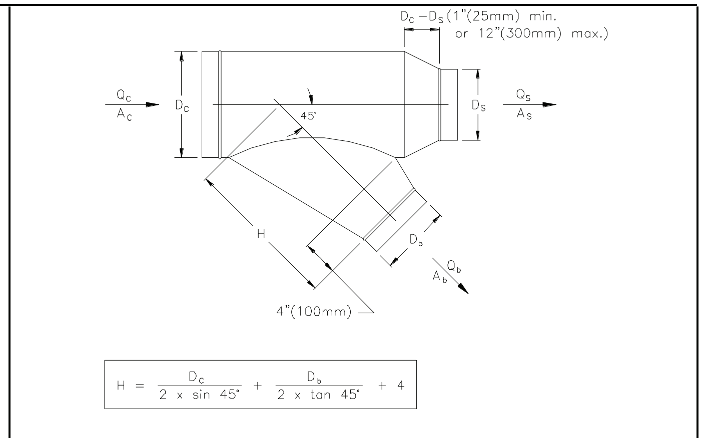



CD3-14

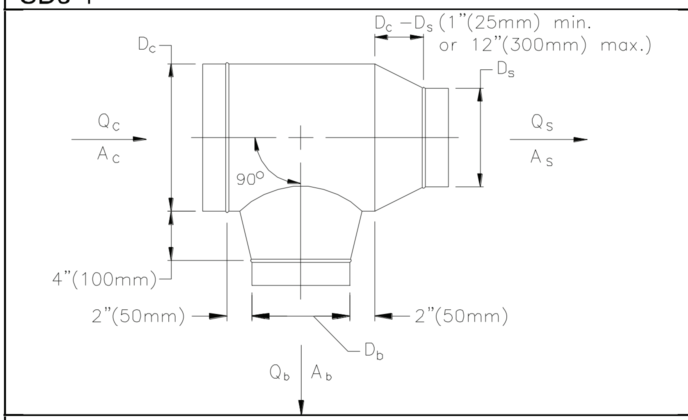
**Round Wyes and Tees** (see Table 7)



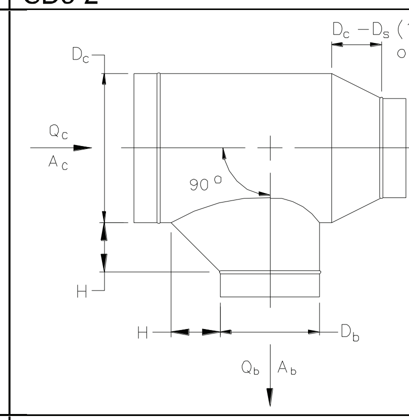

SD5-1




SD5-2

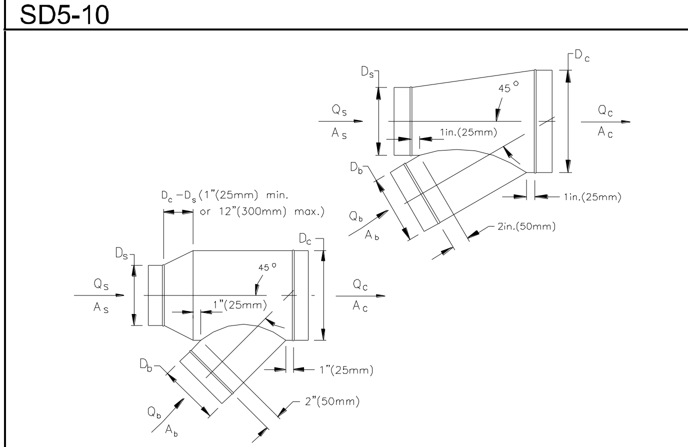



SD5-10




| $D_b$ | | H | |
|---|---|---|---|
| in. | mm | in. | mm |
| 3 – 8 | 75 – 200 | 4 | 100 |
| 8 1/2 – 14 | 220 – 350 | 7 | 180 |
| 14 1/2 – 26 | 370 – 660 | 10 | 250 |
| > 26 | > 660 | 13 | 330 |

SD5-12




ED5-2

**END OF SECTION**

# DUCT ACCESSORIES
# 23 33 05

## 1 GENERAL

### 1.1 Scope

.1 Provide duct accessories as shown.

### 1.2 Shop drawings

.1 Submit product data sheets for:

- .1 flexible connections
- .2 sealants
- .3 tapes
- .4 duct access doors and hardware
- .5 instrument test ports

## 2 PRODUCTS

### 2.1 Flexible connections

.1 Neoprene:

- .1 galvanized 0.66 mm (24 ga) sheet metal frame, with fabric clenched with double locked seams,
- .2 fire resistant, self-extinguishing, neoprene coated glass fabric,
- .3 operating temperature: -40°C to 90°C (-40°F to 194°F),
- .4 density: 0.653 kg/m$^2$ (0.13 lb/sq ft) in conventional systems.

*Standard of Acceptance*

- ° Duro-Dyne - Durolon
- ° Ventfabric - Ventglas
- ° Elgin - Neoprene

.2 Vinyl coated, insulated:

- .1 flame resistant, 0.56 mm (0.022 in) thick vinyl coated fabric envelope, enclosing 32mm (1¼ in),12kg/m$^3$ (0.75 lb/cu ft) fiberglass insulation,
- .2 operating temperature: 82°C (180°F) continuous and 93°C (200°F) intermittent,
- .3 installed;
  - (a) in connections for insulated duct systems,
  - (b) in circular duct connections subject to negative pressure with diameter less than 250mm (10 in), and
  - (c) in rectangular duct connections subject to negative pressure with smallest side less than 300mm (12 in)

*Standard of Acceptance*

- ° Duro-Dyne - Insulflex

## 2.2 Sealant

.1 water based polymer emulsion type flame resistant duct sealing compound.

.2 operating temperature range: -29°C to 93°C (-20°F to 200°F).

*Standard of Acceptance*
- Bakor 530 - 14
- RCD #6
- 3M Fastbond 900
- Childers CP-145a & CP-146
- United Duct Sealer (water based)
- Duro Dyne DWN (water based)

## 2.3 Tape

.1 polyvinyl treated open weave glass fibre tape, 50mm (2") wide.

*Standard of Acceptance*
- Duro-Dyne FT-2

## 2.4 Duct access doors

.1 Construction - uninsulated duct or plenum:

  .1 shop or field fabricated from same material as duct, one sheet metal thickness heavier but not less than 0.6mm (26ga.) thick,

  .2 with gasketed sheet metal angle frame.

.2 Construction - insulated duct or plenum:

  .1 shop fabricated as double wall insulated sandwich, of same material as duct, one sheet metal thickness heavier but not less than 0.6mm (26ga) thick,

  .2 with gasketed sheet metal angle frame and 25 mm (1 in) thick rigid glass fibre insulation.

.3 gasketed with neoprene or foam rubber.

.4 fitted with hardware as follows: two sash locks for doors up to 300 mm x 300 mm (12 in x 12 in).

  .1 four sash locks for doors up to 301 mm x 450 mm (13 in x 18 in).

  .2 piano hinge and minimum 2 sash locks for doors up to 451 mm x 1000 mm (19 in x 40 in)

  .3 piano hinge and 2 handles operable from both sides for doors over 1000 mm (40 in) in height.

*Standard of Acceptance*
- Duro-Dyne SP-21 for door handles

## 2.5 Instrument test ports

.1 Construction:

  .1 1.6 mm (16 ga.) thick steel body zinc plated after manufacture,

  .2 chain secured neoprene expansion plug with cam lock handle,

  .3 28 mm (1 in) minimum inside diameter, length to suit insulation thickness,

  .4 Neoprene mounting gasket: flat for rectangular duct and moulded for round duct.

*Standard of Acceptance*
- ° Duro-Dyne IP1 or IP2

# 3 EXECUTION

## 3.1 Flexible connections

.1 Provide to isolate air handling equipment, fans, ductwork, and as shown.

.2 Minimum length: 75 mm (3 in) length of fabric measured in direction of air flow,

.3 Minimum distance between metal parts when system is in operation: 25 mm (1 in).

.4 Anchored on static side of connection.

## 3.2 Sealant and tape

.1 Apply to ductwork joints and seams as detailed in other sections.

## 3.3 Access doors

.1 Install in ductwork;
- .1 before and after reheat coils, and at
- .2 fire dampers,
- .3 duct smoke detectors,
- .4 volume control devices, and
- .5 control elements.

.2 Weld door frames in place for plenums, casings, and high velocity ductwork.

.3 Door sizes:
- .1 as large as possible, with 1:1.5 aspect ratio, for duct sides up to and including 360 mm (14 in),
- .2 300 mm x 380 mm (12 in x 15 in) for duct sides 380 mm (15 in) and larger,
- .3 1500 mm (60 in) high by 450 mm (18 in) wide in casings and plenums.

## 3.4 Instrument test ports

.1 Install for duct velocity traverse readings and for duct air temperature readings.

.2 Locate across duct or plenum at right angles to flow, at not more than 250 mm (10 in) intervals for traverses and at not more than 500 mm (20 in) for temperature measurements.

.3 Install for velocity traverses;
- .1 at ducted inlets to roof and wall exhausters,
- .2 at inlet to and outlet from other fan systems, and
- .3 at main and branch where branch serves more than one outlet. Ports in main to be upstream of branch in both diverging and converging flow.

.4 Install for temperature measurement;
- .1 at outside air intakes,

.2 at inlet and outlet of coils, and

.3 downstream of intersection of converging air streams of different temperatures.

**END OF SECTION**

# DAMPERS - BALANCING
# 22 33 13

## 1 GENERAL

### 1.1 Scope

.1 Provide balancing dampers as shown.

## 2 PRODUCTS

### 2.1 Splitter dampers

.1 Construction:

.1 single thickness construction, of same material as duct but one sheet metal thickness heavier where both dimensions of damper blade are less than 300 mm (12 in),

.2 double thickness construction, one metal thickness lighter than duct, where either dimension of damper blade is 300 mm (12 in) or larger,

.3 of height equal to full depth of branch duct and length 1½ times branch duct width.

.4 fitted with piano hinge pivot, control rod, and locking device accessible from outside fitting.

### 2.2 Single blade dampers in rectangular ductwork

.1 Construction:

.1 shop fabricated of same material and sheet metal thickness as duct, stiffened with longitudinal V-grooves.

.2 maximum aspect ratio: 3:1,

.3 maximum blade height: 250 mm (10 in).

.4 fitted with locking quadrant and inside and outside bearings.

### 2.3 Multi-blade dampers in rectangular ductwork

.1 Construction:

.1 shop fabricated of same material and sheet metal thickness as duct, stiffened with longitudinal V-grooves.

.2 opposed blade configuration

.3 channel frame with angle blade stop,

.4 maximum blade height: 100 mm (4 in),

.5 maximum blade length: 1200 mm (48 in).

.6 bearings with bronze bushings.

.7 shaft extension with locking quadrant.

### 2.4 Single blade dampers in round ductwork

.1 Construction:

.1 shop fabricated butterfly type with round edged 3.5 mm (10 ga) disk set in round sheet metal housing, fitting snugly when closed, 10 degrees from vertical,

.2 fitted with rubber packing glands, shaft extension, wing nuts, and indexing device to indicate disk position.

# 3 EXECUTION

## 3.1 Manual dampers

.1 Install dampers:

.1 where branch serving more than two outlets is taken from main supply duct, use splitter damper in take-off fitting, or single or multiple blade damper in branch.

.2 where branch joins main return or exhaust duct use single or multiple blade damper in branch .

.2 Install splitter dampers and single or multiple blade dampers where branches are taken from or feed into main ducts as specified above.

.3 Provide other manual dampers as shown.

## 3.2 Access for adjustment

.1 Locate dampers to allow adjustment of blade position and locking of quadrant and for servicing damper actuators on motorized dampers.

**END OF SECTION**

# FLEXIBLE DUCTWORK
# 23 33 46

## 1 GENERAL

### 1.1 Scope

.1 Provide flexible ductwork as shown.

### 1.2 Reference standards

.1 Conform to;

| | | |
|---|---|---|
| .1 | ULC S110 | Fire tests for air ducts. |
| .2 | ULC 181 | Factory made air ducts and connections. |
| .3 | NFPA 90A | Installation of air conditioning and ventilating systems. |
| .4 | NFPA 90B | Installation of warm air heating and air conditioning systems. |
| .5 | SMACNA | Flexible duct installation standards |

### 1.3 Product data

.1 Submit manufacturer's data sheets for each product showing;

- .1 Thermal properties.
- .2 Friction loss characteristics,
- .3 Acoustical loss factors,
- .4 Leakage rates,
- .5 Fire rating.

## 2 PRODUCTS

### 2.1 Flexible ductwork

.1 General requirements:

- .1 maximum working pressure: 1.5 kPa (6 in wg),
- .2 maximum negative working pressure: 1.25 kPa (5 in.wg.)
- .3 pressure drop coefficients as listed below based on sheet metal duct pressure drop coefficient of 1.00,
- .4 flame spread rating not to exceed 25 and smoke developed rating not to exceed 50.
- .5 Listed to ULC-S110 as a Class 1 product.

*Standard of Acceptance*

- Flexmaster
- Peppertree Air Solutions Inc
- Trans Continental Equipment

### 2.2 Metallic flexible ductwork

.1 Construction:

- .1 spiral wound flexible aluminum with interlocked seams,

.2 maximum pressure drop coefficient: 3,

.3 airtight.

## 2.3 Metallic insulated flexible ductwork

.1 Construction:

.1 spiral wound flexible aluminum with interlocked seams,

.2 factory applied flexible glass fibre thermal insulation with vapour barrier and vinyl or aluminum jacket, maximum “U” value of 1.25 W/m2/K (0.22 Btu/hr/sq.ft/°F),

.3 maximum pressure drop coefficient: 3,

.4 airtight.

## 2.4 Nonmetallic flexible ductwork

.1 Construction:

.1 coated mineral base fabric type helically supported by steel wire,

.2 maximum pressure drop coefficient: 3,

.3 airtight.

## 2.5 Nonmetallic insulated flexible ductwork

.1 Construction:

.1 coated mineral base fabric type helically supported by steel wire with factory applied flexible glass fibre thermal insulation with vapour barrier and vinyl or aluminum jacket, maximum “U” value of 1.25 W/m2/K (0.22 Btu/hr/sq.ft/°F),

.2 maximum pressure drop coefficient:3,

.3 airtight.

**2.6**

## 2.6 Sealing compound

*Standard of Acceptance*

- Durodyne
- Transcontinental Equipment
- Dyn Air

# 3 EXECUTION

## 3.1 Duct installation

.1 Length of flexible duct feeding ceiling outlet: 1.5 to 2 m (5 to 6 ft)

.2 Length of flexible duct feeding return/exhaust grilles: 1.5 to 2 m (5 to 6 ft).

.3 Do not install flexible duct on exhaust grilles serving high humidity spaces including shower rooms, bathing rooms, pools, equipment process rooms, cold rooms with temperatures below 15°C (60°F), kitchens including clean-up areas, and central sterile processing areas.

.4 Provide flexible duct and make connections to supply diffusers and grilles [and induction units] as shown. Do not use flexible duct connectors on return or exhaust air grilles unless shown.

.5 Use sealing compound and tape at connection points between sheet metal and flexible duct. Make a further mechanical connection using sheet metal screws.

.6 Centre-line radius of bends in flexible ductwork to be greater than one duct diameter.

.7 Do not install flexible ductwork through floors, partitions or masonry walls.

**END OF SECTION**

# DUCT CLEANING
# 23 3347

## 1 GENERAL

### 1.1 Scope

.1 Professionally duct clean all existing and new supply and return duct systems connected to existing & new systems.

.2 Clean all existing and new exhaust ductwork revised or connected to as part of the renovation. Extent of exhaust ductwork cleaning will be limited to the same floor as the renovation. Cleaning is to be performed by robots to ensure maximum access to the ductwork while the Air Handling Unit System (AHU) is under a vacuum pressure and exhausted through a HEPA Filter System. An AHU system is considered to start at the air intake and end at the last diffuser in the duct run inclusive and all parts between. The system includes both supply, exhaust (relief air from the unit) and return air systems.

.3 Provide schedule details to the General contractor at the time of tender so duct cleaning can be factored into the overall schedule. The duct cleaning to be performed after all dust producing construction is complete and before the system is balanced. If not, then the balancer will have to verify and rebalance system to ensure dampers were not moved in the cleaning process. If duct cleaning is done too early and the ducts become re-contaminated as a result of the construction, the ducts will be re-cleaned at the contractor's cost.

### 1.2 Proof of Cleaning

.1 Submit written verification that duct work has been completely cleaned and verified on site. Provide a written report and a colour video of the system before and after cleaning

### 1.3 Qualifications

.1 Cleaning to be performed by agent specializing in this field of work, be a member in good standing with National Air Duct Cleaners Association (NADCA), and to comply with NADCA standards.

## 2 PRODUCTS

### 2.1 Self-propelling Full Contact Brushes for Unlined Ducts Only:

.1 Employ brushes specially made and shaped to fit the individual ducts or components in which they are used. Ensure continuous full contact and powerful scrubbing action of the interior surfaces of the ducts or components in which they are installed.

.2 Brush bristles to be of nylon, polypropylene or other non-metallic material.

.3 Brushes to be robotic or self-propelled, in either case having an integrally-mounted propulsion motor or drive. Motors or drives must be powerful enough to continue to propel the brush even when the brush bristles have been severely distorted

.4 Brushes to have the capability to clean ventilation ducts of 80 sq. mm. to 500 sq. mm.

**2.2 Robotic Brush:**

.1 A remote controlled self-propelled vehicle with robotic brush is to be used in all areas where a self-propelled brush is not suitable or cannot reach.

.2 To ensure continuous full contact and powerful scrubbing action of the interior surfaces of the ducts or components, the robot-manipulated brush is to be of the same material as all other brushes and to have a rotary action mounted on a shaft at right angles to the longitudinal axis of the duct.

.3 The rotary action brushes and mounting shaft to be adjustable in all dimensions to maintain contact with the interior surfaces of the duct.

.4 The robotic vehicle is to have a mounted camera device to monitor cleaning and record to video tape at all times.

**2.3 Robotic Acoustic Lining Cleaner:**

.1 Cleaning of acoustically-lined ductwork and components is to be carried out only with use of specially designed apparatus that has been demonstrated not to damage the lining, and is directly connected to the remote controlled, self-propelled video camera unit so that progress can be constantly monitored and maximum force can be used in vibrating the lining material without causing damage.

**2.4 Robotic Acoustic Lining Sealing:**

.1 Sealing of the acoustic lining shall be a specially designed self-propelled and robotic assembly which is equipped with a spraying mechanism that has been demonstrated not to damage the lining and is constantly video monitored to ensure that the application of the sealing material is properly directed and applied at the designed rate.

**2.5 Robotic Video Camera - Cleaning:**

.1 A remote vehicle is to have video camera device mounted to monitor cleaning process and record to video tape at all times the condition of the ventilation duct and components after cleaning as proof that cleaning has been completed as per the contract.

**2.6 Robotic Video Camera - Inspection:**

.1 The video camera used for the survey and visual inspections shall be a remote controlled, self-propelled unit capable of entering a duct as small as 175 x 175 mm square or 175 mm diameter round without any loss of maneuverability or control, and to continually provide video coverage of the duct or component of the system being checked.

.2 The camera shall be capable of being mounted on a probe of up to 3 meters in length and in this configuration shall be able to enter a duct as small as 100 mm x 100 mm diameter.

.3 For optimum clarity, the camera shall be of HD quality

.4 The video camera unit shall have full remote control, allowing it to stop at any time, turn left or right, back up and to focus on any object or feature within the duct.

.5 The video camera unit shall be equipped with sufficient light to illuminate the entire viewing area of the camera without causing "hot spots" or shadowed edges or corners on the monitor.

## 2.7 Vacuum Unit:

.1 Vacuum unit shall consist of fan, HEPA filter section, hose and vacuum head. All vacuum units shall be equipped with integral HEPA filters. Filters must be maintained in top condition.

.2 Vacuum cleaning units shall be used only to supplement direct contact brushing.

.3 Vacuum units shall be powerful enough and multiple units shall be used, to entrain all removed dirt and particulate matter in the airstream until captured by the vacuum units.

.4 No cleaning operations shall take place until vacuum units are in place and operating.

.5 Coils, walls, humidifiers, elements and heat exchangers are to be brushed and vacuumed and where necessary low pressure washed in place. Fan blades will be wiped and vacuumed.

.6 A HEPA filter system in the negative air pressure unit must be installed before any cleaning can take place.

.7 Any altered components such as dampers will be reset to their original positions after cleaning.

# 3 EXECUTION

.1 Complete a preliminary inspection of the ventilation ducts and components of individual specified ventilation systems in building identified in this Contract. At least 10 percent (10%) of all ductwork and components to be cleaned shall be checked, including proportionate representative samples of main supply and return ducts as well as branch ducts and other components. .

.2 The section being cleaned must be isolated from other areas and put under vacuum pressure through a HEPA filter system.

.3 The cleaning must encompass all surfaces that air passes over in the AHU.

.4 Where brushing and vacuuming is not appropriate or sufficient to clean a component, dismantle and remove to the outside and clean with a pressure washer.

.5 The system's state of cleanliness shall be determined through the use of the following three methods:

.6 Visual inspection: Through the use of robotic video camera and by direct inspection of various sections and components of the system;

.7 Submit a preliminary inspection report outlining the general condition of the inspected ductwork describing both its physical state and its degree of cleanliness

## 3.2 Cleaning of Components:

.1 All components of the system are to be thoroughly cleaned, turning vanes, diffusers, grilles, reheat coils, control components including sensing bulbs, branch take-off points, fire dampers, balancing dampers, splitter dampers and any other internal duct or system features, especially corners and pockets where dirt or dust may accumulate.

.2 Before starting and cleaning, carefully mark and record all and any adjustable dampers or other air-flow balancing devices so that, if disturbed, they can be reset to their original positions. This includes all branch take-offs, balancing dampers, splitter dampers, grilles and diffusers and adjustable louvres in the system.

.3 Isolate sections of the duct with friction-fitted blocks of closed-cell polyurethane foam, install HEPA vacuums at one end, and inset the full contact brushes at the other. Energize brushes so that they travel towards vacuum units, changing brush sizes as necessary to ensure a constant interference fit within the duct or component.

.4 Clean all fittings, components and other features within the system on the same section-by-section basis so that dirt from a section being cleaned will never pass through a section that has already been cleaned.

.5 Pass brushes through sections or components as many times as necessary to achieve the degree of cleanliness required.

.6 Where brushing and vacuuming is not appropriate or not sufficient to clean a component of the system, dismantle and remove the component to the outside where it shall be pressure-washed to the required state of cleanliness.

**3.3 Manual Cleaning:**

.1 Cleaning operations performed by hand are acceptable only for purposes of cleaning individual components of the system such as fan blades, dampers, controls, turning vanes, etc. Manual brushing and vacuuming shall not be acceptable for purposes of cleaning the entire system.

.2 Compressed air or manual or hand cleaning is not to be used for cleaning of ventilation ducts except in isolated instances and when duct size is too small to use robotic equipment or only if specifically instructed by the Engineer in writing.

**3.4 Cleaning Standards:**

.1 The ventilation system being cleaned shall be cleaned to like-new condition throughout unless specifically noted otherwise in this specification.

.2 Ducting and components shall be cleaned to the following standards:

.1 Supply side ductwork and components: Particulate: Scale rating of 1; and microbial growth: Scale rating of 1.

.2 Exhaust and return side ductwork and components: Particulate: Scale rating of 2 or less; and microbial growth: Scale rating of 2 or less.\

**3.5 Inspection After Cleaning:**

.1 This inspection shall only take place after all systems and components have been cleaned.

.2 Follow the same video survey plan used for the preliminary survey.

.3 Perform video survey of same sections, features and points as were previously recorded for purposes of comparison.

.4 Perform visual inspections throughout as well as Microbial Growth Evaluation wherever this method was used in preliminary examination.

.5 Incorporate all data, observations and recommendations in to the final report as described elsewhere in this specification.

## 4 REPORTS:

.1 Submit two (2) copies of separate reports both before and after the cleaning procedure has been undertaken. Both reports shall include the following:

- .1 Name of facility and address
- .2 Name and address of cleaning contractor
- .3 Description of the ventilation system with drawings or clear neat sketches showing the various systems
- .4 Identification scheme for all points in system that were examined and notes describing method of examination or testing used
- .5 Description and location of problem areas encountered and special or unusual situations or conditions and any comments or recommendations
- .6 Comments complete with photos illustrating each sampling location and other observed features of the system
- .7 DVD format videos showing all areas tested for particulate analysis or microbial growth evaluation, all areas of special interest and general representative sections of the duct and components for each ventilation system cleaned.
- .8 Report verification by a TAB Agent and Certification that NADCA standards have been met

.2 Submit two (2) USB sticks with all pre and final videos and pdfs of all reports and tests with each report.

.3 Reports shall be bound in binders, complete with index and title page.

**END OF SECTION**

# TERMINAL BOXES
# 23 36 13

## 1 GENERAL

### 1.1 Scope

.1 Provide terminal boxes as shown.

### 1.2 Shop drawings

.1 Submit manufacturer's data sheets with equipment model numbers, performance and design data, outline dimensions, enclosure details, support and connection arrangements and electrical power requirements where applicable.

### 1.3 Applicable codes and standards

.1 ARI Standard 880 Standard for Air Terminals

.2 ARI Standard 885 Standard for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.

.3 ASHRAE Standard 180 Methods of Testing for Rating Ducted Air Terminal Units

## 2 PRODUCTS

### 2.1 General

.1 Selection of units to meet air quantities shown to be based on;

- .1 maximum Inlet Air Pressure; 750 Pa (3 in wg),
- .2 minimum Inlet Air Pressure; 75 Pa (0.3 in wg),
- .3 maximum room NC sound pressure level ( $2 \times 10^{-4}$ microbar reference) at maximum inlet pressure to be less than 40 at discharge and 42 radiated for box with attenuator mounted exposed (without ceiling).

.2 Where sizes, model numbers and unit types are indicated, selections are taken from E.H. Price catalogue.

*Standard of Acceptance*
- E.H. Price
- Titus
- Environmental Technologies
- Nailor Industries.
- Carnes
- Metalaire

### 2.2 Terminal box

.1 Construction:

- .1 pressure independent type with pneumatic velocity sensor, damper assembly, factory calibrated controller and actuator with adjustable minimum stop
- .2 damper arranged "normally open" for morning warm-up.

.3 controller capable of maintaining air quantity within ±5% of set value, between zero and stipulated rated air flow,

.4 sound level below specified values when operating from minimum to maximum inlet static pressure.

.2 Silencer/attenuator:

.1 on box discharge, acoustically treated open end or multiple outlet attenuator 900mm (30 in) long on boxes up to Size 10 and 1.5 m (5 ft) long on boxes Size 12 and larger

.2 acoustic lining - fibreglass:[

(a) 20 mm (13/16 in) thick, 64kg/m$^3$ (4 lb/sq ft) density, rigid fibreglass with fire resistive reinforced aluminum foil-scrim-kraft (FSK) facing,
(b) flame spread rating not to exceed 25, smoke development rating not to exceed 50,
(c) fastened to interior sheet metal surface with 100% coverage of adhesive, and fasteners at 1 pin per 0.2m$^2$ (2 sq ft) but not less than 1 row on each duct side.
(d) edges concealed by metal nosings at inlet and discharge, with notch and tuck fabrication and seams protected by Z strips

*Standard of Acceptance*
° Steri-Liner

.3 acoustic lining - elastomeric:

(a) spray coated, flexible, closed cell elastomeric insulation in sheet form, with self-adhering backing]
(b) flame spread rating not to exceed 25, smoke development rating not to exceed 50,
(c) fastened to interior sheet metal surface with 100% coverage of adhesive, and fasteners at 1 pin per 0.2m$^2$ (2 sq ft) but not less than 1 row on each duct side.

*Standard of Acceptance*
° Armacell AP Armaflex SA

.4 duct liner fasteners:

(a) 2.0 mm (1/16 in) diameter pins,
(b) length selected to suit thickness of insulation,
(c) 32 mm (1¼ in) square Nylon retaining clips.

**2.3 Reheat boxes**

.1 Construction:

.1 terminal units as specified above,

.2 outlet end of attenuator fitted with serpentine hot water reheat coils;

(a) copper tube, aluminum fin construction in galvanized steel casing,
(b) water side minimum working pressure 860 kPa (125 psi),

.3 access doors in attenuator section upstream of reheat coil.

**2.4 Fan powered boxes**

.1 Construction:

.1 reheat units or terminal units as specified above

.2 fitted with supply fan and supply/return air mixing arrangement capable of modulating from 100% cold air to 100% return air.

.3 statically and dynamically balanced forward curved fans with sleeve bearings, and brushless DC electronically commutated motor (ECM) with permanent magnet rotor and motor control package for single phase 120 VAC 60Hz power supply.]

### 2.5 Controllers

.1 Direct Digital Controllers (DDC) including actuators to be supplied by Section 25 14 00, B.A.S. Equipment Controllers, and factory mounted by Terminal Box Manufacturer. Costs associated with receiving, storage, installation and calibration to be included by Terminal Box Manufacturer.

.2 Air flow sensor to be provided by Terminal Box Manufacturer.

.3 120 VAC to 24 VAC transformer for DDC controller to be supplied by Section 25 14 00, B.A.S. Equipment Controllers, and factory installed by the Terminal Box Manufacturer.

## 3 EXECUTION

### 3.1 Box installation

.1 Support terminal boxes from building structure with angles, hangers and supplementary steel before installation of piping and connecting ductwork.

.2 Provide access door in ductwork downstream of reheat coil.

### 3.2 Ductwork connections

.1 Connect inlet ductwork with spiral flat seam round duct of same diameter as terminal box inlet

.2 Support outlet ductwork independent from box.

.3 Seal openings in box and attenuator for reheat coil and connections, ]control, and power wiring.

### 3.3 Piping connections

.1 Connect supply and return piping to reheat boxes

.2 Install isolating valve on supply and lock shield ball valve and automatic control valve on return of each reheat coil.

.3 Provide screw driver air vent at high point of piping to each coil.

### 3.4 Electrical connections

.1 Electrical Division 26 will provided 120 Volt, single phase power supply with a junction box for each group of terminal boxes with maximum of 12 terminal box controls fed from one junction box. For fan powered terminal boxes Electrical Division 26 will provided 120 Volt, single phase power supply for fan motors and controls at a junction box adjacent each fan powered terminal box.

.2 Extend power supply from these junction boxes and connect to terminal units.

### 3.5 Leakage testing

.1 Terminal boxes and attenuators to be included in ductwork leakage testing.

**END OF SECTION**

# GRILLES, REGISTERS AND DIFFUSERS
# 23 37 13

## 1 GENERAL

### 1.1 Scope

.1 Provide grilles, registers, and diffusers as shown.

### 1.2 Shop drawings

.1 Submit manufacturer's data sheets with equipment model numbers, performance and design data, outline dimensions, support recommendations and connection details.

### 1.3 Samples

.1 Submit examples of each type and style of register, diffuser and grille with sample finishes when requested.

## 2 PRODUCTS

### 2.1 General

.1 Grilles, registers and diffusers:

- .1 product of one manufacturer where same model or type identification is used.
- .2 standard catalogue products selected to meet capacity, throw, and noise level.
- .3 prime coated, stamped or cold rolled steel material with mitred corners and exposed joints welded and ground smooth.
- .4 extruded satin finish, clear anodized aluminum material with mitred corners and mechanical fasteners.
- .5 Frames with full perimeter gaskets, plaster stops where set into plaster or gypsum board, and concealed fasteners.

### 2.2 Type designations

.1 Diffuser, register and grille schedule identifies model or type identifiers used on floor plans with model numbers taken from listed manufacturer's catalogue.

.2 Where several manufacturer's model numbers are given, these are acceptable alternatives.

.3 Where only one manufacturer's model number is given, provide designated item.

*Standard of Acceptance*
- E.H. Price
- Nailor

### 2.3 Supply registers

.1 double deflection style with face bars vertical and rear bars horizontal,

.2 perimeter border with gasket,

.3 opposed blade dampers (OPD) with concealed manual operator,

.4 of steel or aluminum material.

### 2.4 Return and exhaust grilles

.1 single deflection type, with horizontal face bars, 20  maximum turn up,

.2 perimeter border with gasket,

.3 opposed blade damper with concealed operator,

.4 of steel or aluminum material.

### 2.5 Diffusers

.1 circular or square multiple cone or perforated face type, with adjustable pattern control,

.2 of steel or aluminum material.

## 3 EXECUTION

### 3.1 Layout

.1 Drawings showing position of air distribution outlets are essentially diagrammatic. Coordinate exact location of diffusers with other elements in ceiling and shown on reflected ceiling drawings and select trim to suit ceiling materials listed in Finish Schedules.

### 3.2 Special installations

.1 Grilles, registers and diffusers penetrating fire walls and fire partitions, to have steel sleeves secured to structure in accordance with NFPA 90A-1985.

.2 In gymnasium provide safety chain on each diffuser face and core and bolt diffuser in place.

.3 For laminar flow diffusers, with or without HEPA filters, support diffuser from the building structure with steel cable, independent of ceiling system and ductwork.

.4 For security grilles and diffusers, and other grilles and diffusers exceeding 5 kg (12 lbs) weight, mechanically fasten grille/diffuser to ceiling or wall structure, independent of ductwork connection or support.

### 3.3 Installation of grilles and registers

.1 Install supply registers with face bars vertical and exhaust and return registers with face bars horizontal.

.2 Install registers and grilles with oval head cadmium plated screws in countersunk holes where fastenings are visible.

### 3.4 Installation of diffusers

.1 Diffusers to be installed with concealed fastenings.

.2 Round, square and rectangular diffusers to be provided with equalizing deflectors, mounted in neck, accessible from diffuser face, with blades oriented at right angles to direction from which air is flowing.

.3 Except for last diffuser on branch, each diffuser installed in underside of supply duct to have extract volume control damper.

**END OF SECTION**

# DUCTLESS SPLIT AIR CONDITIONERS
# 23 81 26

## 1 GENERAL

### 1.1 Scope

.1 Provide ducted split air conditioning units and heat pump units as shown.

### 1.2 Shop drawings

.1 Submit shop drawings for each condensing unit and evaporator with;

- .1 equipment model number,
- .2 outline dimensions,
- .3 enclosure details,
- .4 space requirements for service and maintenance,
- .5 support arrangements.

.2 Provide rating information showing capacity and power input requirements for heating and cooling at full load.

.3 Provide diagrams showing;

- .1 requirements for field assembly with air flows, connection pipe sizes and rated air flow,
- .2 unit internal and external electrical power and control wiring with motors, starters, relays and interlocks identified, and with terminal and wire numbers marked.

### 1.3 Warranty

.1 Compressors to be warranted against failure for five (5) years and warranty to include for labour and materials used in replacing compressors, and in cleaning, dehydrating and charging refrigeration system.

## 2 PRODUCTS

### 2.1 General

.1 Package system, factory assembled and tested with pre-charged refrigeration piping, refrigerant and oil charge.

.2 Ready for connection of electric power at evaporator unit and condensing unit and control wiring between units.

*Standard of Acceptance*

- Mitsubishi
- Daikin
- Copeland

### 2.2 Evaporator Unit

.1 Concealed indoor evaporator unit;

.1 pre-charged direct expansion type cooling coil, arranged with counter flow between air and refrigerant,

.2 three speed fans statically and dynamically balanced,

.3 disposable filters for particulate and odour control,

.4 condensate pan draining to 20 mm (¾ in) side outlet connection.

.5 exposed: plastic enclosure with removable panels for servicing,

.6 conceaned: enamel sheet metal enclosure with access doors and concealed fasteners,

.7 concealed suspension brackets

.8 operating sound level less than 45dB(A)

### 2.3 Condensing unit

.1 Outdoor, air cooled, hermetic compressor;

.1 mounted on vibration isolators,

.2 air cooled condensing coil,

.3 condenser fans, motor starters, and controls,

.4 sheet metal enclosure with mounting lugs and fan safety grille primed and enameled to withstand 1000 hr salt spray test.

.5 low ambient operation to -22°C (-7°F)

.6 operating sound level less than 55dB(A)

### 2.4 Refrigerant circuit

.1 Piping, valves, fittings and related parts to CSA B52.

.2 Pipe insulation: 19 mm (¾ in) thick flexible elastomeric insulation on suction line.

### 2.5 Temperature control system

.1 Hard wired electronic thermostat and control module to operate heating, and cooling in sequence in response to thermostat sensed temperature, with indication for;

.1 operating mode (heat/cool)

.2 compressor operation,

.3 no heat,

.4 touch sensitive key pad to allow hour/day operating program and adjustment of thermostat set point.

## 3 EXECUTION

### 3.1 Installation

.1 Install evaporator unit in space, route drain piping as shown.

.2 Install condensing unit with adequate clearance for service and maintenance.

.3 Run refrigeration suction and liquid piping as shown in accordance with manufacturer's instructions with respect to horizontal and vertical length limitations

.4 Charge systems and leak test in accordance with manufacturer's instructions

.5 Provide un-fused weatherproof disconnect on or adjacent condenser and evaporator units and run electric power and control wiring.

.6 As required, depending on manufacturer, sub-feed electrical power for evaporator unit from condenser unit.

.7 Provide sheet-metal wind-baffle shield on condenser as required by manufacturer's instructions for low ambient operation.

**3.2 Start-up service**

.1 Arrange for manufacturers' field representative to supervise installation, start-up system and instruct Owners operations and maintenance personnel.

**END OF SECTION**