

**TOWN OF LADYSMITH**

*Celebrate our Present. Embrace our Future. Honour our Past.*



**FACILITY OPERATIONS**

**Invitation to Tender**

**No. 2026-PRC-01**

**Ladysmith RCMP – HVAC Upgrade**

**For further information:**  
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[rfrost@ladysmith.ca](mailto:rfrost@ladysmith.ca)  
250.245.6430

**Tender Issue Date:** April 24<sup>th</sup>, 2026  
**Tender Closing:** 1:30 p.m., Friday, May 22<sup>nd</sup>, 2026  
**Tender Opening:** 1:45 p.m., Friday, May 22<sup>nd</sup>, 2026  
Ladysmith City Hall

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## TOWN OF LADYSMITH

### INVITATION TO TENDER

#### 1.0 Introduction

The Town of Ladysmith (the "Town") invites Tenders from qualified and experienced contractors for the supply of Roof Top Units and associated mechanical, electrical, structural, and controls work in accordance with the Tender Specifications outlined in sections Divisions 20, 23 and 25.

#### 2.0 Tender Submission

Proponents are to submit their Tenders **no later than 1:30 pm on May 22<sup>nd</sup>, 2026**, by E-bidding on [BCBid's](#) secure portal or delivering by courier, mail, or in person. Proposals received after the deadline – whether through BCBid or courier, mail, or in person delivery - will be rejected.

If submitting by courier, mail, or in person, proposals must be addressed to:

Sue Bouma, Manager of Corporate Services  
Town of Ladysmith  
410 Esplanade  
PO BOX 220  
Ladysmith, BC V9G 1A2

All submissions must be clearly marked "Request for Tenders No. 2026-PRC-01".

Submissions in response to this RFT will be opened publicly at the Town of Ladysmith City Hall on **May 22<sup>nd</sup>, 2026, at 1:45 pm.**

#### 3.0 Scope of Work

Work under this Tender consists of the replacement of the existing heating and cooling system with new rooftop units and split system heat pumps. The Prime Contractor must oversee and coordinate all necessary work, material, equipment and labour to complete the Work. The Prime Contractor shall fully coordinate with all involved sub-trades and ensure the Work is completed successfully, including but not limited to the following:

- A. Demolition: Removal and disposal of all equipment, ducting, piping and components associated with the existing system for heating and cooling.

- B. Electrical: Installation and provision of all wiring, connections/disconnections and power requirements for newly installed equipment.
- C. Mechanical: Installation and provision of all ducting, hangers, penetrations, insulation, connections/transitions, refrigeration and condensate piping and components associated with newly installed equipment.
- D. Roofing: Installation and provision of supports, roof curbs, roof penetrations, re-works, finishing associated with the installation of new equipment.
- E. Seismic Review: Provision and supplement all new equipment with appropriate seismic restraints in alignment with relevant codes and standards.
- F. TAB: Completion of testing, adjusting, and balancing the function and performance of all equipment in the mechanical system.
- G. Controls: Provision all wiring, programming, and control devices required to integrate control interfaces with new mechanical systems.

#### 4.0 Form of Tender

Tenders must be completed using the BCDC/CCDC Form of Tender, Tender Specifications and any applicable schedules and addenda as supplied.

#### 5.0 Tender Opening

Tenders received by the Tender Closing Date and Time noted above at the Tender closing location will be opened in public at the City Hall, at 410 Esplanade, Ladysmith at 1:45 p.m. PST on May 22<sup>nd</sup>, 2026.

#### 6.0 Mandatory Site Review

- a. Bids will only be accepted from Prime Contractors who register for a mandatory site tour and walk-through, scheduled for **May 6<sup>th</sup>, 2026, between 1:00 PM and 2:00PM.**
- b. The site visit is mandatory for contractors intending to act as Prime Contractors.
- c. As the project primarily involves mechanical work, Mechanical Contractors are invited to bid as Prime Contractors. In the event that contractors who are not qualified to carry out the mechanical installation work intend to bid as Prime Contractors, they shall be accompanied on the site visit by the Mechanical Contractor they intend to carry as a sub-Contractor.
- d. The person attending the mandatory walkthrough must be a principal of the firm, an estimator employed by the firm, or a ticketed gas, pipe or sheet metal tradesman, with a valid TQ number, indicative of competency in mechanical systems installation and an understanding of the project requirements described by the Owner and Consultant.

- e. The person attending the mandatory site visit will require RCMP security clearance and is advised to check in with the detachment on the requirements of security clearance if unsure.
- f. The site tour is not mandatory for other subcontractors.

## **7.0 Late Submissions**

Tenders received after the Closing Date and Time will be returned unopened to the Tenderer.

## **8.0 The lowest or any tender will not necessarily be accepted.**

<b>INSTRUCTIONS AND CONDITIONS TO TENDERERS</b>
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## 1.0 DEFINITIONS

1.1 In the Tender Documents the following words have the following meanings, unless the context otherwise requires:

**"Contract"** means an agreement for the performance of the Work to be executed by the Town and the Tenderer to whom the Work is awarded as applicable;

The Town of Ladysmith is referred to as **"the Town"**;

The successful tenderer is referred to as **"the Supplier"**;

**"Tender Closing Date and Time"** means the date and time stipulated in section 2 for the receipt of Tenders;

**"Tender Documents"** means the Invitation to Tender, the Form of Tender, the Instructions and Conditions of Tendering, the Tender Specifications(Schedule "E"), and all addenda; and

**"Work"** means all work to be done, performed and completed by the Tenderer under the Contract if awarded the Tender by the Town.

## 2.0 TENDER CLOSING DATE AND TIME

2.1 Sealed Tenders, made on the Tender Form provided, together with all other Tender Documents required will be received by E-bidding on [BCBid's](#) secure portal or delivered by courier, mail, or in person., Proposals received after the deadline – whether through BCBid or courier,mail, or in-person delivery – will be rejected.

If submitted by courier, mail, or in person, proposals must be addressed to:

Sue Bouma, Manager of Corporate Services  
Town of Ladysmith  
410 Esplanade  
PO BOX 220  
Ladysmith, BC V9G 1A2

2.2 Tenders will be received up to **1:30 p.m. PST**, on May 22<sup>nd</sup>, 2026.  
Tenders received after the closing time will be returned unopened.

The Tender Form being submitted must be signed by an authorized representative of the tenderer.

An award from this tender may require the approval of Town Council which, at its sole and unfettered discretion, can accept or reject any tender offered.

No tenderer may withdraw their tender within 60 days after the actual date of opening.

Tenderers are responsible for all costs relating to the preparation and submission of tenders.

This tender and any subsequent contracts resulting from this tender shall be governed by and interpreted in accordance with the laws of the Province of British Columbia.

It is the Tenderer's responsibility to allow sufficient time for their agent to deliver their Tender by the time and date specified above. The Tenderer should instruct their delivery agent to have the receptionist at the main reception desk at the City Hall time and date stamp the Tender. The Town will apply its date stamp upon receipt of Tenders delivered by Canada Post or courier.

### **3.0 TENDER OPENING**

3.1 Tenders will be opened publicly at **1:45 p.m. PST on May 22<sup>nd</sup>, 2026**, at Ladysmith City Hall, 410 Esplanade, Ladysmith (corner of Roberts Street and Trans Canada Highway).

### **4.0 TENDER SUBMISSION**

4.1 Late Tenders will not be accepted, opened or considered and will be returned unopened to the Tenderer upon the Town determining that the Tender was submitted after the Closing Date and Time.

### **5.0 FORM OF TENDER**

5.1 Tenders must be submitted on the form of the Tender Documents provided.

### **6.0 AMENDMENT OR WITHDRAWAL**

6.1 Tenders may be amended or withdrawn, provided written notice is received by the receptionist at the main reception desk at the City Hall prior to the stipulated closing time on the Closing Date.

6.2 Revisions to bid prices should state changes to unit prices only.

6.3 No revisions or withdrawals will be accepted after the Closing Date and Time.

## **7.0 APPENDICES TO BE COMPLETED**

- 7.1 Tenderers must complete and submit as part of the Tender all Appendices that form part of the Tender Documents other than the Contract General Conditions attached as Schedule “D”.
- 7.2 Any deviations from the specifications shall be separately noted in the space provided on the specification sheets, with separate information required attached.

## **8.0 PRICES AND GST**

- 8.1 Prices quoted are to be in Canadian dollars. Goods and Services Tax (GST) is to be shown as a separate item on the Form of Tender.

The prices shown as UNIT COSTS/HOURLY RATES on the Tender Form shall include all material costs, labour costs, and any other charges so as to be the final cost to the Town.

## **9.0 ORAL, EMAIL AND FACSIMILE TENDERS NOT ACCEPTED**

- 9.1 Oral, electronic mail or facsimile Tenders or amendments to Tenders will not be accepted.

## **10.0 COMPLETION OF TENDER AND ERRORS**

- 10.1 All prices and notations must be typewritten or written in ink. No erasures or additions to the Tender Documents are permitted. In the case of mistake in extension of price, unit price will govern.
- 10.2 In case of mistake by the Tenderer, the mistake must not be erased but crossed out with the correction typewritten or written in ink adjacent thereto and such corrections must be initialed by the Tenderer's authorized signing officer or employee referred to in section 10 of the Instructions to Tenderers.

## **11.0 SIGNATURE REQUIRED**

All tenders must be signed in the place provided on the front page and on the Form of Tender by an officer or employee having authority to bind the Tenderer by his or her signature.

## **12.0 BID IRREVOCABLE**

The Tenderer agrees that in submitting a Tender, the Tender will be irrevocable and remain open for acceptance by the Town for 60 (sixty) calendar days from the day following the Closing Date and Time.

No tender may be withdrawn after the Closing Date and Time without the written consent of the Town, which may be withheld in its sole discretion.

### **13.0 MISTAKE IN TENDER DOCUMENTS**

If the Tenderer discovers or suspects any ambiguity between the Tender Summary, the Specifications, the plans, or any addenda, the Tenderer shall seek clarification from the Town, in writing, before submitting a Tender.

If deemed necessary by the Town, and in its sole discretion, an addendum will be issued to all parties that have indicated an interest in submitting a Tender. The Town reserves the right to revise, expand or delete any portion of the Tender Documents as part of the addendum.

Requests for clarifications must be submitted to the Town in writing and received not less than five (5) working days before the Tender Closing Date.

An addendum issued under this section will be considered to form part of the Tender Documents.

### **14.0. TENDER AWARD**

The Town reserves the right to reject any or all Tenders and the lowest or any Tender will not necessarily be accepted.

Without limiting the generality of section 8.1, the Town reserves the right to:

- waive any informality or irregularity in a Tender;
- reject a Tender which contains qualifying conditions or otherwise fails to conform to these Tender Documents;
- reject any single Tender if only one Tender is received;
- make decisions regarding Tender acceptance with regard to:
  - compliance with specifications, warranties, lead times, price and any other such factors as may be relevant factors in determining which Tender will provide the Town with the best value based on quality, service and price;
  - the overall cost impact of the Tender on the operations of the Town including, where applicable, factors such as acquisition cost, disposal cost, residual value, training cost, maintenance cost, product performance and environmental impact;

- the reputation and experience of the Tenderer and of the Tenderer's staff to be allocated to the Work, the supply of the goods and services or the supply of any equipment required by this Tender;
  - the technical experience, financial resources, and environmental responsibility of the Tenderer;
  - the Town's assessment of the capability of the Tenderer to perform the Work within the timeframe required by the Town; and
  - demonstration that the Work undertaken will meet or exceed requirements of environmental standards; and
- award the Work based on the best value to the Town based on quality, service, and price, and any criteria set out herein based solely on the Town's assessment of the tender.

Refer to Schedule “B” for further clarification on the proposal evaluation process and scoring.

#### **15.0. NO DUTY OF CARE**

It is the responsibility of the Tenderer to thoroughly examine the Tender Documents including any attachments and appendices to satisfy itself regarding the full requirements of the Tender and the Work.

While the Town has made reasonable efforts in good faith to ensure an accurate representation of information in this Tender, the information contained herein is supplied solely as a guideline for Tenderers, and the Town does not warrant or represent such information to be accurate, or complete.

The Tenderer acknowledges and agrees that in the preparation of the Tender, supply of oral or written information to Tenderers, review of Tenders or the carrying out of the Town's responsibilities under this Tender, the Town does not owe a duty of care to the Tenderers, and waives for itself, its successors and assigns, the right to sue the Town in tort for any loss, including economic loss, costs, expenses, losses, damages, or liability incurred by the Tenderer as a result of or arising out of any error, omission or misrepresentation occurring in the preparation of the Tender Documents, supply of oral or written information to Tenderers, review of Tenders or any document submitted in response to the Invitation to Tender.

Tenderers are solely responsible for their own expenses in preparing a Tender and for subsequent negotiations, if any. If the Town elects to reject any or all Tenders, or to cancel the Tender for any reason, the Tenderer acknowledges and agrees that the Town will not be liable to any Tenderer for any claims, including, without limitation,

costs or damages incurred by the Tenderer in preparing the Tender, or loss of any anticipated profit in connection with the Work contemplated by this Tender, or any other matter whatsoever.

## **16.0 QUERIES**

16.1 All enquiries regarding the tender submission process may be directed to Sue Bouma, Manager of Corporate Services [bid@ladysmith.ca](mailto:bid@ladysmith.ca).

16.2 All queries regarding the technical specifications forming part of this Tender may be made by contacting participants listed in Schedule “C”.

**Schedule “A”**

**BCDC-2 and CCDC-2**



## **Part 1.1: DIVISION 00** **Procurement and Contracting Requirements**

*For use with CCDC 2-2020 Stipulated Price Contract*

### **00 11 13 - ADVERTISEMENT FOR BIDS**

Reset All

#### **1. BID CALL**

- .1 *Town of Ladysmith*  
will receive bids for this *Project* on or before *1:30 PM (PST)* on *Friday, May 22, 2026*  
(unless modified by addendum) at:
  - .1a *Sue Bouma, Manager of Corporate Services, Town of Ladysmith*  
*Town of Ladysmith*  
*410 Esplanade PO Box 220*
  - .1b *BC Bid secure portal*
- .2 The official bid closing time will be determined by the [*reception desk clock*] [*online system*]  
at the bid closing location.
- .3  This bid call is by invitation only. The following Bidders have been invited to bid:
  - .3.1 Submit bids only in the name indicated in the letter of invitation to bid. Bids submitted in a  
name different to that indicated in the invitation, or from Bidders not invited to bid per 00 11  
13 1.3, will be returned unopened, or if inadvertently opened, will be rejected and deemed as  
non-compliant.
- .4 Bid Opening Process:  
Bids will be opened publicly and reviewed by the Town of Ladysmith and Consultant prior to award.



- .5 Unofficial bid results will be disclosed promptly to all Bidders. Such disclosure will not imply that the bids received are compliant or that a contract will be awarded to the lowest or any Bidder.

## **2. BID DOCUMENT AVAILABILITY**

- .1 Bid Documents are available in electronic form. It does not confer a license to use the Bid Documents for any other purpose. Bid Documents may be obtained from:
- BC Bid Website
- .2  Bid Documents are available in hard copy form. It does not confer a license to use the Bid Documents for any other purpose. Hard copy Bid Documents may be obtained at :

## **3. PROJECT DESCRIPTION**

*HVAC upgrades including installation of one ducted fan coil unit, one ductless fan coil unit, two heat pumps, four rooftop units, and silencers. Scope includes demolition of the existing fluid cooler, associated piping, and all existing coils. Ductwork to be revised as indicated on the drawings. Prime Contractor to coordinate all electrical, controls, demolition, testing adjusting and balance, mechanical, structural, and seismic work associated with this project.*

END OF SECTION



## **00 21 13 INSTRUCTIONS TO BIDDERS**

### **1. DOCUMENTS**

#### 1.1 DOCUMENTS

- .1 Carefully examine the following information. Failure to follow these instructions may result in bid disqualification.
- .2 Project information:
  - .1 Project / Contract Name: Ladysmith RCMP - HVAC Upgrade
  - .2 Project / Contract No.: 2026-PRC-01
  - .3 *Owner*: Town of Ladysmith
  - .4 Project Address: 810 6th Ave  
Ladysmith, BC V9G 1A2
- .3 Examine the Bid Documents and promptly notify the person designated to receive inquiries of any perceived errors, omissions, conflicts or discrepancies in the Bid Documents.

#### 1.2 BID DOCUMENTS

- (a) BCDC 2 - 2022, Part 1.1 Division 00 11 13 Advertisement for Bids;
- (b) BCDC 2 - 2022, Part 1.1 Division 00 21 13 Instructions to Bidders; 00 73 16 Insurance Requirements; 00 73 63 Contract Security Requirements;
- (c) BCDC 2 - 2022, Part 1.1 Division 00 41 13 Bid Form and Appendices;
- (d) CCDC 2 - 2020, Articles of Agreement;
- (e) CCDC 2 - 2020, General Conditions;
- (f) BCDC 2 – 2022, Part 1.2 Supplementary Conditions;
- (g) BCDC 2 – 2022, Part 1.3 Project Specific Amendments, if any;
- (h) General Requirements;
- (i) Drawings and Specifications;
- (j) Appendices, if any;
- (k) Addenda.

#### 1.3 CONTRACT DOCUMENTS

- .1 Upon award of contract the Contract Documents consist only of (b) to (k) above. The *Owner* will prepare two copies of the Contract.



## **2. PRE-BID INQUIRIES**

- .1 Direct inquiries relating to Bid Documents, only to the *Consultant/Owner* at:

*sbouma@ladysmith.ca*  
*rfrost@ladysmith.ca*  
*aaron.mullaley@rpeng.ca, kyle.lorondeau@rpeng.ca*

- .2 Submit inquiries as early as possible in the bid period and not less than 5 Working Days before the bid closing time. Inquiries received after this time may not receive a response.

## **3. PRE-BID SITE VISIT**

- .1 There will not be a pre-bid site visit for the Project.

- .2 There will be pre-bid site visit for the Project.

2.1 Mandatory Site Visit

Failure of a Bidder's representative to attend and sign the attendance sheet will cause the Bid to be rejected as non-compliant.

2.2 Optional Site Visit

A pre-bid site visit has been scheduled for 1:00pm-2:00pm local time on May 6, 2026. Attendees will meet at Ladysmith RCMP @ 810 6th Ave Ladysmith, BC V9G 1A2

Bidders will be required to sign an attendance sheet during the meeting. Names of Bidders attending will be issued by addendum.

Issues arising from the pre-bid site visit will be addressed as required in an addendum to the Bid Documents. No meeting minutes will be issued. Bidders may not rely upon any information given verbally or otherwise at the pre-bid site visit and that is not confirmed by addendum.

Bidders visiting the Place of the Work must be accompanied at all times by a representative of the *Owner*.

Bidders visiting the Place of the Work must provide their own personal protective equipment.

2.3 *Owner* Requirements of Site Visit

*all participants in the mandatory site visit are required to hold an up to date and valid security clearance by the RCMP.*



#### **4. PARTICULARS AFFECTING BID PRICE**

##### **4.1 MATERIALS**

- .1 Establish the Bid Price based on the use of materials specified in Drawings and Specifications.
- .2 Proposed substitutions to materials specified will be considered during the bidding period only if full descriptive data are submitted in writing to the *Consultant/Owner* at least 5 Working Days before the bid closing date.
- .3 Approved substitutions will be incorporated in the Drawings and Specifications by issuance of an Addendum.

##### **4.2 CONDITIONS RELATED TO THE WORK**

- .1 Become familiar with the site and existing conditions prior to submitting a bid and make allowances for conditions related to the Work.
- .2 Claims for an increase in Contract Price or Contract Time arising from observable conditions will be rejected by the *Owner*.

##### **4.3 TAXES**

- .1 Include in bid price all taxes and customs duties in effect at the time of the bid closing, except for Value Added Taxes as defined in the CCDC standard form of contract.

#### **5. ADDENDA**

- .1 Addenda may be issued to modify the Bid Documents in response to Bidder inquiries or as may be considered necessary.
- .2 All addenda issued during the bid period will become part of the Bid Documents.
- .3 No addenda will be issued later than 3 Working Days before the bid closing time, unless absolutely necessary.
- .4 Each Bidder must ascertain before bid submission that it has received all addenda issued during the bid period and must indicate the addendum number(s) of all addenda received with their bid submission.

#### **6. INTERPRETATION AND MODIFICATION OF BID DOCUMENTS**

1. If an inquiry requires an interpretation or modification of the Bid Documents, the response to that inquiry will be issued in the form of a written Addendum only, to ensure that all Bidders base their bids on the same information.
2. Replies to inquiries or interpretations or modifications of the Bid Documents made by e-mail, verbally, or in any manner other than a written Addendum, will not form part of the Bid Documents and will not be binding.



## 7. BID DEPOSITORY

- .1 This Project will not use BidCentral Online Bidding for Subcontractors (“BOBS”), a bid depository system.
- .2 This Project will use BidCentral Online Bidding for Subcontractors (“BOBS”), a bid depository system.
  - 2a. The following subcontractors must submit their bid through BOBS and provide bonding per the Rules of Procedure (“Rules”):
    - 2b. The following subcontractors must submit their bid through BOBS and do not require bonding:
      - .1 The date and time for the BOBS closing will be not less than two (2) working days prior to General Contractor bid closing and up to 3:00 PM on the date specified, subject to the Rules.
      - .2 The Rules of Procedure for BOBS, in force at the bid closing time, will apply.
      - .3 Subcontractors listed must submit their bids through BOBS via the specified method as defined in BidCentral (<https://www.bidcentral.ca/online-bidding-for-subcontractors/>).
      - .4 Where stipulated in section 2a, BOBS requirements in the Project Documents, and as required under the Rules, the subcontractor must provide a bond. Such bond must conform to the requirements of the Rules.
      - .5 General Contractors must confirm their Intention to Bid no later than two (2) Working Days (to the hour) prior to the BOBS closing date and time as per the requirements in the Rules for BOBS.
      - .6 Notwithstanding the requirements for exclusion of work contained in the Rules, ensure all Work described in the Bid Documents is included in the Bid Price.
      - .7 Where required by 2a and when requested to do so the Bidder agrees to provide the *Owner* with proof of Subcontractor bonds within ten (10) Working Days of Contract award.
      - .8 Only General Contractor Bids which list Trade Contractor Bids submitted in accordance with the Rules of Procedure for BOBS for those sections or divisions specified, will be subject to a recommendation of acceptance from the Bid Calling Authority to the *Owner* and any others will be rejected.



## **□ Bid Submission: PAPER SUBMISSIONS**

### **8P. COMPLETION OF BID FORM & APPENDICES**

- .1 The Bidder must:
  1. Complete the bid on the Bid Form included with the Bid Documents in a non-erasable medium and execute in accordance with provisions of Clause 9 of the Instructions to Bidders, - EXECUTION OF THE BID.
  2. If required, state the number of weeks within which the Bidder will achieve *Ready-for-Takeover*.
  3. Initial erasures or corrections to entries on the Bid Form.
  4. Indicate receipt of Addenda.
  5. Complete all appendices as required by the *Owner*.
    - Appendix 'A' – List of Subcontractors
    - Appendix 'B' – Alternate Prices
    - Appendix 'C' – List of Unit Prices
    - Appendix 'D' – List of Cash Allowances
- .2 The *Owner* must specify the specific subcontractors each Bidder must list in Appendix 'A' – LIST OF SUBCONTRACTORS. To the extent that the *Owner* does not list the subcontractors, there is no requirement for the Bidder to name the subcontractors.
- .3 Where the Bid amount in writing is different than the numerical amount, the bid amount in writing will take precedence.

### **9P. EXECUTION OF THE BID**

- .1 Execute the Bid Form in one of the following ways:
  - .1 Limited Company: Include the company's full name and the name(s) and status of the authorized signing officer(s) in the spaces provided for that purpose. Affix the signature(s) of authorized officer(s) and date the Form; or
  - .2 Partnership: Print the partnership name and the name(s) of the person(s) signing in the spaces provided. Affix the signature of one or more of the authorized partners, who must sign in the presence of a witness who must also sign and date the Form; or
  - .3 Sole Proprietor: Print the business name and the name of the sole proprietor in the spaces provided. The sole proprietor must sign and date the Form in the presence of a witness who must also sign and date the Form.

### **10P. DELIVERY OF THE BID**

- .1 Enclose the properly completed and executed Bid Form in a properly addressed envelope.
- .2 Ensure the name and address of the Bidder, the project name, (and project number where provided by the *Owner*) appear on the envelope face.
- .3 Seal the envelope and deliver it to the submission location stated in the Invitation to Bid prior to the time and date specified for the closing of bids.



- .4 The *Owner* will immediately record the date and time on envelopes containing bids and on bid revisions received by fax and this information will take precedence over machine-initiated date and time information transmitted through a fax machine.
- .5 Bids and other related documents received after the stated time and date of closing will not be considered by the *Owner*.
- .6 The *Owner* is neither liable nor responsible for costs incurred by Bidders in the preparation, submission, or presentation of the bid. Bid documents become the property of the *Owner*.

## **11P. BID WITHDRAWAL AND MODIFICATION**

- .1 If withdrawing a bid, Bidders must submit a signed letter to the *Owner* prior to closing.
- .2 Modifications or withdrawals must be signed by an authorized signing officer.
- .3 Bidders are warned that faxed or email modifications or withdrawals are submitted solely at their risk and will not be considered received until they have been received at the designated contact information, and date and time of the modification has been recorded by the bid authority.
- .4 The *Owner* will assume no responsibility or liability for modifications or withdrawals that are, for any reason, delayed, illegible, unclear as to intent, ambiguous, contrary to these instructions, or otherwise improperly received.
- .5 Email modifications or withdrawals to a bid must be submitted via a PDF document or an image file (i.e., jpeg, jpg, png) attached to the email and in the prescribed format identified in the procurement solicitation documents.
- .6 For email modifications and withdrawals, the time received by the Bid Authority's servers will determine as to whether the bid modification was received by the closing time.
- .7 For faxed modifications and withdrawals, the clock used for the official bid closing time will govern. The *Owner's* handwritten date and time or time stamp from the clock used for the official bid closing will take precedence over facsimile machine generated time and date.
- .8 Bid modifications:
  - .1 Modifications will be accepted prior to the time and date specified for the closing of bids, in a manner determined by the *Owner* using the bid amendment form included in Division 00 00 43 13 Appendix 'F' – BID MODIFICATION
  - .2 Only the Bidder's entries on the delivered Bid Form may be revised; the modification must state only the amount by which a bid figure is to be increased or decreased), or specific directions as to the exclusion or inclusion of particular words.
  - .3 Ensure all bid modifications to the original bid are clearly legible. State monetary modifications to the bid amount numerically and in writing.
  - .4 State all addendum numbers received, if different from what was indicated on the originally submitted Bid Form.



- .5 If changes are required to Appendices A, B, C, and D, new appendix forms must be submitted and revised in their entirety on new appendix submission forms. Where applicable, prices are completely new prices. These changes in price or in time are **not** a subtraction from or addition to already submitted on Appendices A, B, C, and D.

## **12P. BID SECURITY REQUIREMENTS**

- .1 Ensure the Bid Form is accompanied by a bid bond in the amount of ten percent (10%) of the Bid Price. Certified cheques and guaranteed letters of credit will not be accepted.
- .2 Ensure the bid bond is issued on a CCDC 220 Bid Bond form
- .3 If a successful Bidder declines to enter a *Contract* within the period set out in the Bid Form, or a further agreed period of time, the principal and surety will be required to pay to the *Owner* a sum equivalent to the difference between the principal's bid and the accepted bid or ten percent (10%) of the principal's bid, whichever is the lesser.
- .4 Upon request, bid bonds of unsuccessful Bidders will be returned after the successful Bidder has entered into a contract with the *Owner* and provided the specified contract security, or earlier at the *Owner's* discretion.
- .5 The bid bond must name the *Owner* as specified in the bid document as the obligee and must be signed, sealed, and dated by both Bidder and surety.



## **☒ Bid Submission: ONLINE BIDDING SYSTEM SUBMISSIONS**

### **8E. COMPLETION OF BID FORM**

- .1 All Bidders should familiarize themselves regarding online bidding requirements relating to system failure, functionality of the online system, Exclusion of Liability, Terms and Conditions for Online Bidding and Privacy Policy.
- .2 Bidders must complete the bid on the Bid Form included in the Online Bidding System and execute in accordance with provisions of Clause 9E of the Instructions to Bidders - EXECUTION OF THE BID.
- .3 If required, state the number of weeks within which the Bidder will achieve *Ready-for-Takeover*.
- .4 If required, indicate receipt of Addenda.

### **9E. EXECUTION OF THE BID**

- .1 Execute the Bid Form by the method of the Bidder's identification and authentication as designated in the On-line Bidding System.

### **10E. DELIVERY OF THE BID**

- .1 All Bids must be submitted through the On-line Bidding System not later than the date and time specified for the On-line Bidding System closing. Bids submitted after On-line Bidding System closing time will not be allowed by the On-line Bidding System.
- .2 The time as indicated on the On-line Bidding System will be the official time for the On-line Bidding System closing.
- .3 The *Owner* is neither liable nor responsible for costs incurred by Bidders in the preparation, submission or presentation of the bid. Bidders will be required to accept on-line the Terms and Conditions of the On-line Bidding System in Clause 13.2 Terms and Conditions.
- .4 Bid documents become the property of the *Owner*.

### **11E. BID MODIFICATION AND WITHDRAWAL**

- .1 Bidders must comply with procedures for electronic bid modification and withdrawal established by the online bidding system.

### **12E. BID SECURITY REQUIREMENTS**

- .1 Digitally Verified Bid Bonds must be submitted through the online bidding system. Digitally verified Bid Bonds must be provided by the Bidder's Surety representative through one of the ebond providers assessed by the Surety Association of Canada. Bid Bonds must include a clearly legible signature and seal. The attachment by the Bidder of the Bid Bond with the on-line creates the lawful act of validating the bond by the Bidder.
- .2 Ensure the Bid Form is accompanied by a bid bond in the amount of ten percent (10%) of the Bid Price, Certified cheques and guaranteed letters of credit will **not** be accepted.
- .3 Ensure the bid bond is issued on a CCDC 220 Bid Bond form or other form approved by the Surety Association of Canada and issued by a Surety acceptable to the *Owner*.



- .4 If a successful Bidder declines to enter a Contract within the period set out in the Bid Form, or a further agreed period of time, the principal and surety will be required to pay to the *Owner* a sum equivalent to the difference between the principal's bid and the accepted bid or ten percent (10%) of the principal's bid, whichever is the lesser.
- .5 The bid bond must name the *Owner* as specified in the bid document as the obligee and must be signed, sealed, and dated by both Bidder and surety.

## **00 21 13 (con't) INSTRUCTION TO BIDDERS**

### **13. BID ACCEPTANCE**

- .1 The lowest or any bid will not necessarily be accepted.
- .2 The *Owner*, at its sole discretion, may accept or reject any or all of the Alternative Prices submitted in the Bid Documents. Alternative Prices will not be considered in determining the successful Bidder.
- .3 Alternative Prices listed in the Bid Documents will remain open for acceptance by the *Owner* for the period stated in the Bid Documents, from the time and date specified for closing of bids.
- .4 Bids which contain qualifying conditions or otherwise fail to conform to these Instructions to Bidders may, at the sole discretion of the *Owner*, be disqualified or rejected.
- .5 The *Owner* retains the separate right to waive minor irregularities in the Bid Form if such irregularities have not provided the Bidder with a competitive advantage.
- .6 In the event a single bid is received, the *Owner* may open the bid privately without reference to the Bidder. If the bid is opened and it is in excess of the *Owner's* budget, the *Owner* reserves the right to re-issue the Bid Documents for new public re-bid without revisions being made to the Bid Documents and without disclosing the single Bid Price. The *Owner* reserves the right to accept or reject a single bid.
- .7 The *Owner* has the right to enter into over-budget negotiations with the lowest compliant Bidder or a single Bidder, without cancellation of all bids or consideration to other Bidders, and to require that Bidder to negotiate with Subcontractors named on their Bid Form.

### **14. BID ACCEPTANCE PERIOD**

- .1 Bids will remain open to acceptance by the *Owner* and will be irrevocable until another Bidder enters into a contract with the *Owner* for performance of the Work or until expiry of the bid acceptance period stated in the Bid Form, whichever occurs first.
- .2 After bid closing and before expiry of the bid acceptance period stated in the Bid Form, the *Owner* may request all Bidders to agree to an extension of the originally specified bid acceptance period. In such case the bid acceptance period will be extended subject to the Bidder, whose bid the *Owner* wishes to accept, having agreed in writing to the extension.
- .3 Where the bidding for procurement of construction services for this project has a method where unofficial bid results are made available publicly after the bid closing time, and before expiry of the bid acceptance period stated in the Bid Form, the *Owner* may request all Bidders to agree to an extension of the originally specified bid acceptance period. In such case, the bid acceptance period will be extended, subject to the lowest compliant Bidder having agreed in writing to the extension.



## **15. WORKSAFE BC LETTER**

- .1 After bid closing, upon request, the lowest compliant Bidder agrees to provide a WORKSAFE BC Letter of Good Standing within forty-eight (48) hours.

END OF SECTION



**00 41 13 BID FORM - STIPULATED PRICE**

**Project/Contract:** Ladysmith RCMP - HVAC Upgrade

**Project/Contract No.:** 2026-PRC-01

**From (Bidder):** \_\_\_\_\_  
*company name*

\_\_\_\_\_  
*street address or postal box number city/town*

\_\_\_\_\_  
*province and postal code*

**Bidders Ph.** \_\_\_\_\_ **Bidders Fax.** \_\_\_\_\_

**Bidders Email** \_\_\_\_\_

**To (Owner):** Town of Ladysmith

We, the undersigned, having examined the Bid Documents for the above named project/ contract, including Addendum Number(s) \_\_\_\_\_, and being familiar with the site and existing conditions, hereby offer to perform the Work in accordance with the Bid Documents, for the stipulated bid price of:

\$ \_\_\_\_\_  
*amount in writing* in Canadian dollars, excluding Value Added Taxes.

\$ \_\_\_\_\_ in Canadian dollars, excluding Value Added Taxes.  
*amount in figures*

We, the undersigned, declare that:

a) Schedule:

We agree to attain *Ready-for-Takeover* within (*Contractor* to fill in) \_\_\_\_\_ weeks after receiving notice of contract award and the contract time noted herein WILL NOT be taken into account by the *Owner* in awarding the contract. The date of contract award will be the date the letter of award is sent to the Bidder.

We agree to attain *Ready-for-Takeover* within (*Contractor* to fill in) \_\_\_\_\_ weeks, taking into account the milestones and/or schedule noted in Division 01 of these Project Specifications, and after receiving notice of contract award. The contract



time noted herein MAY BE considered by the *Owner* in evaluating the bid and determining contract award. The date of contract award will be the date the letter of award is sent to the Bidder.

We agree to attain *Ready-for-Takeover* within (*Owner* to fill in) \_\_\_\_\_ weeks after receiving notice of contract award. This contract time is identified by the *Owner* based on the rational included in Part 1.3 Project Specific Amendments. The date of contract award will be the date the letter of award is sent to the Bidder.

- b. We have arrived at this bid without collusion with any competitor,
- c. This bid is open to acceptance by the *Owner* for a period \_\_\_\_\_ days from the date of bid closing, and
- d. All bid form supplements called for by the Bid Documents form an integral part of this bid.

**Signatures:**

Signed and submitted by:

\_\_\_\_\_  
*legal company name*

\_\_\_\_\_  
*name and title of authorized signing officer*

\_\_\_\_\_  
*signature of authorized signing officer*

\_\_\_\_\_  
*name of witness*

\_\_\_\_\_  
*signature of witness*

\_\_\_\_\_  
*name and title of authorized signing officer*

\_\_\_\_\_  
*signature of authorized signing officer*

\_\_\_\_\_  
*name of witness*

\_\_\_\_\_  
*signature of witness*

Dated this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_\_.



**□ Appendix 'A' – LIST OF SUBCONTRACTORS**

**Project/Contract:** Ladysmith RCMP - HVAC Upgrade  
**Project/Contract No.:** 2026-PRC-01  
**From (Bidder):** \_\_\_\_\_  
*company name*

The *Owner* has specified below the subcontractors are required to be named by the Bidder.

We, the above-named Bidder, intend to use for the above-named project the Subcontractors named below:

<b>□ <u>Item of Work</u></b>	<b><u>Name of Subcontractor</u></b>
1. [_____]	[_____]
2. [_____]	[_____]
3. [_____]	[_____]
4. [_____]	[_____]
5. [_____]	[_____]

The *Owner* cannot reject a bid on the basis of the subcontractor(s) named herein.

<b>□ <u>BOBS Section/Division</u></b> <i>Closing via BOBS per Section 00 21 13 Clause 7.2</i>	<b><u>Name of Subcontractor</u></b> <i>Closing via BOBS per Section 00 21 13 Clause 7.2</i>
1. [_____]	[_____]
2. [_____]	[_____]
3. [_____]	[_____]
4. [_____]	[_____]
5. [_____]	[_____]
6. [_____]	[_____]
7. [_____]	[_____]
8. [_____]	[_____]
9. [_____]	[_____]
10. [_____]	[_____]

All parties should refer to the BCDC Guide.



**□ Appendix 'B' – ALTERNATIVE PRICES**

**Project/Contract:** Ladysmith RCMP - HVAC Upgrade

**Project/Contract No.:** 2026-PRC-01

**From (Bidder):** \_\_\_\_\_  
*company name*

We, the above-named Bidder, offer the alternative prices requested below. The amount to be added to, or deducted from, our bid price (as entered in the Bid Form) is entered for each alternative requested. These prices do NOT include Value Added Taxes. If there is no change to the bid price for an alternative, we have so indicated. It is understood that:

- a. the *Owner* may accept any of the alternatives and corresponding alternative prices in any order or combination, including all or none,
- b. alternatives and alternative prices are open for acceptance by the *Owner* for the same period of time as the bid price, notwithstanding the award of the *Contract*.
- c. the *Work* of the *Contract* and the *Contract Price* will reflect the alternatives and alternative prices, if any, accepted by the *Owner* at the time of contract award, and
- d. acceptance of any alternatives will not affect the bid price contract completion time, unless we have specifically indicated an increase or decrease in time, in number of days, on account of a particular alternative.
- e. Acceptance of any alternative price will not affect the Listed Subcontractors on Appendix A unless it is noted below.

<u>Description of Alternative</u>	<u>Effect on Bid Price</u>		
	<u>Add</u>	<u>Deduct</u>	<u>Change to Listed Subcontractor</u> (if applicable)
Alternate Price No. 1			
	\$ _____	\$ _____	_____
Time (in Days)	_____	_____	



Alternate Price No. 2

Time (in Days)      \$ \_\_\_\_\_      \$ \_\_\_\_\_      \_\_\_\_\_

Alternate Price No. 3

Time (in Days)      \$ \_\_\_\_\_      \$ \_\_\_\_\_      \_\_\_\_\_

Alternate Price No. 4

Time (in Days)      \$ \_\_\_\_\_      \$ \_\_\_\_\_      \_\_\_\_\_

Alternate Price No. 5

Time (in Days)      \$ \_\_\_\_\_      \$ \_\_\_\_\_      \_\_\_\_\_



**□ Appendix 'C' – LIST OF UNIT PRICES**

**Project/Contract:** Ladysmith RCMP - HVAC Upgrade

**Project/Contract No.:** 2026-PRC-01

**From (Bidder):** \_\_\_\_\_  
*company name*

The following are our Unit Prices for the units of work listed hereunder. The Unit Prices listed apply to performing the units of work only during the Contract Time.

The below unit price(s) are intended for adjustment to the quantities, after contract award and as specified in the contract documents.

These prices do **NOT** include Value Added Taxes.

<u>Unit of Work</u>	<u>Unit Price (\$)</u>	
	<u>Add per unit</u>	<u>Deduct per unit</u>
[ ]	_____	_____
[ ]	_____	_____
[ ]	_____	_____
[ ]	_____	_____
[ ]	_____	_____
[ ]	_____	_____
[ ]	_____	_____
[ ]	_____	_____
[ ]	_____	_____
[ ]	_____	_____
[ ]	_____	_____



**□ Appendix 'D' – LIST OF CASH ALLOWANCES**

**Project/Contract:** Ladysmith RCMP - HVAC Upgrade

**Project/Contract No.:** 2026-PRC-01

**From (Bidder):** \_\_\_\_\_  
*company name*

We, the above named Bidder, have provided the Cash Allowance(s) included in our bid price (as entered in the Stipulated Price Bid Form) as requested below. These prices do **NOT** include Value Added Taxes.

<u>Description of Cash Allowance</u>	<u>Amount \$</u>
[ ]	[ ]
[ ]	[ ]
[ ]	[ ]
[ ]	[ ]
[ ]	[ ]
[ ]	[ ]
[ ]	[ ]
[ ]	[ ]
[ ]	[ ]
[ ]	[ ]
[ ]	[ ]
[ ]	[ ]
[ ]	[ ]
[ ]	[ ]
[ ]	[ ]





**□ Appendix 'F' - BID MODIFICATION**

(To be used where required)

**Project/Contract:** Ladysmith RCMP - HVAC Upgrade

**Project/Contract No.:** 2026-PRC-01

**Owner:** Town of Ladysmith

**From (Bidder):** \_\_\_\_\_

**Date:** \_\_\_\_\_

Submit by:

Fax \_\_\_\_\_

Email \_\_\_\_\_

*Bidders are to identify the project number and bid amendment in the email subject line*

Physical Address \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

WE HEREBY MODIFY OUR BID PRICE AS FOLLOWS:

	TO PREVIOUSLY SUBMITTED BID PRICE	FROM PREVIOUSLY SUBMITTED BID PRICE
	ADD	SUBTRACT
MODIFICATION TO BID PRICE (in figures)	\$ _____	\$ _____
MODIFICATION TO BID PRICE (in writing)	ADD / SUBTRACT	\$ _____

These prices do **NOT** include Value Added Taxes.

Other amendments including issued addendum numbers are (or reference and include by attachment):

\_\_\_\_\_



**AMENDMENT TO SCHEDULE**

If applicable, the amended change in time from the original bid is:

Add \_\_\_\_\_ calendar days/weeks; Subtract \_\_\_\_\_ calendar days/weeks.  
*Bidders are to cross out which does **not** apply, days or weeks*

**APPENDICES A, B, C AND D**

If changes are required to Appendices A, B, C, and D, they must be submitted on new Appendix submission forms. Where applicable, these prices are completely new prices as per Division 00 21 13 Clause 11P Instructions to Bidders.

LEGAL NAME OF BIDDER: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

TELEPHONE: \_\_\_\_\_ FAX: \_\_\_\_\_

EMAIL: \_\_\_\_\_

AUTHORIZED SIGNING OFFICER:

Name and Title: \_\_\_\_\_

Signature: \_\_\_\_\_

END OF SECTION



## 00 73 16 INSURANCE REQUIREMENTS

### 1 – OWNER PROVIDED INSURANCE

.1 Refer to GC 11.1 - INSURANCE, GC 12.1 - INDEMNIFICATION and Supplementary Condition(s).

### 2 – CONTRACTOR PROVIDED INSURANCE

.1 Refer to GC 11.1 - Insurance, GC 12.1 - Indemnification and Supplementary Condition(s).

END OF SECTION



## 00 73 63 CONTRACT SECURITY REQUIREMENTS

### PERFORMANCE BONDS AND LABOUR AND MATERIAL PAYMENT BONDS

- .1 The successful Bidder agrees to:
  - .1 Provide a Performance Bond and a Labour and Material Payment Bond each in the amount of fifty percent (50%) of the Contract Price.
  - .2 Provide these bonds within ten (10) Working Days of contract award. Maintain bonds in good standing until Contract fulfillment. Ensure requirements of GC 1 2.3 – WARRANTY are met and payment obligations arising under the Contract are made while bonds are still in place.
  - .3 Ensure the Performance Bond is issued on CCDC-221 Performance Bond form, and Labour and Material Performance Bond is issued on CCDC-222 Labour and Material Performance Bond form or other forms approved by the Surety Association of Canada and issued by a Surety acceptable to the *Owner*.
  - .4 Include bonding costs in the Bid Price.
  - .5 Ensure the obligee on the bonds is the *Owner*.

END OF SECTION



## **PART 1.3 SUPPLEMENTARY CONDITIONS**

*For use with CCDC 2-2020 Stipulated Price Contract*

### **ARTICLES**

Add new:

Article A-9 TIME IS OF THE ESSENCE

"Time is of the essence in the performance of the Contract."

### **GENERAL CONDITIONS OF THE STIPULATED PRICE CONTRACT**

#### **PART 2 ADMINISTRATION OF THE CONTRACT**

##### GC 2.3 REVIEW AND INSPECTION OF THE WORK

2.3.2 Add, in the first sentence "review," before the word "tests".

2.3.4 In the first sentence, replace "special" with "review," and add "review," before the third instance of "inspections".

Add new:

2.3.8 Should the *Consultant* be required to make more than one review of rejected work or should the *Consultant* perform additional reviews due to failure of the Work to comply with the application for status of completion made by the *Contractor*, the *Contractor* is required to compensate the *Owner* for such additional *Consultant* services including expenses incurred. Adjustment for such compensation should be made as outlined under PART 6 CHANGES IN THE WORK.

#### **PART 3 EXECUTION OF THE WORK**

##### GC 3.5 SUPERVISION

3.5.1 Add after the last sentence:

"The appointed *Contractor* representative shall not be changed without consultation with and written acceptance of the *Owner*. This acceptance shall not be unreasonably withheld."

##### GC 3.6 SUBCONTRACTORS AND SUPPLIERS

3.6.4 Add at the end of the sentence ", as outlined in GC 6.3 – CHANGE DIRECTIVE."



## **PART 4 ALLOWANCES**

### GC 4.1 CASH ALLOWANCES

- 4.1.2 Add, after the first sentence “Unless noted otherwise, none of the work included in the drawings and specifications is intended to be paid for by the cash allowances. The cash allowances are for the *Owner’s* use, at the *Owner’s* sole discretion.”

## **PART 5 PAYMENT**

Amend the heading “**GC 5.1 FINANCING INFORMATION REQUIRED OF THE OWNER**” to read “**GC 5.1 FINANCING INFORMATION REQUIRED**”

Delete paragraph 5.1.1 and 5.1.2 in their entirety and replace with:

- 5.1.1 The *Owner* and the *Contractor* shall provide each other with timely *Notice in Writing* of any material change in their financial ability to fulfill their respective obligations under the *Contract*.

### GC 5.2 APPLICATIONS FOR PAYMENT

- 5.2.4 Add, after the first sentence:  
“A secondary schedule, stating the anticipated monthly progress payments, is to be submitted upon request.”

Add new:

- 5.2.9 An application for payment shall be deemed received only if submitted complete with required supporting documentation as determined by the *Consultant*.

### GC 5.3 PAYMENT

- 5.3.1.1 Add another sentence:  
“If, after a certificate of payment has been issued to the *Owner* (and prior to payment by the *Owner*), the *Consultant* determines on the basis of new information that the amount certified for payment is inappropriately high or low relative to the value of the work performed, then the *Consultant* shall issue a revised certificate of payment, and promptly advise the *Contractor* in writing giving reasons for the amendment.”

Add new:

- 5.3.2 At the first application for payment following *Ready-for-Takeover*, the *Consultant* shall issue to the *Owner* and copy to the *Contractor*, a certificate for payment for an amount that deducts an amount equal to twice the value of any deficiencies as determined by the *Consultant*.



Add new:

- 5.3.3 Partial payment may not be made for the completion or correction of any deficiencies shown on the comprehensive list of items to be completed or corrected prior to the date of the issuance of the final certificate of payment.

#### GC 5.4 SUBSTANTIAL PERFORMANCE OF THE WORK AND PAYMENT OF HOLDBACK

- 5.4.1 Change "20 calendar days" to "10 days".

Add new:

- 5.4.7 At *Substantial Performance of the Work*, the *Consultant* shall issue a list itemizing the value of any items to be corrected or completed to the *Owner* and copy to the *Contractor*.

#### GC 5.5 FINAL PAYMENT

- 5.5.2 Change "calendar days" to "Working Days"
- 5.5.4 Change "5 calendar days" to "10 Working Days"

### **PART 6 CHANGES IN THE WORK**

#### GC 6.2 CHANGE ORDER

Add new:

- 6.2.3 The following shall determine *Contractor* markup on *Change Orders* by percentage:
- .1 To the cost of the *Work* performed by the *Contractor* directly, the *Contractor* may add a maximum of 20% markup for overhead and profit combined.
  - .2 To the cost of the *Work* performed by *Subcontractors* for the *Contractor*, before the *Subcontractor's* markup, the *Contractor* may add a maximum of 10% markup for overhead and profit combined.
  - .3 On *Work* deleted from the *Contract*, not covered by unit prices, the credit to the *Owner* shall be the cost of the *Work* as set out in GC 6.3 – CHANGE DIRECTIVE, article 6.3.7.
  - .4 For a detailed list of what the *Contractor* may include in the cost of the *Work* before adding markups, refer to GC 6.3 CHANGE DIRECTIVE, article 6.3.7.



### GC 6.3 CHANGE DIRECTIVE

Add new:

6.3.14 The following shall determine *Contractor* markup on *Change Directives* by percentage:

- .1 To the cost of the *Work* performed by the *Contractor* directly, the *Contractor* may add a maximum of 20% markup for overhead and profit combined.
- .2 To the cost of the *Work* performed by Subcontractors for the *Contractor*, before the Subcontractor's markup, the *Contractor* may add a maximum of 10% markup for overhead and profit combined.
- .3 On *Work* deleted from the Contract, not covered by unit prices, the credit to the Owner shall be the cost of the *Work* as set out in GC 6.3 – CHANGE DIRECTIVE, article 6.3.7.

### GC 6.5 DELAYS

6.5.3.3 Add the word "local" after the word "adverse".

Add new:

6.5.6 The party making the claim shall submit to the *Consultant*, within 10 *Working Days*, an estimated quantum of the claim and of the *Contract Time* extension claimed, and the grounds upon which the claim is based complete with required supporting documentation as determined by the *Consultant*.

Add new:

- 6.5.7 Should the *Consultant*, in consultation with the *Contractor*, determine the *Contractor* is delayed in performance of the *Work*, or any part thereof, by the *Contractor's* inaction, or by delay or inaction of anyone employed or engaged by the *Contractor* directly or indirectly, and the *Contract Time* is compromised:
- .1 Then the *Contractor* shall accelerate the *Work* as required to meet the *Contract Time*.
  - .2 The *Consultant* will promptly give *Notice in Writing* of such determination to the *Owner* and the *Contractor*.
  - .3 The *Contractor* shall then promptly give the *Owner* and the *Consultant* *Notice in Writing* of specific changes to the construction scheduling and construction processes the *Contractor* will implement to accelerate the *Work*.
  - .4 The *Contractor* shall not be entitled to payment for costs to accelerate the *Work* to meet the *Contract Time*.
  - .5 If either party does not accept the *Consultant's* determination, the disagreement shall be settled in accordance with Part 8 of the General Conditions – DISPUTE RESOLUTION. It being understood that by so doing neither party will jeopardize any claim the party may have to be reimbursed.



## GC 6.6 CLAIMS FOR A CHANGE IN CONTRACT PRICE

6.6.1 Delete: "Timely" and add "10 Working Days from the event or series of events giving rise to the claim"

## **PART 7 DEFAULT NOTICE**

### GC 7.1 OWNER'S RIGHT TO PERFORM THE WORK, STOP THE WORK, OR TERMINATE THE CONTRACT

7.1.5 In the first sentence, after "paragraph 7.1.1," replace "and" with "or".

## **PART 9 PROTECTION OF PERSONS AND PROPERTY**

### GC 9.4 CONSTRUCTION SAFETY

Add to end of 9.4.1: "and be designated as the prime contractor"

## **PART 10 GOVERNING REGULATIONS**

### GC 10.2 LAWS, NOTICES, PERMITS, AND FEES

Add new:

10.2.8 The *Contractor* shall provide to the *Consultant* copies of all inspection reports from the various authorities having jurisdiction within two *Working Days* of their receipt.

### GC 10.4 WORKERS' COMPENSATION

Add new:

10.4.2 The *Contractor* is formally designated as the "prime contractor."

## **PART 12 OWNER TAKEOVER**

### GC 12.2 EARLY OCCUPANCY BY THE OWNER

Add new:

#### GC 12.2.5

The *Owner* may take possession of and use completed or partially completed portion of the *Work*, in addition to occupancy conditions included in the Contract, providing:

- .1 Only as agreed by the Contractor, such agreement will not be unreasonably withheld.
- .2 the portion of the *Work* is ready to be used for the purpose intended, to the satisfaction of the *Consultant* and authorities having jurisdiction; and
- .3 the *Owner's* possession and use do not interfere with the Contractor's *Work*; and
- .4 the *Consultant* conducts a review prior to possession by the *Owner*; and
- .5 any extra costs are borne by the *Owner*, subject to the provisions of GC 6.5 Delays.



### GC 12.3 WARRANTY

12.3.4 Add a second sentence "In effecting a correction of defects or deficiencies, the *Contractor* shall also bear all costs involved in removing, replacing, repairing, or restoring aspects of the *Work* that may be affected in the process of making the correction."

Add new:

12.3.7 Where a material, product or installation referenced in 12.3.1 covered by warranty fails, the stipulated warranty and warranty period shall be renewed for the specific work being replaced or repaired, with the exception of warranties referred to in GC 12.3.6. Such extended warranties referenced in 12.3.1, shall not exceed one year from the date of removing, replacing, repairing, or restoring.

Add new:

## **PART 14 MISCELLANEOUS**

### 14.1 CONFIDENTIALITY

14.1.1 All information provided by or obtained from the *Owner* in any form in connection with the *Project*:

1. is the sole property of the *Owner* and must be treated as confidential;
2. is not to be used for any purpose other than the performance of the *Work*;
3. is not to be disclosed without prior written authorization from the *Owner*; and
4. must be returned to the *Owner* immediately upon request.

### 14.2 INFORMATION TECHNOLOGY RELATED THREATS

14.2.1 The *Contractor* shall notify the *Owner* and its mutual affiliates, as soon as reasonably possible, of any information technology related threat that may be transmitted electronically to the *Owner* or any of its affiliates which includes but is not limited to: viruses, rogue security software, trojan horses, spyware, computer worms, phishing, rootkits and any real or perceived electronic attack (the "IT Threat").

14.2.2 In the event the *Owner* becomes aware of an IT Threat, the *Owner* may as soon as reasonably possible, notify any organization that it reasonably believes could be exposed to the same IT Threat and include in such notification any relevant details for the purpose of avoiding or minimizing any negative impact.



## **Part 1.4: DIVISION 01 GENERAL REQUIREMENTS:** **Recommended Modifications**

*These are BCDC recommended modifications to the CCDC Division 01*

### **SECTION 01 11 00 SUMMARY OF WORK**

#### 1.8 OWNER-SUPPLIED PRODUCTS

##### .2 Contractor Responsibilities:

Add:

“.13 Provide to the *Consultant* copies of all inspection and testing reports within two *Working Days* of their receipt.”

### **01 26 00 CONTRACT MODIFICATION PROCEDURES**

#### 1.6 FEES FOR OVERHEAD AND PROFIT – CHANGE ORDERS

*Note to editor: These clauses for Section 01 26 00, 1.6 Fees for Overhead and Profit – Change Orders are captured in the Supplementary Conditions and should not be duplicated in the Division 01.*

### **Section 01 29 00 PAYMENT PROCEDURES**

#### 1.1 SCHEDULE OF VALUES

*Note to editor: These clauses for Section 01 29 00, 1.1 Schedule of Values are captured in the Supplementary Conditions and should not be duplicated in this Division 01.*

### **01 33 00 SUBMITTAL PROCEDURES**

#### 1.1. ADMINISTRATIVE

1.4: Add after the word “data” in the first sentence, “models, mock-ups,”

### **CCDC 01 77 00 - CLOSEOUT PROCEDURES**

#### 1.2 INSPECTION AND REVIEW BEFORE *READY-FOR-TAKEOVER*

1.2.4: Delete after the word “until” in the second sentence, “the *Work* is *Ready-for-Takeover* and“

#### 1.5 SUBSTANTIAL PERFORMANCE OF THE WORK

1.5.1: Add after the word “attaining” the following: “*Substantial Performance of the*”

**THIS PAGE REPRESENTS THE  
CANADIAN CONSTRUCTION DOCUMENTS COMMITTEE  
STIPULATED PRICE CONTRACT CCDC-2 (2020)**

**END OF STIPULATED PRICE CONTRACT  
SECTION 00700**

## Schedule “B”

### Evaluation Process

#### **TECHNICAL EVALUATION**

Tenders will be evaluated by a minimum of two Ladysmith staff. The scoring criteria shown below will be used to assist in the evaluation; however, the highest scoring tender will not necessarily be selected. Other evaluation criteria may impact the selection, such as an interview, reference checks, or value-added services.

#### COSTS INCLUDED IN TENDER EVALUATION

All personnel fees, salaries, wages and reimbursable expenses will be considered in the tender evaluation. Points will be awarded based on a combination of rates, proposed budget relative to scope, suitable budget allocation to tasks, and value.

#### MINIMUM TECHNICAL SCORE

Each technical presentation will be evaluated on the basis of the firm's experience, competence of its personnel and acceptability of the method proposed. Technical portions of tenders must achieve a score of at least 70% to be considered “technically qualified”.

#### SCORING

The table below describes the weighting that will be used to evaluate all tenders.

<b>THE METHOD</b>	<b>40</b>
General Approach	8
Proposed list of activities and reporting	10
Understanding of objectives	12
Proposed level of effort	10
<b>FIRM PROFILE</b>	<b>10</b>
Experience with similar projects	5
Location of the firm	2
Practices and/or policies within the organization governing its work with First Nations	3

<b>THE PERSONNEL</b>	<b>15</b>
Project Manager - How will they support the delivery of services by the firm? - What is their experience with similar projects on Vancouver Island and within BC? - Provide details on times when they challenged conventional wisdom and/or engineering standards in order to provide the best solution for the client.	5
Project Members - Provide a half-page bio of why each key staff member is suited for this role. Include project examples showcasing experience, qualifications, and local knowledge.	5
Team Organization	5
<b>PRESENTATION</b>	<b>10</b>
Quality - clear and concise	5
Content -relevant information provided without redundancies	5
<b>PRICE PROPOSAL</b>	<b>25</b>
Cost	15
Breakdown of costs	10
<b>TOTAL</b>	<b>100</b>

#### INTERVIEWS AND REFERENCES

The Town may request an interview and/or reference check with any or all shortlisted firms. An interview format has not been determined and would likely focus on areas of a tender that are unclear to the evaluation team. The outcome of an interview would be used in the evaluation. If an interview is requested, an in-person or Microsoft Teams online meeting would be made available.

## Schedule “C”

### Participants and Site

**OWNER**                      **Town of Ladysmith**  
(FOR TENDER                410 Esplanade, PO Box 220  
CLOSING)                    Ladysmith, British Columbia  
                                      (SUBMIT BIDS ELECTRONICALLY, SEEPAGE 3, SECTION 2,)

#### Make Bids to the Attention of:

Contact:                      Sue Bouma– Manager of Corporate Services

**Amendments to Previously Submitted Bids to the Attention of:**  
(submitted electronically, via [BCBid](#))

Contact:                      Sue Bouma – Manager of Corporate Servies  
                                      bid@ladysmith.ca

#### For Further Information about the Project:

Contact:                      Richard Frost – Manager of Facility Operations  
                                      rfrost@ladysmith.ca

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**SITE**                              **Ladysmith RCMP**  
                                      320 6th Ave.  
                                      Ladysmith, BC V9G 1A2  
                                      Telephone: (250.245.2215)

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**PRIME AND**                      **ROCKY POINT ENGINEERING LTD.**  
**MECHANICAL**                301-17 Church Street,  
**CONSULTANT**                Nanaimo, BC V9R 5H5

Contact:                      Kyle Lorondeau, ASCT  
                                      Project Manager  
                                      kyle.lorondeau@rpeng.ca

Aaron Mullaley, *P.L.Eng. (BC/AB), ASCT, PTech, LEED®AP*  
Principal  
aaron.mullaley@rpeng.ca  
Telephone: (250) 585-0222

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## Schedule “D”

### Contract General Conditions

GENERAL CONDITIONS
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#### 1.0 Payment

Payment by the Town, subject to any holdbacks under the *Builder's Lien Act (British Columbia)* or any amounts held back under the Contract for deficiencies or other reason will be made within thirty (30) days after completion of the Work and/or delivery of tendered equipment, receipt of invoice, and acceptance by the Town. The Work will not be accepted for payment until all conditions and tendered specifications have been met.

#### 2.0 Notices

Any notice required to be given in this contract shall be deemed to be duly given to the Town if sent by registered mail addressed to the Town of Ladysmith, PO BOX 220, Ladysmith, B.C. V9G 1A2 and to the contractor if sent by registered mail at the address set forth in the Tender.

#### 3.0 Ownership of Tender & Freedom of Information and Confidentiality

All documents submitted in response to this Tender shall become the property of the Town and as such will be subject to the disclosure provisions of the *Freedom of Information and Protection of Privacy Act*.

The Tenderer should advise the Town in writing if any information is supplied as part of the Tender processing confidence and to which section 21 of the *Freedom of Information and Protection of Privacy Act* applies.

#### 4.0 Queries

All queries regarding the technical specifications forming part of this Tender may be made by contacting the parties outlined in Schedule “C”.

#### 5.0 Indemnification

5.1 In carrying out these works, the Supplier will act as an independent contractor and must agree to keep the Town indemnified against any and all claims, actions or demands that may be brought, made or arise in respect of anything done or omitted to be done by its employees who shall be and remain at all times and for all purposes, the servants or employees of the Supplier.

## **6.0 Insurance**

6.1 The Supplier shall submit to the Town, upon acceptance of the tender, a Certificate of Insurance containing the following:

- a provision naming Town of Ladysmith as an additional insured to the Liability Policy;
- a Cross Liability Clause;
- Comprehensive General Liability in an amount not less than **\$5,000,000.00**;
- A provision requiring the Insurer to give the Town 30 days' notice of cancellation or lapsing or any material change in the insurance policy;
- Liability insurance in an amount not less than **\$5,000,000.00** with the Insurance Corporation of British Columbia on any licensed motor vehicles of any kind.

## **7.0 Safety**

7.1 In tendering for this work, the Supplier, when called upon to enter into contract with the Town, will be bound to comply with and be subject to the provisions, rules and regulations of the Workers' Compensation Act, and with all other Statutes and Municipal by-laws pertaining to the work.

7.2. All materials delivered and services provided must be in accordance with all laws, regulations and requirements of B.C. Workers' Compensation Board and Occupational Health and Safety Legislation.

7.3 Proof of WorkSafe registration must be submitted, along with proof of up-to-date assessment payment, prior to commencement of work.

## **8.0 Sub-contracting**

8.1 Sub-contracting of work is not permitted without prior approval, in writing, from the Director of Infrastructure Services.

## **9.0 Quantities**

9.1 Anticipated quantities listed in the tender forms are estimated annual requirements based on historical and anticipated usage. The Town will not be responsible for any variations in usage.

## **10.0 Cancellation**

10.1 The Town reserves the right to cancel this Tender at any time and for any reason, and will not be responsible for any loss, damage, cost or expense incurred or suffered by any Tenderer as a result of that cancellation.

10.2 The Town reserves the right to cancel the Contract, at its sole and absolute discretion, with 30 days' written notice to the Contractor, and the Contractor will have no rights or claims against the Town. Cancellation would not, in any manner whatsoever, limit the Town's right to bring action against the Contractor for damages for breach of contract.

### **11.0 Tenderers' Expenses**

11.1 Tenderers are solely responsible for all their own costs/expenses relating to the preparation and submission of tenders. If the Town elects to reject all tenders, the Town will not be liable to any tenderer for any claims, whether for costs or damages incurred by the tenderer in preparing the tender, loss of anticipated profit in connection with any final Contract, or any other matter whatsoever.

### **12. Limitation of Damages**

12.1 Without limiting the provision of the previous clause, the Tenderer, by submitting a Tender, agrees that it will not claim damages, for whatever reason, relating to the Contract or in respect of the competitive process, including any costs incurred by the Tenderer in preparing its Tender and the Tenderer, by submitting a Tender, waives any claim for loss of profits if no Contract is made with the Tenderer.

### **13. Responsibility of Tenderers**

13.1 Each tenderer is responsible for informing themselves as to the contents and requirement of this tender including the Town's Purchasing Policy, which governs the award of this tender. The Purchasing Policy may be requested from City Hall. Each tenderer is solely responsible to ensure that they have obtained and considered all information necessary to understand the requirements of the tender and to prepare and submit their tender. The Town will not be responsible for any loss, damage or expense incurred by a tenderer as a result of any inaccuracy or incompleteness in this tender, or as a result of any misunderstanding or misinterpretation of the terms of the tender on the part of any tenderer.

13.2 If a Tenderer is in doubt as to the true meaning of any part of this Tender, or finds omissions, discrepancies or ambiguities, a request for interpretation or correction may be submitted to the office of Manager of Legislative Services and, if deemed necessary by the Town, an addendum will be issued to all firms registered as having received this Tender. This procedure also applies should the Town, of its own accord, wish to expand or delete any part of this Tender.

### **14. Accuracy of Information**

14.1 The Town makes no representation or warranty, either expressed or implied, with respect to the accuracy or completeness of any information contained in or referred to in the Tender.

**15. Dispute Resolution**

15.1 In the event of a dispute between the Town and the Supplier, both parties agree to appoint representatives who, in good faith, will use their best efforts to resolve the dispute.

15.2 Should the representatives be unable to promptly resolve the dispute, both parties shall agree to continue the work as required, being understood that neither party will jeopardize any claim that they may have.

15.3 Further to clause 15.2, both parties agree to resolve the dispute using a single arbitrator as provided for under the Commercial Arbitration Act of British Columbia with the costs being split equally between the parties.

15.4 Any verbal representations, promises, statements or advice made by any employees of the Town, other than that offered through the Manager of Legislative Services, should not be relied upon.

**Schedule E**

**Division 20 Mechanical**

**Division 23 Heating, Ventilating, and Air Conditioning (HVAC)**

**Division 25 Integrated Automation**

## 1 GENERAL

### 1.1 Application

- .1 This Section specifies requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and shall be read accordingly.

### 1.2 Note Re: Bold Lettering

- .1 "**Bold**" type lettering is used throughout this Specification in an attempt to enhance the readability of the text. The use of "**bold**" lettering does not indicate a greater level of importance.

### 1.3 Submittals

- .1 As specified in this Section, submit the following to the Consultant:
  - .1 **Notice for field reviews:** written notice for attendance at the site for field reviews.
  - .2 **Project close-out documentation:** O & M Manuals, record as-built drawings, and all associated data.
  - .3 **Progress payment breakdown:** a detailed breakdown of the mechanical work cost.
  - .4 **Contractor's P.Eng. Documentation:** the name, qualifications, and evidence of current liability insurance for all professional engineers to be retained by the Contractor to perform work associated with the Contract.
  - .5 **Extended Warranties:** copies of all extended warranties specified, and in the name of the Owner.
  - .6 **O & M Training Schedules & Modules:** a proposed schedule of demonstration and training dates and times.

### 1.4 Definitions

- .1 The following are definitions of words found in mechanical work Sections of the Specification and on associated drawings:
  - .1 "Concealed" – means work hidden from normal sight in furred spaces, shafts, tunnels, ceiling spaces, walls, and partitions.
  - .2 "Exposed" – means work normally visible, including work in equipment rooms and similar spaces.
  - .3 "Provide" (and tenses of provide) – means supply and install complete.
  - .4 "Install" (and tenses of install) – means install and connect complete.
  - .5 "Supply" – means supply only.
  - .6 "Finished area" - means any area or part of an area which receives a finish such as paint, or is factory finished.
  - .7 "Governing authority" and/or "regulatory authority" and/or "Municipal authority" – means all government departments, agencies, standards, rules and regulations that apply to and govern the mechanical work and to which the work must adhere.
  - .8 "Consultant" – means the Architect or Consulting Engineer who has prepared the Contract Documents on behalf of the Owner.
- .2 Wherever the words "indicated", "shown", "noted", "listed", or similar words or phrases are used in the specification they are understood, unless otherwise defined, to mean that the product referred to is "indicated", "shown", "listed", or "noted" on the drawings.
- .3 Wherever the words "approved", "satisfactory", "as directed", "submit", "permitted", "inspected" or similar words or phrases are used in the specification or on the drawings they are understood, unless otherwise defined, to mean that work or product referred to is "approved by", "inspected by", etc., the Consultant. In the mechanical specification, singular may be read as plural, and vice-versa.

### 1.5 Quality Assurance

- .1 All mechanical work shall be done by journeyman tradesmen who perform only the work that their certificates permit, or by apprentice tradesmen under direct on-site supervision of

an experienced journeyman tradesman. The use of apprentice tradesmen shall be limited and the journeyman/apprentice ratio is 1 journeyman for every 2 apprentices.

- .2 All journeyman tradesmen are to have valid trade certificates available at the site for review by the Consultant at any time.
- .3 An experienced and qualified superintendent shall be on-site at all times when mechanical work is being performed.
- .4 Submit to the Consultant for review, a Quality Assurance Programme within 21 days of Contract award. Upon review and acceptance, the programme shall be implemented for the duration of the Contract.

### **1.6 Codes, Regulations, and Standards**

- .1 All Codes, Regulations, and Standards referred to in this Section and in Sections to which this Section applies are the latest edition of the Codes, Regulations, and Standards in effect at the time of issue of a building permit or bidding on this Project, whichever comes first.
- .2 All work shall be in accordance with requirements with Codes, Regulations, and Standards applied by governing authorities, including:
  - .1 The British Columbia Building Code.
  - .2 The British Columbia Plumbing Code
  - .3 Inspection branches of Technical Safety BC.
  - .4 Technical Safety BC.
  - .5 WorkSafe BC
  - .6 Canadian Standards Association  
Municipal and City ByLaws
  - .7 British Columbia Electrical Code
- .3 All mechanical piping system work, including equipment, must comply in all respects with requirements of local technical standards authorities and CSA Standard B51, Boiler, Pressure Vessels and Pressure Piping Code. Where required, mechanical work products must bear a CRN number.
- .4 Where any governing Code, Regulation, or Standard requires preparation and submission of special details or drawings for review they are to be prepared and submitted. Pay all associated costs associated with these submittals.
- .5 All electrical items associated with mechanical equipment are to be certified and bear the stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, etc., or bear a stamp to indicate special electrical utility approval.
- .6 Requirements of the Contract Documents are to take precedence when they are more stringent than codes, ordinances, standards, and statutes.
- .7 Ventilation systems and equipment are to be installed and conform to ASHRAE and SMACNA standards.

### **1.7 Imperial and Metric Measurements**

- .1 Conform to requirements of CAN/CSA-Z234.1, Canadian Metric Practice Guide.
- .2 If both Metric and Imperial units of measurement are indicated in the Mechanical Specification, Metric measurements are "soft" and have been rounded off.

### **1.8 Examination of Site and Documents**

- .1 When estimating the cost of the work and prior to submitting a bid for the work carefully examine all of the bid documents and visit the site to determine and review all existing site conditions that will or may affect the work, and include for all such conditions in the bid price.
- .2 Report to the Consultant, prior to bid submittal, any existing site condition that will or may affect performance of the work as per the drawings and specifications. Failure to do so will not be grounds for additional costs.

### 1.9 Drawings and Specification

- .1 Read the mechanical work drawings in conjunction with all other structural, architectural, sprinkler, electrical, etc., drawings and, where applicable, the Code Consultant's report.
- .2 The mechanical drawings are performance drawings, diagrammatic, and show approximate locations of equipment and connecting services. Any information regarding accurate measurement of the building are to be taken at the site. Do not scale the drawings, and do not use the drawings for prefabrication work.
- .3 The drawings are intended to convey the scope of work and do not show architectural and structural details. Provide, at your cost, all offsets, fittings, transformations, and similar products required as a result of obstructions and other architectural and structural details not shown on the drawings.
- .4 The locations of equipment and materials shown may be altered, when reviewed by the Consultant, to meet requirements of the equipment and/or materials, other equipment or systems being installed, and of the building, all at your cost.
- .5 Sections of the mechanical specification are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and the Sections are to be read as a whole.
- .6 The mechanical specification does not generally indicate the specific number of items or extent of material required. The specification is intended to provide product data and installation requirements. It is necessary to refer to drawing schedules, layouts, schematic diagrams, riser diagrams, and details to determine correct quantities.
- .7 The mechanical drawings and specification are intended to be cooperative. Perform all work that is shown, specified, or reasonably implied on the drawings but not mentioned in the specification, or vice-versa, as though fully covered by both.
- .8 The mechanical drawings and specifications have been prepared solely for the use by the party with whom the Consultant has entered into a contract and there are no representations of any kind made by the Consultant to any other party.
- .9 When the scale and date of the drawings are the same, or when the discrepancy exists within the specification, the costliest arrangement will take precedence.
- .10 In the case of discrepancies between the drawings and specifications, the documents will govern in the order specified in the General Conditions, however, when the scale and date of the drawings are the same, or where the discrepancy exists within the specification, the costliest arrangement will take precedence.

### 1.10 Planning and Layout of The Work, and Associated Drawings

- .1 Properly plan, coordinate, and establish the locations and routing of services with general contractor and all subcontractors affected prior to installation such that the services will clear each other as well as any obstructions, including structural components of the building. Unless otherwise specified, the order of right-of-way for services shall be as follows:
  - .1 Piping requiring uniform pitch.
  - .2 Piping 100 mm (4") diameter and larger.
  - .3 Large ducts (main runs).
  - .4 Electrical cable tray and bus duct.
  - .5 Conduit 100 mm (4") diameter and larger.
  - .6 Piping less than 100 mm (4") diameter.
  - .7 Smaller branch ductwork.
  - .8 Conduit less than 100 mm (4") diameter.
- .2 Unless otherwise shown or specified, conceal all work in finished areas, and conceal work in partially finished or unfinished areas to the extent made possible by the area construction. Install piping, ductwork, and similar services as high as possible to conserve headroom and/or ceiling space. Notify the Consultant where headroom or ceiling space

appears to be inadequate prior to installation of the work and where location of valves and equipment requiring maintenance access appears to be too high for ease of access.

- .3 Revise or alter the arrangement of work that has been installed without proper coordination, study and review, even if it was completed in accordance with the Contract Documents, in order to conceal the work behind finishes, or to allow the installation of other work, at no additional cost. In addition, pay for the cost of alterations in other work required by the alterations to your work.
- .4 All shut-off valves, balancing devices, air vents, equipment and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.
- .5 Relocate improperly located holes and sleeves.
- .6 Drill for expansion bolts, hanger rods, brackets and supports. Obtain written approval from Consultant prior to altering structural members.
- .7 **Layout Drawings:** Do not use the Contract Drawing measurements for prefabrication and layout of piping and sheet metal work. Locations and routing are to generally be in accordance with the Contract Drawings, however, layout drawings are to be prepared for all such work. Use established bench marks for both horizontal and vertical measurements. Confirm inverts, coordinate with and make allowances for the work of other trades, accurately layout the work, and be entirely responsible for all work installed in accordance with layout drawings. Where any invert, grade, or size is at variance with the Contract Drawings, notify the Consultant prior to proceeding with the work.
- .8 **Interference Drawings:** Prepare dimensioned working interference drawings, supplementary to the Contract Drawings for all areas where multiple services and/or equipment occur, or where the work due to architectural and structural considerations requires special study and treatment. Review interference drawings with the Consultant before the work is installed. Where your work has been installed in such areas without preparation of interference drawings and conflicts occur, revise your work to suit at no additional cost.

#### **1.11 Alteration Works**

- .1 Where existing utilities are removed, relocated, or abandoned, cap, valve, plug, or by-pass to make a complete and working installation.
- .2 A "complete and working installation" includes providing new surfaces identical to the ones removed or disturbed and matching adjacent surfaces with no visible difference between new and existing.
- .3 Where repainting of a surface is required, paint the entire surface between the nearest adjacent corners, i.e. the entire plane of the surface containing the disturbed area.
- .4 Where concealed conditions differ from those indicated on the drawings, immediately notify the Consultant.

#### **1.12 Coordination of the Work**

- .1 Review all the Contract Documents and coordinate the work with the work of all subcontractors. Coordination requirements are to include, but not be limited to, the following:
  - .1 Preparation of electronic coordination drawings as required, submitted as for shop drawings, with drawing scale as required to indicate the necessary details.
  - .2 Written notification of all concrete work such as housekeeping pads, sumps, bases, etc., required for mechanical work, and including required dimensions, operating weight of equipment, location, etc.
  - .3 Depth and routing of excavation required for mechanical work, and requirements for bedding and backfill.

- .4 Schematic wiring for all wiring work required for mechanical equipment and systems but not specified to be done as part of the mechanical work, including termination points, wiring type and size, and any other requirements.

#### 1.13 General Re: Installation of Equipment

- .1 Unless otherwise specified all equipment shall be installed in accordance with the equipment manufacturer's recommendations and instructions, Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions.
- .2 Ensure that proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Remove and replace any equipment which does not meet this requirement.

#### 1.14 Energy Efficiency Standards

- .1 All applicable mechanical equipment has been selected to meet energy efficiency requirements of the Model National Energy Code of Canada for Buildings or ANSI/ASHRAE/IESNA 90.1, Energy Standards for Buildings, and shop drawings/product data submittals for such equipment must indicate compliance with this Standard or they will be returned for correction and re-submittal.

#### 1.15 Permits, Fees, and Certificates

- .1 Apply for, obtain and pay for all permits required to complete the mechanical work.
- .2 Submit to the Consultant, all approval/inspection certificates issued by governing authorities to confirm that the work as installed is in accordance with the rules and regulations of the governing authorities. Pay any costs associated with issue of the certificates.
- .3 Include a copy of all approval/inspection certificates in each operating and maintenance manual.

#### 1.16 Workplace Safety

- .1 Comply with requirements of the Workplace Hazardous Materials Information System (WHMIS) regarding the use, handling, storage and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for all products where required, and maintain one copy at the site in a visible and accessible location available to all personnel.
- .2 Comply with all requirements of WorkSafe BC Occupational Health and Safety Regulations and all other regulations pertaining to health and safety, including worker's compensation/ insurance board and fall protection regulations.
- .3 **Asbestos, Mould, Lead Paint, Etc.:** If at any time during the course of the work asbestos containing materials, black mould, lead paint, or any other such materials are encountered or suspected, immediately report the discovery to the Consultant and cease all work in the area in question. Do not resume work in affected areas until the situation has been properly corrected and without written approval from the Owner.

#### 1.17 Fall Restraint for Roof Mounted Equipment

- .1 Wherever possible, locate roof mounted mechanical equipment or access hatch a minimum of 2 m from the edge of any roof 3 m or higher above the surrounding grade.
- .2 Where mechanical equipment or hatches are located within 2 m from the edge of any roof 3 m or higher above the surrounding grade, supply roof anchors (a minimum of 2 per piece of equipment or roof hatch) capable of withstanding a minimum live load of 800 lb. in any direction and to which personal fall restraint equipment can be secured, and coordinate installation with the roofing trade. Refer also to Part 11 of the WorkSafe BC Occupational Health and Safety Regulations.
- .3 Retain the services of a Professional Engineer registered in the Province of British Columbia to ensure that the fall restraint anchors provided are of adequate capacity and

correctly installed, and to certify in writing (with signed professional stamp) that the anchor installations have been inspected on-site and are correctly installed and of adequate capacity. Submit the certification to the Consultant.

#### 1.18 Shop Drawings and Product Data Sheets

- .1 Prior to supplying any products to the site, submit for review, shop drawings and/or product data sheets indicating in detail the design, construction, and performance of products as requested in Sections of this Specification. The number of copies of shop drawings and/or product data sheets will be as later directed.
- .2 Shop drawings are those prepared specifically for the Project. Product data sheets are copies of manufacturer's standard catalogue, etc., literature.
- .3 Unless otherwise specified or required, submit shop drawings/product data sheets via email in AutoCAD or PDF format only.
- .4 Wherever possible, shop drawings and/or product data sheets are to be 216 mm x 280 mm (8½" x 11"), 216 mm x 356 mm (8½" x 14"), or 356 mm x 432 mm (11" x 17"), with sufficient clear space for review stamps, comments, and identification as specified below.
- .5 Shop drawings and product data sheets must confirm that the product proposed meets all requirements of the Contract Documents.
- .6 Each shop drawing or product data sheet shall be properly identified with the project name and the product drawing or specification reference, i.e. "Exhaust Fan EF-1", and all shop drawing or product data sheet dimensions are to be either SI or Imperial to match dimensions on the drawings.
- .7 Where any item of equipment is required by Code or Standard or By-Law to meet a specific energy efficiency level, or any other specific requirement, ensure that this requirement is clearly indicated on the submission.
- .8 Carefully review each shop drawing and product data sheet prior to submittal to ensure that the proposed product is correct and meets with all requirements of the Project. Endorse each copy of each shop drawing or product data sheet "Correct for Review By Consultant", or "Certified to Be In Accordance with All Requirements" and include your company name, the submittal date, and the signature of an officer of your company to indicate your review and approval as above.
- .9 The Consultant will review shop drawings and product data sheets and will indicate the review status by stamping the shop drawings and product data sheets as follows:
  - .1 **"Reviewed" or "Reviewed as Modified"** to indicate that his review is final and no re-submittal is required.
  - .2 **"Revise and Resubmit"** to indicate that the submission is rejected and shall be revised in accordance with comments marked on the shop drawings and product data sheets by the Consultant and re-submitted.
  - .3 **"Not Reviewed"** to indicate that the submission has not been reviewed.
- .10 The following shall be read in conjunction with the wording on the Consultant's review stamp applied to each and every mechanical work shop drawing or product data sheet submitted:

"This review is for the sole purpose of ascertaining conformance with the general design concept. This review does not approve the detail design inherent in the shop drawings, responsibility for which remains with the Contractor, and such review does not relieve the Contractor of the responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. Be responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation, and for coordination of the work of all sub-trades."

**1.19 Changes or Revisions to the Work**

- .1 Whenever the Consultant proposes in writing to make a change or revision to the design, arrangement, quantity or type of any work from that required by the Contract Documents, prepare and submit to the Consultant for approval, a quotation being your proposed cost for executing the change or revision.
- .2 Your quotation shall be a detailed and itemized estimate of all products, material, labour, and equipment costs associated with the change or revision, plus overhead and profit percentages and all applicable taxes and duties.
- .3 Unless otherwise stated in the Contract Documents, the following requirements apply to all quotations submitted:
  - .1 When the change or revision involves deleted work as well as additional work, the cost of the deleted work (less overhead and profit percentages but including taxes and duties) shall be subtracted from the cost of the additional work before overhead and profit percentages are applied to the additional work.
  - .2 Material costs are not to exceed those published in local estimating price guides such as Allpriser or RS Means, less applicable trade discounts.
  - .3 Costs for journeyman and apprentice labour must not exceed prevailing rates at the time of execution of the Contract and must reflect the actual personnel performing the work.
  - .4 Cost for the site superintendent must not exceed 10% of the total hours of labour estimated for the change or revision, and the change or revision must be such that the site superintendent's involvement is necessary.
  - .5 Costs for rental tools and/or equipment are not to exceed local rental costs.
  - .6 If overhead and profit percentages are not specified in the General Conditions of the Contract, Supplementary Conditions, or elsewhere in preceding Sections of the Specification, but allowable under the Contract, then allowable percentages for overhead and profit are to be 10% and 10% respectively.
  - .7 The overhead percentage will be deemed to cover all quotation costs other than actual site labour, product and materials, and rentals.
  - .8 All quotations, including those for deleted work, must include a figure for any required change to the Contract time.
- .4 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable the Consultant to expeditiously process the quotation and issue a Change Order will not be grounds for any additional change to Contract time.
- .5 If, in your opinion, changes or revisions to the work should be made, inform the Consultant in writing and, if the Consultant agrees a Notice of Change will be issued.
- .6 Do not execute any change or revision until written authorization for the change or revision has been obtained

**1.20 Notice for Required Field Reviews**

- .1 Whenever there is a requirement for the Consultant to perform a field review and/or inspection prior to concealment of any work (including piping/duct system leakage testing, to inspect/re-inspect the work for deficiencies prior to Substantial Performance, for commissioning demonstrations, and any other such field review, give the Consultant a minimum of 72 hours written notice.
- .2 If the Consultant is unable to attend a field review when requested, arrange an alternative date and time.
- .3 Do not conceal work until the Consultant advises that it may be concealed.
- .4 When the Consultant is requested to perform a field review and the work is not ready to be reviewed, reimburse the Consultant for all time and travel expenses.
- .5 Give the Consultant a minimum of 2 full working day's notice for attendance at field reviews.

### 1.21 Scaffolding, Rigging, and Hoisting

- .1 Unless otherwise specified or directed, supply, erect and operate all scaffolding, rigging, hoisting equipment and associated hardware required for your work. Immediately remove from the site all scaffolding, rigging, and hoisting equipment when no longer required.
- .2 Do not place major erection loads on any portion of the structure without approval from the Consultant.

### 1.22 Trial Usage

- .1 When directed by the Consultant, promptly arrange, pay for, and perform site tests on any piece of equipment or any system for such reasonable lengths of time and at such times as may be required to prove compliance with the Specification and governing Codes and Regulations, prior to Substantial Performance of the work.
- .2 When, in the opinion of the Consultant, tests are required to be performed by a certified testing laboratory, arrange and pay for such tests.
- .3 All tests are not to be construed as evidence of acceptance of the work, and it is agreed and understood that no claim for damage will be made for injury or breakage to any part or parts of the equipment or system due to the test where such injuries or breakage were caused by faulty parts and/or workmanship of any kind.
- .4 When, in the Consultant's opinion, tests indicate that equipment, products, etc., are defective or deficient, immediately remove such equipment and/or products from the site and replace them with acceptable equipment and/or products, at no additional cost.

### 1.23 General Re: Project Closeout Submittals

- .1 Prior to application for Substantial Performance, submit all required items and documentation specified, including the following:
  - .1 Operating and Maintenance Manuals.
  - .2 As-built record drawings and associated data.
  - .3 Extended warranties for equipment as specified.
  - .4 All operating test certificates, i.e. Sprinkler test certificate.
  - .5 Final commissioning report and TAB report.
  - .6 Identified keys for mechanical equipment and/or panels for which keys are required, and all other items required to be submitted.
  - .7 Other data or products specified.
  - .8 Written verification that all systems complete and fully operational or a complete list of items that are not finished or are deficient.

### 1.24 Operating and Maintenance Manuals

- .1 Submit 3 hard copies of operating and maintenance manuals consolidated in hardcover 3 "D" ring binders, each binder sized to include approximately 25% spare space for future data, and identified permanently with the Project name, "MECHANICAL OPERATING AND MAINTENANCE MANUAL" wording, and the date. Manuals are to include the following:
  - .1 An Introduction sheet listing the Consultant's, Contractor's, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses.
  - .2 A Table of Contents sheet, and corresponding index tab sheets.
  - .3 A copy of each "Reviewed" status shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, and the email address for local source of parts and service.
  - .4 Pressure leakage test reports for all piping systems.
  - .5 Certificates issued by governing authorities.
  - .6 **Operating Data:** Operating data shall include:
    - .1 A description of each system and its controls.
    - .2 Control schematics for equipment/systems including building environmental controls.
    - .3 If applicable, the building automation system (bas) "as-built" architecture and all required operating data.

- .4 Description of operation of each system at various loads together with reset schedules and seasonal variances.
- .5 Operation instruction for each system and each component.
- .6 Description of actions to be taken in event of emergencies and/or equipment failure.
- .7 Valve tag schedule, and flow diagrams to indicate valve locations.
- .7 **Maintenance Data:** Maintenance data shall include:
  - .1 Servicing maintenance, operation and trouble-shooting instructions for each item of equipment and each system.
  - .2 Schedules of tasks, frequency, tools required, and estimated task time.
  - .3 Complete parts lists with numbers.
- .8 **Performance Data:** Performance data shall include:
  - .1 Equipment and system start-up data sheets.
  - .2 Copies of all signed and dated piping system leakage test data.
  - .3 Equipment performance verification test results, and final commissioning report.
  - .4 Final testing adjusting and balancing reports.
- .9 **Review Submittal:** Assemble one copy of the O & M Manual and submit to the Consultant for review prior to Owner training and instructions, and assembling the remaining copies. Incorporate all comments into the final submission.
- .10 **Digital O & M Manuals:** Submit digital version of the hard copy manual using the latest version of Adobe Acrobat Portable Document format and enhanced with bookmarks, internet links, and internal document links. The digital copies are to be copied to a USB Flash Drive with custom label indicating the project name, date, the Consultant's name, and "Operating & Maintenance Manual for Mechanical Systems".

#### 1.25 Record "As-Built" Drawings and Data

- .1 As work progresses at the site, clearly mark in red "as -built" conditions in a neat and legible manner on a set of white print drawings printed from a PDF of the mechanical drawings supplied by the Consultant. Drawings will be kept on site at all times and available for reference.
- .2 "As-Built" conditions include all significant changes and deviations from the routing of services and locations of equipment shown on the Contract Drawings and resulting from the issue of Addenda, Site Instructions, Change Orders, and job conditions.
- .3 Use notes marked in red as required. Maintain the white print red line as-built set at the site for the exclusive use of recording as-built conditions, keep the set up-to-date at all times, and ensure that the set is always available for periodic review. The as-built set is also to include the following:
  - .1 The size, location, route, and extent of ductwork, piping, control devices and wiring conduit, cleanouts, valves, and similar items.
  - .2 The dimensioned location of all inaccessible concealed work the locations of control devices with identification for each.
  - .3 The location of all piping system air vents and water hammer arrestors.
  - .4 The location and tag identification for all tagged valves.
  - .5 For underground piping, including service entrance/exit piping, record dimensions, invert elevations, all offsets, fittings, cathodic protection and accessories if applicable, including invert elevations for underground drainage piping at each cleanout, manhole, and change in direction both inside and outside the building, and locate dimensions from benchmarks that will be preserved after construction is complete.
  - .6 For fire protection systems, record actual locations of equipment, sprinkler heads, and valves, drains, and test locations, and deviations of pipe routing and sizing from that shown on the drawings.
  - .7 The location of all concealed services terminated for future extension.
- .4 **Electronic Files of "As-Built" Drawings:** When work on site is complete, and prior to Substantial Performance, engage and pay for the services of either a competent drafting service or the Consultant to transfer all the as-built red line information to PDF electronic

drawing files. The Consultant will supply electronic files of the mechanical construction issue drawings to drafting service if requested.

- .5 **Review and Submittal:** Prior to Substantial Performance of the work, and after the red line site as-built white prints have been transferred to PDF electronic files, plot a set of bond prints the electronic file as-built drawings, neatly add the notation 'CERTIFIED RECORD DRAWINGS", date and sign the bond prints, and submit the prints and the electronic files to the Consultant for review. The Consultant will review the drawings and, if necessary, return the electronic files and the marked-up prints for corrections or further revisions, in which case complete the corrective and/or revision work and resubmit the electronic files and vellum prints until they are determined to be acceptable, all prior to Substantial Performance.

#### **1.26 Progress Payment Breakdown**

- .1 Submit, prior to submittal of the first progress payment draw, a breakdown of the cost of the mechanical work to assist the Consultant in reviewing and approving monthly progress payment claims.
- .2 The payment breakdown is subject to the Consultant's approval and progress payments will not be processed until an approved breakdown is in place. The breakdown shall include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including testing, adjusting and balancing, and project closeout submittals.
- .3 Equipment, material and labour costs are to be indicated for site services (if applicable), plumbing and drainage, fire protection, HVAC piping, HVAC sheet metal, controls, and insulation work, etc., in the same manner as they will be indicated on the monthly progress draw.

#### **1.27 Requirements for Contractor Retained Engineers**

- .1 All professional engineers retained by you to perform consulting services with regard to your work, i.e. seismic engineer, fire protection engineer, structural engineer, are to be members in good standing with the local Association of Professional Engineers, and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of the governing authorities in the locale of the work.
- .2 Your engineer's professional liability insurance is to protect your Consultants and Sub-Consultants, and their respective servants, agents, and employees against any loss or damage resulting from the professional services rendered by your Consultants, Sub-Consultants, and their respective servants, agents, and employees in regards to the work of this Contract.
- .3 Liability insurance requirements are as follows:
  - .1 Coverage shall be a minimum of \$1,000,000.00 inclusive of any one occurrence.
  - .2 The insurance policy is not to be cancelled or changed in any way without the insurer giving the Owner a minimum of thirty days written notice.
  - .3 Liability insurance shall be obtained from an insurer registered and licensed to underwrite such insurance in the location of the work.
  - .4 Evidence of the required liability insurance in such form as may be required shall be issued to the Owner, the Owner's Consultant, and Municipal Authorities as required prior to commencement of your Consultant's services.

#### **1.28 Guarantee-Warranty**

- .1 The Contractor shall furnish a written warranty stating that all work executed will be free from defects of material and workmanship for a period of **one year** from the date of total performance. Warranty shall include any part of equipment, units or structures furnished hereunder that show defects in the works under normal operating conditions and/or for the purpose of which they were intended.

- .2 The Contractor further agrees that they will, at their own expense, promptly investigate any mechanical or control malfunction, and repair or replace all such defective work, and all other damages thereby which becomes defective during the time of the guarantee-warranty

### 1.29 Extended Warranties

- .1 All extended warranties specified in mechanical work Sections of the Specification are to be full parts and labour warranties, at the site, and in accordance with requirements of the Contract warranty, but direct and in writing from the equipment manufacturer/supplier to the Owner. Submit signed and dated copies of extended warranties which clearly state requirements specified above.

### 1.30 Phasing of The Work

- .1 Phasing of the work is required to maintain the existing building in operation, all as specified in Division 01. Include all costs for phasing the work including all required "off hours" premium time labour costs.

### 1.31 Equipment and System Manufacturer's Certification

- .1 When equipment/system installation is complete, but prior to start-up procedures, arrange and pay for the equipment/system manufacturer's authorized representative to visit the site to examine the installation, and when any required corrective measures have been made, to certify in writing to the Consultant that the equipment/system installation is complete and in accordance with the equipment/system manufacturer's instructions.

### 1.32 Equipment and System Start-Up

- .1 When installation of equipment/systems is complete, but prior to commissioning, perform start-up for equipment/systems as specified in mechanical work Sections in accordance with the following requirements:
  - .1 Submit a copy of each equipment/system manufacturer's blank start-up report sheet to the Consultant for review and incorporate any comments.
  - .2 Under direct on-site supervision and involvement of the equipment/system manufacturer's representative, start-up the equipment/systems, make any required adjustments, document the procedures, leave the equipment/systems in proper operating condition, and submit a complete set of start-up documentation sheets signed by the manufacturer/supplier and the Contractor.

### 1.33 Equipment and System Commissioning

- .1 After successful start-up and prior to Substantial Performance, commission the mechanical work in accordance with requirements of CSA Z320, Building Commissioning. Use commissioning sheets included with the CSA Standard, and any supplemental commissioning sheets required. Submit final commissioning data sheets, TAB reports, project closeout documents, and other required submittals.

### 1.34 Equipment and System O & M Demonstration & Training

- .1 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Operating and Maintenance Manuals are to be used during the training sessions, and training modules are to include:
  - .1 **Operational Requirements and Criteria:** Requirements and criteria are to include but not be limited to equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations.
  - .2 **Troubleshooting:** Troubleshooting shall include but not be limited to diagnostic instructions, test and inspection procedures.
  - .3 **Documentation:** Documentation shall include but not be limited to equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like.
  - .4 **Maintenance:** Maintenance requirements are to include but not be limited to inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools.

- .5 **Repairs:** Repair requirements are to include but not be limited to diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.
- .2 Assemble the training modules into a training manual and submit a copy to the Consultant for review prior to scheduling training. Ensure that each participant in each training session has all required training material.
- .3 Schedule demonstrations and training at mutually agreed to times with a minimum of 7 working days notice.
- .4 The following sub-contractors are required to participate and assist with the demonstration and training session:
  - .1 Controls
  - .2 Balancing
  - .3 Manufacturer's representative for the following equipment:
    - .1 Rooftop Units
    - .2 Split System Heat Pumps
- .5 **Demonstration and Training Confirmation:** Obtain a list of personnel to receive demonstration and training from the Consultant, and have each participant sign the list to confirm that he/she understood the demonstration and training session.

END OF SECTION

## 1 GENERAL

### 1.1 Application

- .1 This Section specifies products, common criteria and characteristics, and methods and execution that are common to one or more mechanical work Sections of the Specification, and it is intended as a supplement to each Section and shall be read accordingly.

### 1.2 Submittals

- .1 Submit the following for review:
  - .1 **Product data sheets:** submit for:
    - .1 Pressure gauges and thermometers.
    - .2 Electric motors (submit with equipment they are associated with).
  - .2 **Access door locations:** submit white prints of architectural reflected ceiling plan drawings and elevation drawings to indicate proposed access door locations in walls and ceilings in finished areas.
  - .3 **Samples:** submit a sample of each proposed type of access door, and samples of materials and any other items as specified in mechanical work Sections of the Specification.
  - .4 **List of equipment nameplates:** submit a list of equipment identification nameplates indicating proposed wording and sizes.
  - .5 **Pipe & duct identification:** submit a list of pipe and duct identification colour coding and wording.
  - .6 **Valve tag chart:** submit a proposed valve tag chart and a list of proposed valve tag numbering and identification wording.
  - .7 **Waste management and reduction plan:** submit a waste management and reduction plan prior to commencing work and as per requirements specified in this Section.
  - .8 **Drive belts:** as specified in Part 2 of this Section, submit a spare belt set, tagged and identified, for each belt driven piece of equipment.
  - .9 **Piping pressure and temperature access fitting test kit:** submit a hinged case with pressure gauge and a thermometer, each with an adapter for a piping access fitting.
- .2 **Additional submittals:** submit any other submittals specified in this Section or other mechanical work Sections of the Specification.

### 1.3 Equipment and Material Manufacturer Requirements

- .1 Equipment and materials scheduled or specified on the drawings or in the Specification have been selected to establish a performance and quality standard.
- .2 Unless otherwise stated the bid price may be based on products supplied by any of the manufacturers named as acceptable for the particular product. If acceptable manufacturers are not listed for a particular product, base the bid price on the products supplied by the specified manufacturers.
- .3 If products supplied by a manufacturer named as acceptable are used in lieu of the products specified by manufacturer's name and model number, ensure that the product is equivalent in performance and operating characteristics (including energy efficiency if applicable) to the specified product. Pay for any additional costs and changes to associated or adjacent work resulting from the use of products supplied by a manufacturer other than the specified manufacturer. In addition, in equipment spaces where products named as acceptable are used in lieu of the specified products and the dimensions of such products differ from the specified products prepare and submit for review, if requested, accurately dimensioned layouts of the rooms affected to prove that all the equipment in the room will fit properly.
- .4 Do not supply products of different types that have been "bulked" by a supplier who has quoted a lump sum price for the "bulked" products.

**1.4 List of Acceptable Manufacturers and Suppliers**

- .1 Within 2 days after award of a Contract, submit to the Consultant for review, a list to indicate the name of the manufacturers/suppliers you propose to use for each item of equipment, material, or service listed, except for items such as pipe and fittings, insulation, and similar products. Manufacturers and/or suppliers on the list must be named in the Specification or on the drawings.
- .2 If the List of Acceptable Manufacturers and Suppliers is not submitted within two days after award of a Contract, the products specified and scheduled by manufacturer's name and model number and on which the Project is based are to be supplied. No substitutions whatsoever will be accepted unless previously approved in writing by the Consultant.

**1.5 Substituted or Alternative Products**

- .1 Products supplied by a manufacturer/supplier other than a manufacturer specified as acceptable may be considered for acceptance by the Consultant if requested in writing a minimum of five full working days prior to the bid closing date. Requests may be made by letter, by fax, or by email. Telephone requests will not be considered.
- .2 Each request for acceptance of a proposed substitution or alternative product must be accompanied by detailed catalogue and engineering data, fabrication information, and performance characteristics to permit the Consultant to make an informed decision.
- .3 Pay for any additional costs and changes to associated or adjacent work resulting from the use of products supplied by a substituted or alternative manufacturer. In addition, in equipment spaces where substituted or alternative products are used in lieu of the specified or acceptable products and the dimensions of such products differ from the specified or acceptable products, prepare and submit for review, if requested, accurately dimensioned layouts of the rooms affected to prove that all the equipment in the room will fit properly.
- .4 The Consultant's decision regarding any proposed substitution or alternative product is final.

**1.6 Products – Base Bid and Acceptable Manufacturers**

PRODUCT	APPROVED MANUFACTURER
Access Doors	Acudor, E.H. Price, Maxam, Milcor, Mifab, Enpoco
Air Handling Unit - Custom	Engineered Air, Aaon
Commissioning Agencies	Western, MDT Systems Ltd., KD Engineering, Kane
Controls – DDC	Delta (ESC Automation)
Duct Cleaning	Enviro-Vac, Ace Mobile, Power Suction Services
Ductwork – Flexible	Thermaflex, Wiremold, Flexmaster, Canaflex
Ductwork – Round and Oval Spiral	Spiro-Lock, Ecco
Ductwork – Canvas Flexible Connectors	Durodyne, Ventlan
Filters	Farr, Continental, Cambridge, AAF
Firestopping and Smoke Seals	3M Canada "Fire Barrier", Tremco Inc. Fire Protection Systems Group "TREMstop", Hilti (Canada) Ltd. Firestop Systems
Identification – Pipe and Duct	3M, SMS, Duramark, Bradley

PRODUCT	APPROVED MANUFACTURER
Insulation – Piping and Duct	3M, Dow, Fibrex, Knauf, Johns-Manville, Owens Corning, Pittsburgh Corning, Manson, Roxul, Fibreglass Canada, Certainteed
Insulation Jacketing	Childers, Fiberglass, Johns-Manville
Pipe Fittings and Flanges	Crane, Grinnell, Jenkins
Pipe Supports and Hangers	Crane, Unistrut, Myatt, Grinnell, Sarco, Hunt, Taylor
Pressure Gauges	Weiss, Ashcroft, Terrice, Marsh, Winter, Miljoco
Seismic Control and Restraint	Mason Industries Inc., Vibro-Acoustics Ltd.,
Testing, Adjusting and Balancing Agencies	MDT Systems, Scott Technical, Flotech, Honey's Technical, Western Mechanical, KD Engineering, BC Tech Engineering, Stasis, Airmec, Kane, Precision-Air
Vibration Isolation	Refer to section 20 05 20 for specific applications

## 2 PRODUCTS

### 2.1 Firestopping and Smoke Seal Materials

- .1 Firestopping and smoke seal system materials for mechanical penetrations through fire rated construction are specified in Division 07 and the work will be done as part of the work of Division 07.
- .2 Firestopping and smoke seal system materials for mechanical penetrations through fire rated construction are specified in the mechanical work Section entitled Firestopping and Smoke Seal Systems and the work shall be done as part of the mechanical work.

### 2.2 Waterproofing Seal Materials

- .1 Modular, mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so that when the bolts are tightened the links expand to seal the opening watertight. The seal assemblies are to be selected to suit the pipe size and the sleeve size or wall opening size.

### 2.3 Pipe Escutcheon Plates

- .1 One-piece chrome plated brass or #4 finish type 302 stainless steel plates with matching screws for attachment to the building surface, each plate sized to completely cover the pipe sleeve or building surface opening, and to fit tightly around the pipe or pipe insulation.

### 2.4 Piping Hangers and Supports

- .1 **General:** Pipe hanger and support materials, including accessories, are to be, unless otherwise specified, in accordance with the Manufacturers Standardization Society (MSS) Standard Practice Manual SP-58, Pipe hangers and Supports-Materials, Design and Manufacture, and where possible, MSS designations are indicated with each product specified below. Conform to the following requirements:
  - .1 Unless otherwise specified, all ferrous hanger and support products are to be electro-galvanized.
  - .2 Hangers and supports for insulated piping are to be sized to fit around the insulation and the insulation jacket.
- .2 **Horizontal Suspended Piping:** Hangers and supports are to be:
  - .1 Adjustable steel clevis hanger – Anvil Fig. 260 – MSS Type 1.
  - .2 Adjustable swivel ring band type hanger – Anvil Fig. 69 – MSS Type 10.

- .3 **Horizontal Pipe on Vertical Surfaces:** Epoxy coated steel pipe stays are not permitted. Supports are to be:
  - .1 Steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170.
  - .2 Heavy-duty steel pipe bracket – Anvil Fig. 262 or Myatt Fig. 161 – MSS Type 26.
  - .3 Single steel pipe hook - Myatt Fig. 156.
- .4 **Vertical Piping on Vertical Surfaces:** Epoxy coated steel pipe stays are not permitted. Supports are to be:
  - .1 Steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170.
  - .2 Heavy-duty steel pipe bracket or soil pipe bracket – Anvil Fig. 262 or Myatt Fig. 161 – MSS Type 26.
  - .3 Extension split pipe clamp – Anvil Fig's. 138R or Myatt Fig. 129 – MSS Type 12.
- .5 **Horizontal Pipe on Racks:** Unistrut or equal galvanized steel pipe racks with pipe securing hardware as follows:
  - .1 Standard galvanized steel U-bolts/clamps supplied by the rack manufacturer.
- .6 **Special Hangers and Supports:** Special hangers and supports for various applications are as follows:
  - .1 **Vibration isolated riser supports** – black steel riser clamps as specified above, complete with neoprene–steel–neoprene sandwich type vibration isolation pads between the clamp and the floor.
  - .2 **For groups of pipes having the same slope** – Anvil Fig. 195 welded steel brackets, Anvil Fig. 46 universal trapeze assemblies, or Unistrut or equal support assemblies, all with U-bolts, clamps, etc., to secure pipes in place.
  - .3 **For sections of piping connected to vibration isolated equipment** – hangers and supports as specified above but complete with MSS Type 48 spring cushions.
  - .4 **For piping on an existing roof** – Portable Pipe Hangers (Canada) Inc. "PP" Series prefabricated portable pipe support system components to suit the pipe, complete with all required accessories including bases, galvanized structural steel frames, and galvanized steel pipe hangers and/or supports conforming to MSS SP-58.
  - .5 **For bare horizontal copper piping** – generally as above but factory vinyl coated to prevent direct copper/steel contact.
  - .6 **For bare copper vertical piping** – corrosion resistant ferrous clamps with flexible rubber gasket type material (not tape) to isolate the pipe from the clamp.
  - .7 **Insulation protection shields to & including 40 mm (1½") diameter** – equal to Anvil "Rib-Lok" Fig. 168 galvanized steel shields with ribs to keep the shield centred on the hanger.
- .7 **Hanger Rods:** Electro-galvanized carbon steel (unless otherwise specified), round, threaded, complete with captive machine nuts with washers at hangers, sized to suit the loading in accordance with Table 3 in MSS SP-58, but, in any case, minimum 9.5 mm (3/8") diameter and in accordance with ASTM A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000PSI Tensile Strength, and ASME B18.31.3, Threaded Rods (Inch Series).

## 2.5 Access Doors

- .1 Prime coat painted steel (unless otherwise specified) flush access doors, each complete with a minimum #16 gauge frame, minimum #18 gauge door panel, heavy-duty rust-resistant concealed hinges, a positive locking screwdriver lock, and mounting and finishing features to suit the particular construction in which it shall be installed.
- .2 Access door sizes are to suit the concealed work for which they are supplied, and wherever possible they are to be of a standard size for all applications, but, in any case, they are to be minimum 300 mm x 300 mm (12" x 12") for hand entry and 600 mm x 600 mm (24" x 24") for body entry.
- .3 Access doors in fire rated construction are to be ULC listed and labelled and of a rating to maintain the fire separation integrity.

- .4 Where access doors are located in surfaces where special finishes are required, they are to be of a recessed door type capable of accepting the finish in which they are to be installed so as to maintain the final building surface appearance throughout, and constructed of stainless steel with a #4 finish.

## 2.6 Electric Motors

- .1 Unless otherwise specified, motors are to conform to EEMAC Standard MG1, applicable IEEE Standards, and applicable CSA C22.2 Standards, and are to meet NEMA standards for maximum sound level ratings under full load. Confirm motor voltages prior to ordering.
- .2 Vertically mounted and submersible motors are to be purposely designed for mounting in this attitude.
- .3 **AC Motor Efficiency:** The efficiency of single phase AC motors to 1 HP shall be in accordance with CAN/CSA C747. The efficiency of all three phase motors 1 HP and larger shall be in accordance with CAN/CSA C390 or IEEE 112B.
- .4 **Single Phase AC Motors:** Unless otherwise specified, AC motors smaller than ½ HP are to be 115 volt, continuous duty capacitor start type with an EEMAC 48 or 56 frame size, solid base, heavy-gauge steel shell with solid die-cast end shields, dynamically balanced die-cast rotor, integral automatic reset thermal overload protection, Class "B" insulation, and a 1.15 service factor at 40°C (105°F) ambient temperature.
- .5 **Brushless DC Motors:** Energy efficient electronically commutated motors (ECM) are to be brushless DC motors with an integral inverter, a permanent magnet on the rotor, and a programmable microprocessor based motor controller which will accept a remote adjustment signal for integration into a DDC building automation system
- .6 **Explosion-Proof AC Single Phase Motors:** totally enclosed, fan cooled, 115 volt continuous duty capacitor start type in accordance with CSA C22.2 No. 145, as specified for standard single phase motors but suitable for use in Class 1 Group D hazardous locations and complete with a rolled steel shell and a 1.0 service factor at 40°C (105°F) ambient temperature.
- .7 **Three Phase AC Motors:** Unless otherwise specified, motors ½ HP and larger are to be totally enclosed, fan cooled, 3 phase, T-frame, squirrel cage continuous duty induction motors suitable for voltages indicated on the Drawings, EEMAC Design "B" for normal starting torque or Design "C" for high starting torque as required by the application, each complete with Class "B" insulation, a 1.5 service factor at 40°C ambient temperature, grease lubricated open ball bearings with grease fittings to permit re-lubrication without dismantling the motor, a cast iron frame with cast iron feet where required, cast iron end bracket and precision machined bearing fit, and balanced carbon steel shaft assembly with die-cast aluminum rotor windings.
- .8 **Explosion-Proof Three Phase AC Motors:** totally enclosed fan cooled motors in accordance with CSA C22.2 No. 145, generally as specified above for standard 3 phase motors but suitable for use in Class 1 Group D hazardous locations and with a 1.0 service factor at 40°C (105°F) ambient temperature.

## 2.7 Motor Starters and Accessories

- .1 Loose motor starters and accessories, disconnect switches, and motor control centres for mechanical equipment will be provided as part of the electrical work.

## 2.8 Mechanical Work Identification Materials

- .1 **Equipment Nameplates:** Minimum 1.6 mm (1/16") thick 2-ply laminated coloured plastic plates, minimum 12 mm x 50 mm (½" x 2") for smaller items such as damper motors and control valves, minimum 25 mm x 65 mm (1" x 2½") for equipment, and minimum 50 mm x 100 mm (2" x 4") for control panels and similar items. Additional requirements are as follows:

- .1 Unless otherwise specified or required, each nameplate shall be white, complete with bevelled edges and black engraved capital letter wording to completely identify the equipment and its use with no abbreviations.
  - .2 Wording is generally to be as per the drawings, i.e. Fan ef-1, and shall include equipment service and building area/zone served, but must be reviewed prior to engraving.
  - .3 Supply stainless steel screws for securing nameplates in place.
  - .4 Nameplates for equipment suspended above floor level or generally not within easy viewing from floor level are to be increased in size so as to be easily readable from floor level.
- .2 **Standard Pipe Identification:** Standard pipe identification shall be equal to Smillie McAdams Summerlin Ltd. or Brady vinyl plastic with indoor/outdoor type vinyl ink lettering and directional arrows, as follows:
- .1 For pipe to and including 150 mm (6") diameter, coiled type snap-on markers of a length to wrap completely around the pipe or pipe insulation.
  - .2 For pipe larger than 150 mm (6") diameter, saddle type strap-on markers with 2 opposite identification locations and complete with nylon cable ties.
- .3 **Standard Pipe Identification Wording and Colours:** Identification wording and colours for pipe identification materials are to be as follows:

PIPE SERVICE	IDENTIFICATION COLOUR	LEGEND
Refrigerant Gas	To Code	To Code, c/w pressure
Refrigerant Liquid	To Code	To Code

- .4 **Colours for Legends & Arrows:** Colours for pipe identification legends and directional arrows are to be as follows:

IDENTIFICATION COLOUR	LEGEND & ARROW COLOUR
Yellow	Black
Green	White
Red	White

- .5 **Duct Identification:** Custom made Mylar stencils with 50 mm (2") high lettering to accurately describe the duct service, i.e. "AHU-1 SUPPLY", complete with a directional arrow, and coloured ink with ink pads and roller applicators. Ink colour is generally to be black but must contrast with the lettering background.

### 3 EXECUTION

#### 3.1 General Piping and Ductwork Installation Requirements

- .1 Unless otherwise specified, locate and arrange horizontal pipes and ducts above or at the ceiling on floors on which they are shown, arranged so that under consideration of all other work in the area, the maximum ceiling height and/or usable space is maintained. If required to maintain ceiling heights, reroute and/or resize ductwork, with Consultant's approval.
- .2 Unless otherwise specified, install all work concealed in finished spaces, and concealed to the degree possible in partially finished and unfinished spaces. Refer to and examine the Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas. Note that walls which are painted are considered finished.
- .3 Install all pipes and ducts parallel to building lines and to each other.
- .4 Neatly group and arrange all exposed work.
- .5 **Service and Maintenance Access:** Locate all work to permit easy access for service or maintenance as required and/or applicable. Locate all valves, dampers and any other

equipment which will or may need maintenance or repairs and which are installed in accessible construction so as to be easily accessible from access doors. Where valves, dampers and similar piping or ductwork accessories occur in vertical services in shafts, pipe spaces or partitions, locate the accessories at the floor level.

- .6 **Dissimilar Metal Pipe Connections:** Make all connections between pipes of different materials using proper approved adapters. Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe.
- .7 **Cleaning:** Carefully clean all ducts, pipe and fittings prior to installation. Temporarily cap or plug ends of pipe, ducts and equipment which are open and exposed during construction.
- .8 **Surfaces to Receive Your Work:** Inspect surfaces and structure prepared by other trades before performing your work. Verify that surfaces or the structure to receive your work have no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing. Installation of your work will constitute acceptance of such surfaces as being satisfactory.
- .9 **Piping Rust and Dirt:** Any ferrous piping that exhibits in excess of 5% surface rust, either inside or outside or both shall be wire brush cleaned to bare metal and coated with suitable primer. Steel pipe, fittings and accessories are to be free of corrosion and dirt when work is complete or prior to being concealed from view. Where dirt is evident, clean the piping prior to being concealed.
- .10 **Repair of Finished Surfaces:** for factory applied finishes, repaint or refinish all surfaces damaged during shipment and installation. The quality of the repair work shall match the original finish. This requirement also applies to galvanized finishes.
- .11 **Unions and Flanges:** Whether shown or specified on the drawings or not, provide screwed unions or flanges in all piping connections to equipment, and in regular intervals in new piping runs in excess of 12 m (40') to permit removal of sections of piping.
- .12 **Elbows and Eccentric Reducers:** Unless otherwise specified and except where space limitations do not permit, all piping elbows are to be long radius. Eccentric reducers are to be installed with the straight side at the top of the piping.

### 3.2 Pipe Joint Requirements

- .1 Do not make pipe joints in walls or slabs.
- .2 Ream all piping ends prior to making joints.
- .3 **Soldered Joints:** Unless otherwise specified make all soldered joints in copper piping using flux suitable for and compatible with the type of solder being used. Clean the outside of the pipe end and the inside of the fitting, valve, or similar accessory prior to soldering. Comply with requirements of ASTM B828, Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
- .4 **Mechanical Joints:** Install mechanical joint fittings and couplings in accordance with the manufacturer's instructions.
- .5 **Grooved Pipe & Coupling Joints:** Make arrangements with the coupling and fitting manufacturer for shop and/or site instructions and demonstrations as required, and adhere to the manufacturer's instructions with respect to pipe grooving, support, type of gasket required, anchoring and guiding the grooved piping system.

### 3.3 Installation of Waterproof Mechanical Seals

- .1 Provide watertight link type mechanical seals in exterior wall openings where shown or specified.
- .2 Assemble and install each mechanical seal in accordance with the manufacturer's instructions.
- .3 After installation, periodically check each mechanical seal installation for leakage and, if necessary, tighten link seal bolts until the seal is completely watertight.

**3.4 Sleeve and formed Opening Location Drawings**

**3.5 Installation of Fastening and Securing Hardware**

- .1 Provide all fastening and securing hardware required for mechanical work to maintain installations attached to the structure or to finished floors, walls and ceilings in a secure and rigid manner capable of withstanding the dead loads, live loads, superimposed dead loads, and any vibration of the installed products.
- .2 Use fasteners compatible with structural requirements, finishes and types of products to be connected. Do not use materials subject to electrolytic action or corrosion where conditions are liable to cause such action.
- .3 Where the floor, wall or ceiling construction is not suitable to support the loads, provide additional framing or special fasteners to ensure proper securement to the structure that is to support the products. Provide reinforcing or connecting supports where required to distribute the loading to the structural components. Submit support details for review prior to installation.
- .4 Obtain written consent before using explosive actuated fastening devices. If consent is obtained, comply with requirements of CSA Standards CAN3-Z166.1 and CAN3-Z166.2.

**3.6 Installation of Pipe Hangers and Supports**

- .1 Provide all required pipe hangers and supports.
- .2 Provide any additional structural steel channels, angles, inserts, beam champs and similar accessories required for hanging or supporting pipe. Unless otherwise shown or specified, hang or support pipes from the structure only.
- .3 **For Insulated Pipe:** Size the hanger or support to suit the diameter of the insulated pipe and install the hanger or support on the outside of the insulation and insulation finish.
- .4 **Horizontal Above Ground Piping:** Unless otherwise shown or specified, hang and/or support horizontal pipe above ground by means of hangers and/or supports specified in Part 2 of this Section. Unless otherwise shown or specified, hangers for suspended pipe to and including 25 mm (1") diameter are to be clevis type or adjustable ring type, and hangers for suspended pipe 40 mm (1½") diameter and larger are to be adjustable clevis type. Space hangers and supports in accordance with the following:
  - .1 **Cast iron pipe:** hang or support at every joint with maximum 2.4 m (8') spacing.
  - .2 **Plastic pipe:** conform to pipe manufacturer's recommended support spacing.
  - .3 **Copper and steel pipe:** hang or support at spacing in accordance with the following schedule:

PIPE DIA.	MAX. SPACING STEEL (meters)	MAX. SPACING COPPER (meters)
To 25 mm (1")	2.4 m (8')	1.8 m (6')
40 mm (1½")	2.7 m (9')	2.4 m (8')
50 mm (2")	3.0 m (10')	2.7 m (9')
65 mm (2½")	3.6 m (12')	3.0 m (10')
75 mm (3")	3.6 m (12')	3.0 m (10')
90 mm (3½")	3.6 m (12')	3.6 m (12')
100 mm (4")	4.2 m (14')	3.6 m (12')
250 mm (10")	6.0 m (20')	
300 mm (12")	6.7 m (22')	

- .4 **Flexible grooved pipe/coupling joint piping:** as above but with not less than 1 hanger or support between joints.

- .5 **Changes in direction:** where pipes change direction, either horizontally or vertically, provide a hanger or support on the horizontal pipe not more than 300 mm (12") from the elbow, and where pipes drop from tee branches, support the tees in both directions not more than 50 mm (2") on each side of the tee.
- .6 **Grouped piping:** when pipes with the same slope are grouped and a common hanger or support is used, space the hanger or support to suit the spacing requirement of the smallest pipe in the group and secure pipes in place on the common hanger or support.
- .7 **Roller hangers & supports:** provide roller hangers or supports for all heat transfer piping 150 mm (6") diameter and larger and conveying a material 75°C (170°F) or greater to facilitate pipe movement due to expansion and contraction, and at each hanger or support tack weld a steel protection saddle to the pipe to protect the piping insulation.
- .5 **Vertical Piping:** Unless otherwise shown or specified, support vertical piping by means of supports specified in Part 2 of this Section, spaced in accordance with the following:
  - .1 Support vertical pipes at maximum 3 m (10') intervals or at every floor, whichever is lesser.
  - .2 For sections of vertical piping with a length less than 3 m (10'), support the pipe at least once.
  - .3 For all vertical cast iron plain end pipe (mechanical joint type), secure the riser or pipe clamp around the pipe under a flange integral with the pipe for vertical support purposes, or provide a length of hub and spigot pipe to facilitate proper support.
  - .4 For all vertical steel pipe risers in excess of 3 m (10'), weld shear lugs to the pipe to carry the load.
  - .5 For vibration isolated piping risers, provide rubber-steel-rubber vibration isolation pads between the riser clamps and the floor.
  - .6 For piping subject to vertical movement exceeding 40 mm (1½") due to vertical pipe expansion, provide suitable engineered constant support hangers.
- .6 **Piping on The Roof:** Support piping on the roof as follows:
  - .1 **On existing roof** - provide support members as specified in Part 2 of this Section spaced as per the schedule above and of a type to suit the application, and, for each support, carefully scrape away the roofing gravel, bed the support in a heavy covering of roofing mastic, then scrape the gravel back up around the support - secure pipes to supports
- .7 **Isolation for Bare Copper Tubing:** Each hanger, support or securement for horizontal bare copper tubing shall be plastic coated to prevent direct contact between the pipe and the ferrous hanger. Each wall or floor clamp for vertical bare copper piping shall be isolated from the pipe by means of strips of flexible rubber inserts. The use of painted ferrous hangers and supports, including those painted with copper coloured paint, is not acceptable. Site application of tape or other types of isolation is not acceptable.
- .8 **Insulation Protection Shields:** for insulated horizontal piping to and including 40 mm (1½") diameter, provide galvanized steel insulation protection shields between the insulation and the hanger or support. Install shields immediately after the pipe is insulated.
- .9 **Pipe Support from Steel Deck:** Do not support piping from steel deck without written consent from the Consultant.

### 3.7 Supply of Access Doors

- .1 Supply access doors to give access to all mechanical work which may need maintenance or repair but which is concealed in inaccessible construction, except as otherwise specified herein or on the drawings.
- .2 Locate access doors as inconspicuously as possible in walls and partitions and arrange mechanical work such that it is clearly within view and accessible for inspection and servicing, and to suit access door locations shown on the reviewed and approved white

prints of reflected ceiling plan and elevation drawings submitted as per Part 1 of this Section.

- .3 Group piping and ductwork to ensure the minimum number of access doors is required. Access doors will be installed by the trades responsible for the particular type of construction in which the doors are required.
- .4 Submit a sample of each proposed access door for review prior to ordering.

### 3.8 Mechanical Work Identification

- .1 **Exposed Piping & Ductwork:** Identify new exposed piping and ductwork as per Part 2 of this Section in locations such that it can be seen from the floor or service platforms, as follows:
  - .1 At every end of every piping or duct run.
  - .2 Adjacent to each valve, strainer, damper, and similar accessory.
  - .3 At each piece of connecting equipment.
  - .4 On both sides of every pipe and duct passing through a floor, wall, or partition.
  - .5 At 6 m (20') intervals on pipe and duct runs exceeding 6 m (20') in length.
  - .6 At least once in each room, and at least once on pipe and duct runs less than 6 m (20') in length.
- .2 **Concealed Piping & Ductwork:** Unless otherwise specified identify new concealed piping and ductwork as per Part 2 of this Section in locations as follows:
  - .1 At points where pipes or ducts enter and leave rooms, shafts, pipe chases, furred spaces, and similar areas.
  - .2 At maximum 6 m (20') intervals on piping and ductwork above suspended accessible ceilings, and at least once in each room.
  - .3 At each access door location.
  - .4 At each piece of connected equipment, automatic valve, etc.
- .3 **Equipment:** Provide an identification nameplate for each new piece of equipment, including items such as control valves, motorized dampers, instruments, and similar products. Secure nameplates in place, approximately at eye level if possible, with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces. Locate all nameplates in the most conspicuous and readable location. Unless otherwise specified, equipment identification terminology shall be as per drawing identification.
- .4 **Motor Starters and Disconnect Switches:** Provide an identification nameplate for each new motor starter or disconnect switch located in a motor control centre or on a motor starter panel, and on each individually mounted starter which you supply, and on each disconnect switch provided as part of the electrical work for motorized equipment which you provide.
- .5 **Ceiling Tacks or Stickers:** Where new shut-off valves, control dampers, sensors, and similar items which will or may need maintenance and/or repair are located above accessible suspended ceilings, provide round coloured ceiling tacks in the ceiling panel material, or stickers equal to Brady "Quick Dot" on the ceiling grid material to indicate locations of the items. Unless otherwise specified, ceiling tack or sticker colours are to be as follows:

.1 HVAC piping valves and equipment	yellow
.2 HVAC ductwork dampers and equipment	blue
.3 Control system hardware and equipment	orange

### 3.9 Finish Painting of Mechanical Work

- .1 Finish paint exposed mechanical work as specified and/or scheduled in accordance with requirements of the painting Section in Division 09.
- .2 Touch-up paint all damaged factory applied finishes on mechanical work products.

- .3 Finish painting of exposed mechanical work is specified in Division 09 and is part of the work of Division 09.

### 3.10 Pipe Leakage Testing

- .1 Before new piping has been insulated or concealed, and before equipment, fixtures and fittings have been connected, test all piping for leakage.
- .2 Tests are to be witnessed by the Consultant and/or Owner's representative, and, where required, representatives of governing authorities. Give ample notice of tests in writing and verify attendance. Have completed test report sheets dated and signed by those present to confirm proper test results.
- .3 When circumstances prevent scheduled tests from taking place, give immediate and adequate notice of cancellation to all who were scheduled to attend.
- .4 **General Re: All Testing:** The following requirements apply to all testing:
  - .1 Ensure that all piping has been properly flushed, cleaned and is clear of foreign matter prior to pressure testing.
  - .2 Temporarily remove or valve off all piping system specialties or equipment which may be damaged by test pressures prior to pressure testing the systems, and flush piping to remove foreign matter.
  - .3 When testing is carried out below the highest level of the particular system, increase the test pressure by the hydrostatic head of 7 kPa (1 psi) for every 600 mm (24") below the high point.
  - .4 Include for temporary piping connections required to properly complete the tests.
  - .5 Piping under test pressure shall have zero pressure drop for the length of the test period.
  - .6 Make tight leaks found during tests while the piping is under pressure, and if this is impossible, remove and refit the piping and reapply the test until satisfactory results are obtained.
  - .7 Where leaks occur in threaded joints in steel piping, no caulking of these joints will be allowed under any conditions.
  - .8 Tests are to be done in reasonably sized sections so as to minimize the number of tests required.
  - .9 In addition to the leakage tests specified above, demonstrate proper flow throughout the systems including mains, connections and equipment, as well as proper venting and drainage, and include for any necessary system adjustments to achieve the proper conditions.

### 3.11 Supply of Motor Starters and Accessories

- .1 Motor starters for mechanical equipment, except for starters integral with packaged equipment and starters factory installed in equipment power and control panels, will be provided as part of the electrical work.

### 3.12 Electrical Wiring Work for Mechanical Work

- .1 Unless otherwise specified or indicated, the following electrical wiring work for mechanical equipment will be done as part of the electrical work:
  - .1 "Line" side power wiring to motor starters or disconnect switches in motor control centres and starters or disconnects on motor starter panels, and "load" side wiring from the starters or disconnects to the equipment.
  - .2 "Line" side power wiring to individual wall mounted starters, and "load" side wiring from the starters to the equipment.
  - .3 "Line" side power wiring to pre-wired power and control panels and variable frequency drives, and "load" side power wiring from the panels and VFD's to the equipment.
  - .4 Provision of receptacles for plug-in equipment.
  - .5 Provision of disconnect switches for all motors that are in excess of 10 m (30') from the starter location, or that cannot be seen from the starter location, and all associated power wiring.
  - .6 All motor starter interlocking in excess of 24 volts.

- .7 Wiring from motor winding thermistors in motors 30 HP and larger to motor starter contacts.
  - .8 Provision of dedicated 120 volt, 15A-1P circuits terminated in junction boxes in mechanical equipment rooms for automatic control and building automation system wiring connections to be made as part of the automatic controls work.
  - .9 120 volt power connections to electrical receptacles integral with small ceiling exhaust fans, including wiring through light switches or speed controllers.
  - .10 120 volt wiring connections to lighting fixture/switch combinations integral with air handling units.
  - .11 120 volt wiring connections to duplex receptacles integral with air handling unit control panels.
  - .12 120 volt wiring connections to line voltage thermostats.
  - .13 120 volt wiring connections to DDC controls transformers.
  - .14 All disconnects to be provided by Div. 26 unless otherwise noted.
- .2 Mechanical wiring work not listed above or specified herein or on the drawings to be done as part of the electrical work shall be installed in conduit and shall be done as part of the mechanical work in accordance with wiring requirements specified for the electrical work.

### **3.13 Interruption to and Shut-Down of Mechanical Services and Systems**

- .1 Co-ordinate all shut-down and interruption to existing mechanical systems with the Owner/Facilities Manager. Generally, shut-downs may be performed only between the hours of 12:00 midnight Friday until 6:00 a.m. Monday morning.
- .2 Upon award of a Contract, submit a list of anticipated shut-down times and their maximum duration.
- .3 Prior to each shut-down or interruption, inform the Owner/Facilities Manager and Consultant in writing 72 hours in advance of the proposed shut-down or interruption and obtain written approval to proceed. Do not shut-down or interrupt any system or service without such written approval.
- .4 Perform work associated with shut-downs and interruptions as continuous operations to minimize the shut-down time and to reinstate the systems as soon as possible, and, prior to any shut-down, ensure that all materials and labour required to complete the work for which the shut-down is required are available at the site.

### **3.14 Cutting, Drilling, and Patching for Mechanical Work**

- .1 Do all cutting, drilling and patching of the existing building for the installation of your work. Perform all cutting and drilling with proper tools and equipment. Confirm the exact location of cutting and drilling with the Consultant prior to commencing the cutting and/or drilling work.
- .2 Patch surfaces, where required, to exactly match existing finishes using tradesmen skilled in the particular trade or application worked on.
- .3 Where new pipes pass through existing construction, core drill an opening. Size openings to leave 12 mm ( $\frac{1}{2}$ " ) clearance around the pipes or pipe insulation.
- .4 Where drilling is required in waterproof slabs, size the opening to permit snug and tight installation of a pipe sleeve which is sized to leave 12 mm ( $\frac{1}{2}$ " ) clearance around the pipe or pipe insulation. Provide a pipe sleeve in the opening. Pipe sleeves are to be Schedule 40 galvanized steel pipe with a flange at one end and a length to extend 100 mm (4") above the slab. Secure the flange to the underside of the slab and caulk the void between the sleeve and slab opening with proper non-hardening silicone base caulking compound to produce a water-tight installation.

### **3.15 Flashing for Mechanical Work Penetrating the Roof**

- .1 Do all required flashing work, including counterflashing, for mechanical work penetrating and/or set in the roof.

- .2 Perform flashing work in accordance with requirements of drawing details, and requirements specified in Division 07.

**3.16 Cleaning Mechanical Work**

- .1 Refer to cleaning requirements specified in Division 01.
- .2 Clean all mechanical work prior to application for Substantial Performance of the work.
- .3 Include for vacuum cleaning the interior of air handling units and ductwork systems.

**3.17 Maintaining Equipment Prior to Acceptance**

- .1 Maintain all equipment in accordance with the manufacturer's printed instructions prior to start-up, testing, and commissioning.
- .2 Employ a qualified millwright to check and align shafts, drives, and couplings on all base mounted split coupled motor driven equipment.
- .3 Where equipment lubrication fittings are not easily accessible, extend the fittings to accessible locations using copper or aluminium tubing.
- .4 All filters are to be new upon Substantial Performance of the work. This is in addition to any spare filters specified.

**3.18 Connections to Other Equipment**

- .1 Carefully examine the Contract Documents during the bidding period and include for mechanical work piping and/or ductwork connections to equipment requiring such connections.

**3.19 Waste Management and Disposal**

- .1 Separate and recycle waste materials in accordance with requirements specified in Division 01.
- .2 Separate and recycle waste materials in accordance with requirements of Canadian Construction Association Standard Document CCA 81, A Best Practices Guide to Solid Waste Reduction.
- .3 Prepare a waste management and reduction plan and submit a copy for review prior to work commencing at the site.
- .4 Place materials defined as hazardous or toxic waste in designated containers.
- .5 Ensure emptied containers are sealed and stored safely for disposal.

**3.20 Seismic Restraint Anchor Points for Equipment**

- .1 All mechanical equipment requiring seismic restraint (see the mechanical work Section entitled Seismic Control and Restraint) shall be complete with manufacturer designed and rated seismic restraint anchor points and attachments, certified by the equipment manufacturers, so that the equipment may be bolted down or restrained in the field.
- .2 The equipment to be restrained must be designed such that the strength and anchorage of the internal components of the equipment exceeds the force level used to restrain and anchor the equipment itself to the supporting structure.

**END OF SECTION**

## 1 GENERAL

### 1.1 Application

- .1 This Section specifies vibration isolation product requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and shall be read accordingly.
- .2 All mechanical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on or suspended from vibration isolators to reduce the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
- .3 The work in this section includes, by is not limited to:
  - .1 Vibration isolation for piping, ductwork and equipment
  - .2 Equipment isolation bases
  - .3 Flexible piping connections
  - .4 Resilient Pipe Anchors and Guides

### 1.2 Submittals

- .1 Submittals shall be based on actual equipment to be supplied to site and not necessarily the scheduled equipment when approved alternatives have been carried by the Contractor. Vibration isolation submittal shall be coordinated appropriately with other submittals as well as proposed means of installation.
- .2 **Product Data:** Submit copies of manufacturer's product data sheets for all products specified in this Section. Product data sheets shall include:
  - .1 Descriptive Data:
    - .1 Schedules of flexibly mounted equipment, referencing drawings by number
    - .2 Catalog cuts or data sheets on vibration isolators
  - .2 Drawings:
    - .1 Submit details of equipment bases including dimensions, structural member sizes, and support point locations
    - .2 Submit details of isolation hangers for ceiling hung equipment, piping and ductwork
    - .3 Submit details of mountings for floor supported equipment, piping and ductwork
    - .4 All hanger, mounting or pad drawings shall indicate deflections and model numbers as well as any other requirements in the specifications.
    - .5 Spring diameters, rated loads, and deflections, heights at rated load and closed height shall be provided for all springs shown in the submittals in tabular form.

### 1.3 Quality Assurance

- .1 Mechanical vibration isolation product manufacturers are to be current members of the Vibration Isolation & Seismic Restraint Manufacturers Association.
- .2 All isolation materials shall be supplied by the same manufacturer.
- .3 Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

### 1.4 Base Bid and Acceptable Manufacturers

- .1 Refer to the article entitled Equipment and Material Manufacturer Requirements in the Section entitled Mechanical Work General Instructions.
- .2 The following is a list of base bid and acceptable manufacturers for products specified in this Section:
  - .1 Mason Industries Inc.
  - .2 VMC Group.

- .3 Vibro-Acoustics by Swegon.
- .4 Kinetics Noise Control.

## 1.5 Seismic Restraint Requirements

- .1 Refer to the mechanical work Section entitled Seismic Control and Restraint for requirements for use of a Seismic Consultant, and seismic restraint requirements applicable to vibration isolated materials and equipment.
- .2 Hangers used in seismic applications shall be provided with a neoprene and steel rebound washer installed 6mm (1/4") clear of bottom of hanger housing in operation to prevent spring from excessive upward travel.

## 2 PRODUCTS

### 2.1 General

- .1 Vibration isolation products are to be in accordance with the drawing schedule and details, and as specified below.
- .2 **Finishes:** All steel components of isolation products not exposed to the weather or moisture are to be zinc plated or finished in powder coated enamel. All steel components of isolation products exposed to the weather or in a damp, moist environment are to be hot dipped galvanized or factory finished with rust inhibiting primer and 2 coats of neoprene.
- .3 Where the weight of isolated equipment may change significantly due to draining or filling with a liquid, vibration isolators are to be equipped with limit stops to limit spring extensions.
- .4 **Seismic Rated Vibration Isolation:** All seismic restraints supplied with vibration isolation are to meet requirements specified in the mechanical work Section entitled Seismic Control and Restraint.
- .5 **Flexible Piping Connections:** Flexible piping connections to vibration isolated equipment are specified in the appropriate piping sections of the Specification. Neoprene mountings shall have a minimum static deflection of 0.35"(9mm). All metal surfaces shall be neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole and cap screw on top. Steel rails shall be used above the mountings under equipment such as small vent sets to compensate for the overhang. Mountings shall be type ND or rails type RND as manufactured by Mason Industries, Inc.

**2.2 Neoprene Mountings** shall have a minimum static deflection of 0.35"(9mm). All metal surfaces shall be neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole and cap screw on top. Steel rails shall be used above the mountings under equipment such as small vent sets to compensate for the overhang. Mountings shall be type ND or rails type RND as manufactured by Mason Industries, Inc.

**2.3 Spring Isolators** shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4"(6mm) neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be type SLF, as manufactured by Mason Industries, Inc.

**2.4 Pipe Hangers (general)** shall consist of rigid steel frames containing minimum 1-1/4"(32mm) thick LDS Rubber elements at the top and a steel spring with general characteristics as in specification **2.3** seated in a steel washer reinforced LDS Rubber cup on the bottom. The LDS Rubber element and the cup shall have LDS Rubber bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated as clevis hangers nor the LDS Rubber element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before

contacting the cup bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30° capability. Hangers shall be type 30N as manufactured by Mason Industries, Inc.

## **2.5 Curb mounted rooftop equipment**

- .1 Shall be mounted on vibration isolation bases that fit over the roof curb and under the isolated equipment. The extruded aluminum top member shall overlap the bottom to provide water runoff independent of the seal. Aluminum members shall house electro-galvanized or powder coated springs selected for 0.75"(19mm) minimum deflection. Travel to solid shall be 1.5"(38mm) minimum. Spring diameters shall be no less than 0.8 of the spring height at rated load. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4"(6mm) so as not to interfere with the spring action except in high winds. Manufacturer's self adhering closed cell sponge gasketing must be used both above and below the base and a flexible EPDM duct like connection shall seal the outside perimeter. Foam or other sliding or shear seals are unacceptable in lieu of the EPDM ductlike closure. Submittals shall include spring deflections, spring diameters, compressed spring height and solid spring height as well as seal and wind resistance details. Curb mounted bases shall be Type CMAB as manufactured by Mason Industries, Inc.
- .2 Shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind forces. All directional neoprene snubber bushings shall be a minimum of 1/4"(6mm) thick. Steel springs shall be laterally stable and rest on 1/4"(6mm) thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curbs waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 2"(51mm) of insulation. Curb shall be type RSC as manufactured by Mason Industries, Inc. 25

**2.6 Flexible Duct Connections** shall be constructed from EPDM or neoprene. Install 75mm (3") flexible duct connections with a minimum 40mm (1-1/2") metal to metal gap. Flexible duct connections shall be installed so that the duct size is not reduced by the deflection of the flexible connector. Flexible connections shall be rated for duct system pressures and shall meet SMACNA pressure and leakage classifications of connected ductwork. Provide flanged connections to ductwork.

## **3 EXECUTION**

### **3.1 Installation of Vibration Isolation Materials**

- .1 Provide vibration isolation products for mechanical work in accordance with the drawing schedule and details, and requirements specified herein and/or on the drawings.
- .2 Supply to the vibration isolation product manufacturer or supplier a copy of a "Reviewed" shop drawing or product data sheet for each piece of equipment to be isolated, and dimensioned pipe layouts of associated piping to be isolated.
- .3 Unless otherwise specified, all vibration isolation products are to be the product of one manufacturer.
- .4 Ensure that the vibration isolation manufacturer coordinates material selections with equipment provided in order to ensure adherence to performance criteria. Allow for expansion and contraction when material is selected and installed.
- .5 Maintain a minimum clearance of 50 mm (2") between vibration isolated equipment and adjacent structures, piping, ductwork, equipment, and similar items.
- .6 Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stressed or misalignment.

- .7 No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.
- .8 The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.
- .9 Coordinate work with other trades to avoid rigid contact with the building.
- .10 Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineer's attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
- .11 Bring to the architects/engineer's attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor's expense.
- .12 Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor's expense
- .13 Where piping passes through walls, floors, or ceilings the vibration isolation manufacturer shall provide split acoustic wall seals consisting of 19mm (3/4") thick closed cell neoprene sponge as per section **2.15**, Mason SWS or approved equal.
- .14 Locate isolation hangers as near to the overhead support structure as possible.
- .15 Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust when thrust forces exceed 10% of the equipment weight. Horizontal thrust restraints shall be as per **2.10**.
- .16 Rooftop equipment isolators must be bolted to the equipment and structure. Mountings must be designed to resist 100m/h(160 km/h) wind loads.
- .17 Vibration Isolation of Horizontal Piping.**
  - .1 The first four pipe hangers in the main lines near the mechanical equipment shall be as described in specification **2.8**
  - .2 Hangers supporting piping 2"(50mm) and larger in all other locations throughout the building shall be isolated by hangers as described in specification **2.7**.
  - .3 Floor supported piping shall rest on isolators as described in specification **2.6**.
  - .4 Heat exchangers and expansion tanks are considered part of the piping run.
  - .5 The first four isolators from the isolated equipment shall have the same static deflection as specified for the mountings under the connected equipment.
  - .6 If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first four hangers shall have
    - .1 0.75" (19mm) deflection for pipe sizes up to and including 3" (75mm),
    - .2 1-1/2" (38mm) deflection for pipe sizes over 3" (75mm) and up to and including 6" (150mm), and
    - .3 2-1/2" (64mm) deflection thereafter.
  - .7 Where piping connects to mechanical equipment install specification **2.13 Rubber Expansion Joints** or specification **2.14 Stainless Hoses** if **2.13** is not suitable for the service.
  - .8 All piping passing through the equipment walls, floors or ceilings shall be protected against sound leakage by means of an acoustical seal, as described in Specification **2.15**.
- .18 Vibration Isolation of Riser Piping.**
  - .1 All vertical risers shall be supported by spring isolators designed to support the riser filled with water, if it is a water line. Assigned loads must be within the building design limits at the support points. Neutral central resilient anchors close to the center of the run shall direct movement up and down. The anchors shall be capable of holding an

- upward force equal to the water weight when the system is drained. If one level cannot accommodate this force, anchors can be located on 2 or 3 adjacent floors.
- .2 Resilient guides shall be spaced and sized properly depending on the pipe diameter.
  - .3 Submittals must include the initial load, initial deflection, change in deflection, final load and change in load at all spring and anchor support locations, as well as guide spacing. The initial spring deflection shall be a minimum of 0.75" (19mm) or four times the thermal movement at the isolator location, whichever is greater.
  - .4 Calculations shall include pipe stress at end conditions and branch off locations and the manufacturer must include installation instructions.
  - .5 Submittal must be stamped and signed by a licensed professional engineer in the employ of the vibration vendor for at least 5 years.
  - .6 Support spring mountings shall be per Specification **2.3**, anchors per Specification **2.16**, telescoping guides per Specification **2.17**.
- .19 **Vibration Isolation of Ductwork**
- .1 All air ducts with a cross section of 2 ft<sup>2</sup> (0.19m<sup>2</sup>) or larger shall be isolated from the building structure by specification **2.9 (Duct Hangers)** or **2.3 (Spring Isolators)** floor supports with a minimum deflection of 0.75"(19mm). Isolators shall continue for 50'(15m) from the equipment. If air velocity exceeds 1000 fpm(5.3mps), hangers or supports shall continue for an additional 50'(15m) or as shown on the drawings.
  - .2 Provide flexible duct connections on inlet and outlet of all centrifugal fans.
- .20 **Control Wiring Connections:** for all control wiring connections to vibration isolated equipment ensure that flexible metallic conduit with 90° bend is used for conduit 25 mm (1") dia. and smaller, and for conduit larger than 25 mm (1") dia., use Crouse Hinds EC couplings. Connections are to be long enough so that the conduit will remain intact if the equipment moves 300 mm (12") laterally from its installed position, and flexible enough to transmit less vibration to the structure than is transmitted through the vibration isolation. Coordinate these requirements with the mechanical trades involved. If electrical power connections are not made in a similar manner as part of the electrical work, report this fact to the Consultant.
- .21 **Seismic Restraint Isolation:** Refer to the mechanical work Section entitled Seismic Control and Restraint for requirements pertaining to seismically restrained vibration isolation.
- .22 **Adjusting, Commissioning and Testing:**
- .1 Adjust vibration isolators after piping systems are filled and equipment is at operating weight.
  - .2 Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.
  - .3 For large rotating equipment that requires final alignment on-site, provide follow-up vibration isolation adjustment to suit final operating condition and any final equipment alignment requirements, ie for large base mounted pumps, fans, etc. Coordinate vibration isolation adjustment with start-up and commissioning personnel.

**END OF SECTION**

## 1 GENERAL

### 1.1 Application

- .1 This Section specifies thermal insulation requirements that are common to mechanical work Sections of the Specification. It is a supplement to each Section and shall be read accordingly.

### 1.2 Submittals

- .1 **Product Data Sheets & WHMIS Sheets:** Submit a product data sheet and a WHMIS sheet for each insulation system product. Product data sheets must confirm that the product conforms to requirements and insulation thickness of referenced Codes, Standards, and thermal conductivity and density values.

### 1.3 Definitions

- .1 “Concealed” means insulated mechanical services and equipment located in suspended ceiling spaces, non-accessible chases, and furred-in spaces.
- .2 “Exposed” means not concealed as defined above and visible to building occupants.
- .3 “Insulation system” means insulation material, fasteners, jacket, vapour barrier and any other accessory.
- .4 “BCICA” means British Columbia Insulation Contractors Association.
- .5 “Mineral fibre” means glass fibre, rock wool fibre, and slag wool fibre.
- .6 “WHMIS sheets” means Workplace Hazardous Materials Information System sheets
- .7 “TIAC” means Thermal Insulation Association of Canada.

### 1.4 Quality Assurance

- .1 **Insulation System Materials, Application, and Finishes:** Insulation system materials, application, and finishes must, as a minimum, conform to the standards listed in the current version of the BCICA “Quality Standards for Mechanical Insulation.”
- .2 **Insulation Values:** Minimum piping and duct insulation thickness / R values shall conform to the current version of National Energy Code for Canada for Buildings and ASHRAE 90.1 Section 6 - Heating, Ventilation and Air Conditioning & Section 7 – Service Water Heating.
- .3 **Qualification of Applicators:** Mechanical insulation shall be applied by tradespersons with a BCICA membership and a Red Seal or TQ designation in the Heat and Frost Insulation Trade. Registered apprentice tradespersons must be under direct, daily, on-site supervision of a journeyman.
- .4 Do not apply insulation unless leakage tests have been satisfactorily completed.
- .5 Ensure that all surfaces to be insulated are clean and dry.
- .6 Ensure that the ambient temperature is minimum 13°C (55°F) for at least one day prior to the application of insulation, and for the duration of insulation work, and that relative humidity is and will be at a level such that mildew will not form on insulation materials.
- .7 All insulation materials must be stored on site in a proper and dry storage area. Any wet or damaged insulation material shall be removed from the site and replaced.
- .8 **Independent Inspection BCICA Quality Assurance Certificate Program (QACP)**
  - .1 The Contractor shall register the project with BCICA and shall undertake the requirements of the QACP. All costs for undertaking the QACP shall be included as part of the Contractors costs.
  - .2 Inspection of the insulation systems shall be completed as required under the QACP and shall be performed by an independent inspector specifically designated by the BCICA for the purpose of inspecting insulation work.

- .3 QACP inspectors shall provide written field reports at regular intervals in conjunction with the construction work. These reports shall be forwarded to the Engineer and the Owner.
- .4 Correct and remediate all installation in accordance with the QACP inspector requirements.
- .5 At Substantial Performance of the work, furnish the Engineer and Owner with a BCICA Quality Assurance Certificate for the mechanical insulation work in accordance with the BCICA QACP.

## 2 PRODUCTS

### 2.1 Base Bid and Acceptable Manufacturers

- .1 Refer to the article entitled Base Bid and Acceptable Manufacturers in the Section 20 05 10 – Basic Mechanical Materials and Methods.

### 2.2 Fire Hazard Ratings

- .1 Unless otherwise specified, all insulation system materials inside the building must have a fire hazard rating of not more than 25 for flame spread and 50 for smoke developed when tested in accordance with CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.

### 2.3 Thermal Performance

- .1 Unless otherwise specified, thermal performance, i.e. conductivity, of insulation shall meet or exceed the values given in the current version of the National Energy Code of Canada for Buildings and ANSI/IES/ASHRAE Standard 90.1.
- .2 Insulation thickness around pipe fittings, including shoulders and hardware, to be the same installed thickness as the adjacent or adjoining pipe insulation. Pipe and fitting insulation to be equal thickness and thermal performance throughout the entire system.
- .3 Pipe insulation to be continuous through hanging supports, walls, ceilings and floors. Hangers, supports, anchors, etc. that are secured directly to cold surfaces (ie: piping) will be adequately insulated and vapour sealed to prevent condensation.

### 2.4 Ductwork System Insulation Materials

- .1 **BCICA Standard 1502, Type A2, Rigid Mineral Fibre Board:** Preformed board type insulation to ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation, with a factory applied reinforced aluminum foil and kraft paper facing.
  - .1 Knauf Fiber Glass Insulation Board with FSK facing
  - .2 Manson Insulation Inc. "AK BOARD FSK"
  - .3 Johns Manville Inc. Type 814 "Spin-Glas"
  - .4 Owens Corning 703, 704
- .2 **BCICA Standard 1502, Type B2, Flexible Mineral Fibre:** Roll form insulation to ASTM C1393, Standard Specification for Perpendicularly Oriented Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks, with a factory applied vapour barrier facing consisting of cut strips of rigid mineral board insulation glued to an aluminium foil and kraft paper facing.
  - .1 Multi-Glass Insulation Ltd. "Multi-Flex MKF"
  - .2 Glass-Cell Fabricators Ltd. "R-FLEX"
  - .3 Owens Corning Pipe and Tank Insulation
- .3 **Blanket Mineral Fibre:** Blanket type roll form insulation to ASTM Standard C553, Standard Specification for Mineral Fibre Blanket Thermal Insulation, 24 kg/m<sup>3</sup> (1½ lb./ft.<sup>3</sup>) density, 40 mm (1½") thick, with a factory applied vapour barrier facing. Acceptable products are:

- .1 Knauf Fiber Glass Blanket Insulation with multi-purpose "FSK" facing
- .2 Manson Insulation Inc. "ALLEY WRAP FSK"
- .3 Johns Manville Inc. Duct Wrap Type 150 "Microlite"
- .4 Isofab Faced Flexible FSK Insulation

## 2.5 Insulation Fastenings

- .1 **Stainless Steel Banding:** Equal to Childers Products Co. "FABSTAPS" 0.6 mm (1/16") thick, minimum 12 mm (½") wide type 304 stainless steel strapping.
- .2 **Duct Insulation Fasteners:** Weld-on 2 mm (3/32") diameter zinc coated steel spindles of suitable length, complete with minimum 40 mm (1½") square zinc plated steel self-locking washers.
- .3 **Tape Sealant:** Equal to MACTac Canada Ltd. self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match the surface being sealed.
- .4 **Adhesive - Mineral Fibre Insulation:** Clear, pressure sensitive, brush consistency adhesive, suitable for a temperature range of -20°C to 82°C (-4°F to 180°F), compatible with the type of material to be secured, WHMIS classified as non-hazardous,
- .5 **Adhesive – Flexible Elastomeric Insulation:** Armacell "Armaflex" #520 air-drying contact adhesive.
- .6 **Adhesive – Closed Cell Foamed Glass Insulation:** Equal to Pittsburgh Corning PC88 multi-purpose two-component adhesive.

## 2.6 Insulation Jackets and Finishes

- .1 **BCICA Type D2, Rigid Aluminium:** Equal to Childers Metals "Lock-on" 0.406 mm (5/32") thick embossed aluminum jacket material to ASTM B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate, factory cut to size and complete with moisture barrier and continuous modified Pittsburgh Z-Lock, and "Fabstraps" and butt straps to cover end to end joints. Fittings are to be 2-piece epoxy coated pressed aluminum with weather locking edges. Do not use screws or tacks that will compromise vapor seal under covers.
- .2 **BCICA Type D3, Stainless Steel:** Equal to Childers Metals "Lock-on" 0.254 mm (3/32") thick type 304 embossed stainless steel to ASTM A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strap for Pressure Vessels and for General Applications, factory cut to size and complete with moisture barrier and continuous modified Pittsburgh Z-Lock, and butt straps with "Fabstraps" to cover end to end joints. Fittings are to be 2-piece pressed stainless steel with weather locking edges. Do not use screws or tacks that will compromise vapor seal under covers.
- .3 **Adhesive Backed Flexible Aluminium:** MFM Building Products Corp. "Flex-Clad 400" roll form sheet material with an aggressive rubberized asphalt adhesive backing, high density polyethylene reinforcement, and an embossed aluminum facing. Do not use screws or tacks that will compromise vapor seal under covers.
- .4 **Valve, Etc. Covers:** "No Sweat Valve Wrap Inc." "NO SWEAT" reusable insulation wraps with vapour barrier jacket and self-sealing ends and longitudinal seam, with a length to suit the application and an insulation thickness equal to the adjoining insulation.
- .5 Do not use screws or tacks that will compromise vapor seal under covers.
- .6 Do not use screws or tacks that will compromise vapor seal under covers.

## 2.7 Duct Lining

- .1 Minimum 25 mm (1") thick acoustic lining material meeting NFPA 90A requirements, requirements of ASTM C1071, Standard Specification for Fibrous Duct Lining Insulation (Thermal and Sound Absorbing Material), and flame spread and smoke developed fire hazard ratings of CAN/ULC-S102, flexible for round ducts, board type for rectangular ducts,

consisting of a bonded fiberglass mat coated on the inside (airside) face with a black fire-resistant coating.

.1 Where shown on drawings.

.2 Minimum 25 mm (1") thick acoustic lining material meeting NFPA 90A requirements, and flame spread and smoke developed fire hazard ratings of CAN/ULC-S102, flexible, consisting of NBR/PVC based closed-cell, flexible elastomeric foam thermal and acoustic insulation. UL Greenguard gold-certified for low VOC emissions. K-Flex Duct Liner Gray or equivalent.

.1 Where shown on drawings and on all classroom supply air ductwork, minimum 3 meters from outlet of unit ventilator plenum.

## **2.8 Firestopping**

.1 Refer to Section 20 05 60 – Firestopping and Smoke Seal Systems

## **3 EXECUTION**

### **3.1 General Insulation Application Requirements**

- .1 Do not apply insulation unless leakage tests have been satisfactorily completed.
- .2 Ensure that all surfaces to be insulated are clean and dry.
- .3 Ensure that the ambient temperature is minimum 13° C (55° F) for at least one day prior to the application of insulation, and for the duration of insulation work, and that relative humidity is and will be at a level such that mildew will not form on insulation materials.
- .4 All insulation materials must be stored on site in a proper and dry storage area. Any wet insulation material is to be removed from the site and replaced. Repair damaged insulation jackets.
- .5 Install insulation directly over pipes and ducts and not over hangers and supports.
- .6 Install piping insulation and jacket continuous through pipe openings and sleeves.
- .7 Install duct insulation continuous through walls, partitions, and similar surfaces except at fire dampers.
- .8 When insulating "cold" piping and equipment, extend insulation up valve bodies, temperature gauges, shut-off valves and other such projections as far as possible, and protect the insulation jacketing from the action of condensation at its junction with the metal.
- .9 When insulating vertical piping risers 75 mm (3") diameter and larger, use insulation support rings welded directly above the lowest pipe fitting, and thereafter at 4.5 m (15') centres and at each valve and flange. Insulate as per Thermal Insulation Association of Canada National Insulation Standards, Figure No. 9.
- .10 Where mineral fibre rigid sleeve type insulation is terminated at valves, equipment, unions, etc., neatly cover the exposed end of the insulation with a purpose made PVC cover on "cold" piping, and with canvas jacket material on "hot" piping, or with barrier mastic.
- .11 Insulation thickness must be maintained even where there is interference between weld bead, mechanical joints, etc. Bevel away from studs and nuts to permit their removal without damage to insulation, and closely and neatly trim around extending parts of pipe saddles.
- .12 Where thermometers, gauges, and similar instruments occur in insulated piping, and where access to heat transfer piping balancing valve ports and similar items are required, create a neat, properly sized hole in the insulation and provide a suitable grommet in the opening.
- .13 Insulate, vapour seal, and finish all seismic restraints, braces, anchors, hanger rods, and similar hardware directly connected to "cold" piping and/or equipment, for a distance of 300 mm (12") clear of the adjacent pipe or equipment finish, to match the piping and/or equipment insulation.

- .14 Where existing insulation work is damaged as a result of a new mechanical work, repair the damaged insulation work to new work standards.

### 3.2 Insulation for Pipe Mechanical Joint Fittings & Couplings, etc.

- .1 Provide manufactured insulation fittings, the same thickness as the adjoining pipe insulation, for mechanical joint fittings and couplings, and for piping at riser clamps through the floor. Cover with purpose made full thickness PVC covers with joints sealed with tape.

### 3.3 Insulation for Horizontal Pipe at Hangers and Supports

- .1 At each hanger and support location for piping 50 mm (2") diameter and larger and scheduled to be insulated, except where roller hangers and/or supports are required, and unless otherwise specified, supply a factory fabricated section of phenolic foam pipe insulation with integral vapour barrier jacket and captive galvanized steel shield. Supply the insulation sections to the piping installers for installation as the pipe is erected.
- .2 For 100 mm (4") diameter and larger heating system piping where roller type hangers and supports are provided, a steel saddle will be tack welded to the pipe at each roller hanger or support location. Pack saddle voids with loose mineral fibre insulation.
- .3 Coordinate the pre-insulated pipe supports with the mechanical contractor.

### 3.4 Valve Stem Extensions

- .1 Valve stem extensions are required where valve operation will damage or come in contact with the vapor and mechanical insulation jacket.

#### .1 Exposed Insulation finish:

##### Exposed Outside the Building – PF4 Metal Jacket

- .1 Over the pipe insulation, apply aluminum metal jacket using necessary fastenings at minimum 150mm centres including refrigerant piping.
- .2 Over insulated fittings, valve bodies, valve bonnets, strainers and flanges, apply metal jacket or preformed metal fittings to provide a complete metal jacket system. Secure with necessary fastenings.
- .3 Alternatively, 3M VentureClad 1577CW" [3M VentureClad 1577CW-E" stucco embossed surface finish]: A zero permeable, all weather, multi-layered laminate coated with a cold weather acrylic adhesive, resistance to weathering, fungi, UV and extreme environmental conditions may be considered. Install to all manufacturer's recommendations.

#### Note:

- The use of PVC jacketing or fitting covers is limited by the Building Code or by-law requirements for smoke/flare developed classification.
- Where continuous vapour barrier is required, the use of penetrating type fasteners will be avoided and if required, such fasteners shall be sealed to maintain the vapour barrier performance.
- PF-3 Economy finish should only be used where finished appearance is not important.

### 3.5 Ductwork System Insulation Requirements – Inside Building

- .1 Insulate duct systems inside the building and above ground, as scheduled below, in accordance with BCICA Quality Standard 1502, Ductwork and Plenums, as follows:

#### .1 Material:

- .1 Type A2 rigid mineral fibre for exposed rectangular ducts, and all plenums.

.2 Type B2 flexible mineral fibre for concealed rectangular ducts, and concealed and exposed round or oval ducts.

**.2 Insulation application:**

- .1 ER/1 for heating and ventilating system rigid insulation.
- .2 ER/2 for heating and air conditioning system rigid insulation.
- .3 EF/1 for heating and ventilation system flexible insulation.
- .4 EF/2 for heating and air conditioning system flexible insulation.

**.3 Insulation finish: RF/3 for exposed duct systems.**

**3.6 Duct System Insulation Requirements – Outside Building**

- .1 Insulate all exposed exterior ductwork and any associated casings and plenums (except fresh air intake systems) outside the building and above ground, with 19 mm (3/4") thick flexible foam elastomeric sheet insulation applied in 2 layers with staggered tightly butted joints and secured in place with adhesive in strict accordance with the insulation manufacturer's instructions. Ensure that sheet metal joints are sealed water-tight prior to the insulation application.
- .2 Alternatively, 3M VentureClad 1577CW" [3M VentureClad 1577CW-E" stucco embossed surface finish]: A zero permeable, all weather, multi-layered laminate coated with a cold weather acrylic adhesive, resistance to weathering, fungi, UV and extreme environmental conditions may be considered. Install to all manufacturer's recommendations.

**3.7 Common Duct System Insulation Requirements:** Insulation application requirements common to all types of rigid ductwork are as follows:

- .1 At duct connection flanges insulate the flanges with neatly cut strips of the rigid insulation material secured with adhesive to side surfaces of the flange with a top strip to cover the exposed edges of the side strips, then butt the flat surface duct insulation up tight to the flange insulation, or alternatively, increase the insulation thickness to the depth of the flange and cover the top of the flanges with tape sealant.
- .2 The installation of fastener pins and washers shall be concurrent with the duct insulation application.
- .3 Cut insulation fastener pins almost flush to the washer and cover with neatly cut pieces of tape sealant.
- .4 Accurately and neatly cut and fit insulation at duct accessories such as damper operators (with standoff mounting) and pitot tube access covers.
- .5 Prior to concealment of insulation by either construction finishes or canvas jacket material, patch all vapour barrier damage by means of tape sealant.

**3.8 Equipment Insulation Requirements – Inside Building**

- .1 Insulate equipment inside the building the building, as scheduled below, in accordance with BCICA Quality Standard 1503, Equipment, as follows:
  - .1 **Material:** Type A1D semi-rigid mineral fibre.
  - .2 **Insulation application:**
    - .1 1503-H for hot tanks and equipment.
    - .2 1503-C for cold tanks and equipment.
  - .3 **Insulation finish:**
    - .1 EF/2 for hot tanks and equipment.
    - .2 CF/2 for cold tanks and equipment.

### 3.9 Equipment Insulation Requirements – Removable/Reusable Type

- .1 Provide custom designed and manufactured removable and reusable insulation covers for the following:
- .2 Provide "wrap type" removable and reusable insulation covers for "cold" circuit balancing valves, backflow preventers, and similar items, and for steam traps and similar items requiring service in piping less than 150 mm (6") diameter.

### 3.10 Duct Wrap Requirements – Fire Rated Material

- .1 Provide blanket type fire rated duct wrap system material for the following ductwork to produce the fire rating indicated:
- .2 Install the duct wrap material in accordance with ULC design requirements and the wrap supplier's instructions.
- .3 Coordinate installation of duct wrap with the installation of the ductwork.
- .4 Arrange and pay for the duct wrap supplier to examine the completed duct wrap system at the site. Submit a letter from the supplier to certify that the duct wrap system has been properly installed.

### 3.11 Application of Insulating and Protective Coatings

- .1 Apply insulating and protective coatings in accordance with the manufacturer's instructions. Remove any splatter from adjacent surfaces. Apply insulating/protective coating to the following surfaces:
  - .1 Paint all bare metal surfaces clear of "cold" piping and/or equipment insulation for a distance of from 300 mm (12") to 600 mm (24") clear of the pipe or equipment insulation, with "No Sweat-FX" anti-condensation coating.
  - .2 Paint all bare metal surfaces associated with mechanical systems with an operating temperature 60°C (140°F) with "thermalite" insulating coating.
  - .3 Paint all seismic restraint hardware such as hanger rods, braces, anchors, etc., as specified on .1 and .2 above
  - .4 Coat elastomeric foamed insulation (pipe & duct) with 1 coat of the specified coating on all insulation inside the building and 2 coats (with 24 hours between coats) of the specified coating on all insulation outside the building.

### 3.12 Insulation Finish Requirements

- .1 **Protective Coating – Flexible Elastomeric Insulation:** Apply 1 coat of the specified coating to all insulation inside the building. Apply 2 coats (with 24 hours between coats) of the specified coating to all insulation outside the building.

### 3.13 Installation of Duct Lining

- .1 Provide acoustic lining in ductwork in locations as follows:
  - .1 Wherever shown and/or specified on the drawings.
  - .2 For all transfer air ducts.
- .2 Install lining in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, for all installations regardless of velocity, at leading and trailing edges of duct liner sections, provide galvanized steel nosing channel as per the detail entitled Flexible Duct Liner Installation found in the ANSI/SMACNA manual referred to above.

### 3.14 Insulation of Seismic Restraint Hardware:

- .1 Insulate all seismic restraint hardware such as hanger rods, braces, anchors, etc., directly connected to "cold" category piping and equipment for a distance of 300 mm (12") from the piping or equipment with insulation and finish to match the pipe or equipment insulation.

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Coat all seismic restraint hardware for a distance of 300 mm (12") from the termination of the insulation with Robson Thermal "NO-SWEAT-FX" water based anti-condensation coating.

**End of Section**

## 1 GENERAL

### 1.1 Application

- .1 This Section specifies requirements for supply of motor starters, motor control centres, and mechanical wiring for mechanical work that are common to mechanical work Sections of the Specification and it is a supplement to each Section and shall be read accordingly.

### 1.2 Submittals

- .1 **Product Data:** Submit product data sheets for all products specified in this Section except conduit, wiring and accessories. Include all construction and performance details with the submission, as well as wiring and control schematics.
- .2 **Switch Keys:** Submit three identified keys for each key operated manual motor starting switch.

### 1.3 Quality Assurance

- .1 Motor starters shall be accordance with the following standards:
  - .1 CSA-C22.2 N0. 14, Industrial Control Equipment.
  - .2 Tri-National Standard CAN/CSA-60947-4-1/UL 60947-1A/NMX-J-Z90-ANCE, Low Voltage Switchgear and Controlgear-Part 4-1: Contactors and Motor Starters-Electromechanical Contactors and Motor Starters.

## 2 PRODUCTS

### 2.1 Motor Starters

- .1 **General:** General requirements for motor starters are as follows:
  - .1 All motor starters must be capable of starting the associated motors under the imposed loads.
  - .2 Confirm that starter voltage matches the motor prior to ordering.
  - .3 Unless otherwise specified, all motor starters (and disconnect switches) are to have a 50,000 symmetrical SCIA (short circuit interrupting ampacity).
  - .4 Equip starters with accessories and modifications as per the drawing motor starter schedule.
  - .5 Equip every starter associated with a building fire alarm system fan shutdown with a double voltage relay with suitable coil voltage.
- .2 **Single Phase Motor Starters:** Unless otherwise specified or scheduled single phase motor starters are to be manual motor starting switches, each suitable in all respects for the motor it controls and complete with a neon "ON" pilot light, a snap action toggle operator designed to prevent the switch from being held closed under a sustained motor overload, an enclosure to suit the application, and properly sized thermal overload protection which can be reset by moving the toggle to the "OFF" position.
- .3 **Starters for Three Phase Motors Less Than 25 HP:** Unless otherwise specified, starters for three phase motors less than 25 HP are to be combination "quick-make" and "quick-break" fused disconnects and full voltage non-reversing across-the-line starters, each complete with a properly sized thermal overload relay per phase, a 120 volt holding coil, and an enclosure to suit the application.

### 2.2 Motor Control Centres

- .1 Multi-unit, modular, 2.4 m (8') high overall, minimum 300 mm (12") high modules, EEMAC Class II, type "B", factory assembled, dead front, floor mounting, free-standing, front accessible motor control centre(s) as per drawing schedule and details, each capable of operating continuously in a 40° C (105° F) ambient temperature and complete with accessible horizontal and vertical tin plated copper bus including ground bus with grounding lugs, wiring gutter barriered from bus compartments, blank spaces with hinged covers and full bussing where indicated, and an EEMAC Type 1 or Type 2 enclosure as for loose starters specified above. Each motor control centre exterior shall be finished with ASA 61

grey enamel and each interior shall be finished with white enamel. Each motor control centre shall be equipped with starters as specified above, load and barriered control wiring terminal boards, and all required facilities for line and load side power wiring connections.

- .2 The external operating handle of each disconnecting device shall be identified with "ON" and "OFF" indication, and each handle shall be interlocked with the module door such that the handle must be in the "OFF" position before the door can be opened.

### 2.3 Disconnect Switches for Motor Control Centres

- .1 Heavy-duty, CSA certified, front operated switches as per the motor starter schedule, each complete with a handle suitable for padlocking in the "off" position and arranged so that the door cannot be opened with the handle in the "on" position and an EEMAC enclosure as specified for loose starters. Fusible units are to be complete with fuse clips to suit fuse types specified below.

### 2.4 Fuses

- .1 **Fuses:** Unless otherwise scheduled or specified, English Electric Ltd. HRC fuses, Form I Class "J" for constant running equipment and Form II Class "C" for equipment that cycles on and off.

### 2.5 Motor Starter Panels

- .1 Level #14 gauge G60 galvanized sheet steel panel with rolled edges, sized to suit the number of starters/disconnect switches to be mounted plus 20% blank space, secured to a galvanized steel angle framework suitable for wall mounting and equipped with a suitable length of splitter trough to feed the starters/disconnects.

### 2.6 Warning Signs

- .1 Appropriately sized white PVC warning signs with red lettering, screw holes, and stainless steel screws.

## 3 EXECUTION

### 3.1 Supply of Motor Starters and Accessories

- .1 Unless otherwise shown or specified, supply a starter for each item of motorized equipment you provide. Refer to the drawing Motor Starter Schedule.
- .2 **Disconnect Switches in Motor Control Centres:** Where package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with the equipment is fed from a motor control centre, provide a disconnect switch in the motor control centre in lieu of a motor starter.
- .3 **Three Phase Motor Starters on Motor Starter Panels:** Where three phase starters are indicated and/or scheduled to be mounted on a motor starter panel, provide the panel(s). The starters will be mounted and connected, complete with the panels and splitter trough, as part of the electrical work. Hand the starters to the electrical trade at the site when they are required.
- .4 **Disconnect Switches on Motor Starter Panels:** Where package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with the equipment is fed from a motor starter panel, a disconnect switch will be provided on the motor starter panel as part of the electrical work
- .5 **Single Phase Motor Starters:** Unless otherwise specified or shown on the drawings, single phase motor starters will be mounted adjacent to the equipment they serve and connected complete as part of the electrical work. Hand the starters to the electrical trade at the site at the proper time.
- .6 **Warning Signs:** Provide warning signs at starter locations where required, i.e. "Motor is Under Automatic Control and May Start at Any Time without Warning".

### 3.2 Electrical Wiring Work for Mechanical Work

- .1 Unless otherwise specified or indicated, the following electrical wiring work for mechanical equipment will be done as part of the electrical work:
  - .1 "Line" side power wiring to motor starters or disconnect switches in motor control centres and starters or disconnects on motor starter panels, and "load" side wiring from the starters or disconnects to the equipment.
  - .2 "Line" side power wiring to individual wall mounted starters, and "load" side wiring from the starters to the equipment.
  - .3 "Line" side power wiring to pre-wired power and control panels and variable frequency drives, and "load" side power wiring from the panels and VFD's to the equipment.
  - .4 Provision of receptacles for plug-in equipment.
  - .5 Provision of disconnect switches for all motors that are in excess of 10 m (30') from the starter location, or that cannot be seen from the starter location, and all associated power wiring.
  - .6 All motor starter interlocking in excess of 24 volts.
  - .7 Wiring from motor winding thermistors in motors 30 HP and larger to motor starter contacts.
  - .8 Provision of dedicated 120 volt, 15A-1P circuits terminated in junction boxes in mechanical equipment rooms for automatic control and building automation system wiring connections to be made as part of the automatic controls work.
  - .9 120 volt power connections to electrical receptacles integral with small ceiling exhaust fans, including wiring through light switches or speed controllers.
  - .10 120 volt wiring connections to lighting fixture/switch combinations integral with air handling units.
  - .11 120 volt wiring connections to duplex receptacles integral with air handling unit control panels.
- .2 Mechanical wiring work not listed above or specified herein or on the drawings to be done as part of the electrical work shall be installed in conduit and shall be done as part of the mechanical work in accordance with wiring requirements specified for the electrical work.

### 3.3 Installation of Motor Control Centres

- .1 Provide motor control centres where shown.
- .2 Secure each MCC in place on a concrete housekeeping pad.
- .3 Ensure that the electrical trade connecting the MCC's tightens all accessible bus connections using a torque wrench in accordance with the MCC manufacturer's instructions, and does all "load" and "line" side wiring.
- .4 Ensure that all motor starter interlocking work is performed in accordance with Contract Document control diagrams and sequences.
- .5 Supply a complete set of spare identified fuses for each fuse protected device and store in an identified wall mounted steel cabinet within the Electrical Room.
- .6 If MMC and component identification is not factory installed, install at the site using stainless steel screws.
- .7 Coordinate building automation system connections to MCC hardware with the mechanical trade doing the building automation system work. Assist as required during testing and commissioning of the BAS.
- .8 **Equipment and System Manufacturer's Certification:** Refer to the article entitled Equipment and System Manufacturer's Certification in the Mechanical Work General Instructions Section.
- .9 **Start-Up:** Refer to the article entitled Equipment and System Start-up in the Mechanical Work General Instructions Section.
- .10 **Commissioning:** Commission equipment after successful start-up and submittal of reports.

- .11 **Demonstration and Training:** Refer to the article entitled Equipment and System O&M Demonstration & Training in the Mechanical Work General Instructions Section. Include for one 8 hour day of on-site operation demonstration and training for 2 groups of 6 people.

**END OF SECTION**

## **1 GENERAL**

### **1.1 Application**

- .1 This Section specifies requirements, criteria, methods, and execution for mechanical demolition work that are common to one or more mechanical work Sections, and it is intended as a supplement to each Section and shall be read accordingly.

### **1.2 Submittals**

- .1 Submit documentation to confirm that reclaimed refrigerant has been properly removed and stored, recycled, or disposed of as applicable.

### **1.3 Reference Standard**

- .1 Perform demolition work in accordance with requirements of CAN/CSA-S350, Code of Practice for Safety in Demolition of Structures.

## **2 PRODUCTS**

### **2.1 NOT APPLICABLE**

## **3 EXECUTION**

### **3.1 Disconnection and Removal of Existing Mechanical Work**

- .1 Where indicated on the drawings, disconnect and remove existing mechanical work, including hangers, supports, insulation, and similar items. Disconnect at the point of supply, remove obsolete connecting services, and make the system safe. Cut back obsolete piping behind finishes, identify, and cap water-tight unless otherwise specified.
- .2 The scope and extent of the demolition or revision work is only generally indicated on the drawings. Estimate the scope, extent, and cost of the work at the site during the bidding period scheduled site visit(s).
- .3 Where concealed conditions differ from those indicated on the drawings, immediately notify the Consultant.
- .4 Where utilities are removed, relocated, or abandoned, cap, valve, plug, or by-pass to produce a complete and working installation.
- .5 Where deemed necessary by the Owner and Consultant, existing shafts, walls, and inaccessible ceilings will be opened by the Owner to permit site visit inspection of services to be removed/revised as part of the work but usually concealed behind such construction.
- .6 Claims for extra costs for demolition work not shown or specified but clearly visible or ascertainable at the site during bidding period site visits will not be allowed.
- .7 If existing isolation valves are not available to isolate sections of piping to be removed, provide such valves as required. Determine this requirement at the site during the bidding period.
- .8 Where existing valves are removed, remove the valve tags, revise existing valve tag charts, and hand the obsolete tags to the Owner.
- .9 If any re-design is required due to discrepancies between the mechanical drawings and site conditions, notify the Consultant who will issue a Site Instruction. If, in the opinion of the Consultant, discrepancies between the mechanical drawings and actual site conditions are of a minor nature, the required modifications are to be done at no additional cost.
- .10 Where existing mechanical services extend through, or are in an area to serve items which are to remain, maintain the services in operation. Include for rerouting existing services concealed behind existing finishes and which become exposed during the renovation work, so as to be concealed behind new or existing finishes.

- .11 Unless otherwise specified, remove from the site and dispose of all existing materials which have been removed and are not to be relocated or reused.
- .12 When existing DDC controls devices are being removed such as valves or sensors, update the DDC graphics to accurately reflect the changes. Notify the controls contractor of any control devices removed during demolition.

### **3.2 Roofing Work**

- .1 Where roof revisions and/or replacements are part of the project, include for disconnecting, lifting, or temporarily removing mechanical equipment on the roof as required to permit completion of the roofing work, and for re-installing the equipment when the roofing work is complete.

### **3.3 Making Good**

- .1 Where existing building surfaces and finishes are cut or other wise disturbed to permit demolition work, you are responsible for "making good" the existing surfaces and finishes.
- .2 "Making good" means providing new surfaces and finishes identical to the surfaces and finishes cut or disturbed with no visible difference between new and existing.
- .3 Where painting is required, paint the entire surface between the nearest adjacent corners, i.e. the entire plane surface incorporating the cut or disturbed surface.

**END OF SECTION**

## 1 GENERAL

### 1.1 Application

- .1 This Section specifies commissioning requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and shall be read accordingly.

### 1.2 Reference

- .1 Refer to commissioning requirements specified in Division 01.

### 1.3 Commissioning Agent Involvement vs Warranty Obligations

- .1 The involvement of the Commissioning Agent performing duties as described in this Section does not in any way void or alter any Contractual warranty obligations.

### 1.4 Submittals

- .1 **Shop Drawings/Product Data Sheets:** Submit to the Commissioning Agent, at the same time as submittal to the Consultant, 1 copy of each shop drawing or product data sheet associated with equipment or systems to be commissioned.
- .2 **Commissioning Plan, Procedures, Schedule, and Data Sheets:** Submit for review, a Commissioning Plan with schedule, commissioning procedures for all commissioning events, and a copy of the Commissioning Agent's commissioning data sheets for all equipment/systems to be commissioned.
- .3 **List of Commissioning Instruments:** Submit a list of commissioning instruments and for each instrument, indicate the purpose of the instrument and include a recent calibration certificate.
- .4 **Start-Up and Test Report Sheets:** Submit equipment and system manufacturer's start-up and test report sheets for review a minimum of 1 month prior to equipment and system start-up procedures.
- .5 **Letters to Certify Readiness for Functional Performance Testing:** After start-up and successful pre-functional performance testing and submittal of completed forms, submit, for each system or subsystem, a letter to confirm that pre-functional performance testing has been successfully completed and the system or subsystem is ready for functional performance testing and the commissioning process to commence.

### 1.5 Definitions

- .1 The following are definitions of words used in this Section:
  - .1 **Commissioning:** the process of demonstrating to the Owner and Consultant, for the purpose of final acceptance, by means of successful and documented functional performance testing, that all systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of the Contract Documents, all as further described below.
  - .2 **Commissioning Agent:** the commissioning authority who will supervise the commissioning process, and who will recommend final acceptance of the commissioned mechanical work.
  - .3 **Start-Up and Adjusting:** the process of equipment manufacturer's/supplier's technical personnel, with the Contractor, starting and operating equipment and systems, making any required adjustments, documenting the process, and submitting manufacturer's/supplier's start-up reports to confirm that the equipment has been properly installed and is operational as intended, and a pre-requisite to operational performance testing.
  - .4 **Operational Performance Testing:** testing, adjusting and operating of components, equipment, systems and/or subsystems, by the Contractor, after start-up but before functional performance testing, to confirm that all components, equipment, systems and/or subsystems operate in accordance with requirements of the Contract

Documents, including all modes and sequences of control and monitoring, interlocks, and responses to emergency conditions, and including submittal of pre-functional performance testing documentation sheets.

- .5 **Functional Performance Testing:** a repeat of successful operational performance testing by the Contractor, in the presence of the Commissioning Agent and Consultant with completed Commissioning Agent's commissioning documentation sheets to document, validate and verify that the equipment, systems and subsystems are complete in all respects, function correctly, and are ready for acceptance.
- .6 **Commissioning Documentation Sheets:** prepared sheets for operational performance testing and for functional performance testing supplied by the Commissioning Agent for each piece of equipment/system to be commissioned, each sheet or set of sheets complete with the Project name and number, date of commissioning, equipment/system involved, equipment/system name and model number, equipment tag as per the drawings, and, for each commissioning procedure listed, a column giving the expected data as per the Contract Documents, a column to fill in the observed data during commissioning, and space for signatures of the Contractor and Commissioning Agent.
- .7 **BAS:** building automation system.
- .8 **Systems Operating Manual:** a manual prepared by the Commissioning Agent to present an overview of the building mechanical systems and equipment to be used by building maintenance personnel to assist them in daily operation of the systems.
- .9 **Validate:** to confirm by examination and witnessing tests the correctness of equipment and system operation.

## 1.6 Commissioning Agent

- .1 Retain the services of a qualified Commissioning Agent.

## 1.7 Quality Assurance

- .1 Commissioning work shall be in accordance with requirements of the following:
  - .1 CSA Standard Z320, Building commissioning.
  - .2 ASHRAE Guideline 1.2, The Commissioning Process for Existing HVAC&R Systems.
  - .3 ASHRAE Guideline 1.5, Commissioning Smoke Control Systems.
- .2 The Commissioning Agent shall meet the following qualifications:
  - .1 Be a member of the Professional Engineers Association in the Province of the work.
  - .2 Be a member of the Building Commissioning Association, and a Certified Commissioning Professional (CCP) as designated by the Building Commissioning Association.
  - .3 Have a minimum of 5 years of successful documented commissioning experience on projects of similar size and complexity as this Project.
  - .4 Supply a qualified P. Eng. and a Building Commissioning Association Certified Commissioning Professional (CCP) or an ASHRAE Commissioning Project Management Professional (CPMP) on site to supervise the commissioning process.

## 1.8 Commissioning Objectives

- .1 Objectives of the commissioning process are as follows:
  - .1 To support quality management by means of monitoring and checking the installation.
  - .2 To verify equipment/system performance by means of commissioning of the completed installation.
  - .3 To move the completed equipment/systems from the "static completion" state to the "dynamic" operating state so as to transfer a complete and properly operating installation from the Contractor to the Owner.

## 1.9 Testing Equipment

- .1 The Contractor shall supply all instruments and test equipment required to conduct start-up and testing. The Commissioning Agent shall supply all instruments and test equipment required commissioning procedures.

**1.10 LEED Commissioning Requirements**

- .1 Refer to the mechanical work Section entitled LEED Certification Requirements.
- .2 In addition to the commissioning specified in this Section, perform all tasks consistent with the Project achieving LEED credits specified in the LEED Certification Requirements Section.

**2 PRODUCTS**

2.1 *NOT APPLICABLE*

**3 EXECUTION**

**3.1 Commissioning**

- .1 Commission the mechanical work in accordance with requirements of this Section of the Specification.
- .2 **Prerequisites to Commissioning:** Prerequisites to successful completion of commissioning are as follows:
  - .1 Submittal of signed start-up and test reports.
  - .2 Completion by the Contractor of system testing, adjusting, and balancing, and acceptance of the TAB reports.
  - .3 Permanent electrical and control connections of all equipment.
  - .4 Successful completion and documentation of operational performance testing.
  - .5 Submittal of letters to the Consultant certifying that the systems and subsystems have been started, tested, adjusted, successfully operationally performance tested, are ready for functional performance testing, and are in accordance with requirements of the Contract Documents.

**3.2 Phasing of Commissioning**

- .1 The Project will be constructed in phases as described in the Specification. Commissioning must be phased to suit the progress and phases of the work.

**3.3 Deficiencies Listed During Commissioning**

- .1 Deficiencies listed by the Consultant and Commissioning Agent during the commissioning process are to be corrected by the Contractor within 10 calendar days unless agreed otherwise with the Consultant, and when deficiencies have been corrected, notify the Consultant and Commissioning Agent at once.

**3.4 Systems to be Commissioned**

- .1 Mechanical systems to be commissioned include, but are not to be limited to, the systems described below.
- .2 **Natural Gas System:** Commissioning of the natural gas system shall include all pressure regulating equipment and shall be in accordance with requirements of CAN/CSA-B149.1, and any supplemental requirements of governing authorities.
- .3 **Heating Systems:** Commissioning of heating systems shall include all piping, piping specialties, equipment, and control, as well as checking and validating temperature and flow documentation contained in TAB reports. If TAB is not done during the heating season, a follow-up site visit during the heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .4 **Cooling Systems:** Commissioning of cooling systems shall include all piping, piping specialties, equipment, and control, as well as checking and validating temperature and flow documentation contained in TAB reports. If TAB is not done during the cooling season, a follow-up site visit during the cooling season will be required to confirm proper flows and temperatures, and any required system "fine tuning".

- .5 **Air Handling Systems:** Commissioning of air handling systems shall include all equipment, ductwork, ductwork specialties, controls, interlocks, and checking and validating air capacities and flows as per TAB reports.
- .6 **Controls:** Control work commissioning shall include confirmation of proper operation of all individual control components, and overall operation of the controls in conjunction with the operation of the connected building systems, including heating season/cooling season testing requirements specified above.
- .7 **Building Automation System:** Commissioning of the BAS shall include confirmation of proper operation of all components, all input/output points, all hardware and software, and demonstration of the system performing all required procedures.
- .8 **Noise and Vibration Control Systems:** Commissioning of noise and vibration control equipment shall include noise and vibration measurements to confirm proper operation of the equipment.

### 3.5 Commissioning Process

- .1 The commissioning process shall be performed in stages and shall include, but not be limited to, the following:
  - .1 **Stage 1:** Commissioning of mechanical equipment/systems as listed in this Section, which is a prerequisite to an application for Substantial Performance and includes supervising and validating results of functional performance testing, and submittal of the reviewed Systems Operating Manual.
  - .2 **Stage 2:** Commissioning work to be performed twelve months after issue of a Certificate of Substantial Performance and which includes supervision of the Contractor's "fine tuning" of equipment/systems through seasonal occupancy, and any other such work to achieve optimal comfort and performance conditions.
  - .3 **Stage 3:** Successful completion of satisfactory equipment/system operation during the first month after issue of a Certificate of total Performance of the Work.
  - .4 **Stage 4:** Successful completion of satisfactory equipment/system operation during the 3rd month after issue of a Certificate of total Performance of the Work.
  - .5 **Stage 5:** Successful seasonal commissioning of the building.

### 3.6 Responsibilities of the Commissioning Agent

- .1 **Construction Phase:** During the construction phase the Commissioning Agent shall:
  - .1 Review the Contractor's shop drawings for commissioning related issues, and report any such issues to the Consultant.
  - .2 As soon as possible after project start-up, prepare and issue a Commissioning Plan based on the Contractor's construction schedule.
  - .3 Prior to tests, supply and issue operational performance test commissioning data sheets for all equipment and systems to be commissioned.
  - .4 Monitor and inspect the installation on a regular basis throughout the construction stages, issue reports identifying any issues which may have an impact on the commissioning process, and work with the project team to expeditiously resolve any problems that may arise due to site conditions.
  - .5 Arrange with the Contractor for on-site commissioning meetings on an as-required basis, to be attended by the Contractor and applicable subcontractors, the Owner, and the Consultant, chair the meetings, and prepare and distribute meeting minutes to all attendees.
  - .6 Witness and validate tests, identify deficiencies, and issue progress reports.
  - .7 Coordinate commissioning scheduling with the Contractor.
  - .8 Review the final TAB report on site with the Contractor, and check 100% of TAB results for fan equipment, 30% of TAB results for duct systems outward from fan equipment, and issue a report to the Consultant.
  - .9 For smaller multiple items of equipment such as air terminal boxes, fan coil units, backflow preventers, and similar equipment, review completed commissioning data sheets submitted by the Contractor and review data sheet information on-site with the Contractor for 30% of the quantity of each item of equipment.

- .10 Review operational performance test commissioning data sheets submitted by the Contractor, then witness and supervise functional performance testing and supervise and direct the commissioning process, validate the commissioning procedures, witness completion of commissioning data sheets by the Contractor, and sign the completed data sheets.
  - .11 Perform a preliminary review of the Contractor's O & M Manuals, before they are issued to the Consultant, and issue any comments to the Consultant.
  - .12 Coordinate with the Contractor and Owner the training and instructions by the Contractor and his equipment and system manufacturers/suppliers to the Owner's operating and maintenance personnel, and comment on the quality of the training and instructions to the Consultant.
  - .13 Prepare and issue to the Owner prior to equipment and system training by the Contractor, the Systems Operation Manual.
- .2 **Post Construction Phase:** During the post construction phase the Commissioning Agent shall:
- .1 Prepare and issue the final report on commissioning, identifying any deficiencies that remain outstanding.
  - .2 Recommend any training and/or instructions to be given to the Owner's operating and maintenance personnel in addition to training and instructions already given.
  - .3 After Substantial Performance, witness system checks and validate documentation by the Contractor as follows:
    - .1 Once during the 1st month of building operation.
    - .2 Once during the 3rd month of building operation.
    - .3 Once between the 4th and 10th month of building operation but during a season opposite to the 1st or 3ed month visits.
  - .4 Ensure that any deficient work resulting from system checks described above are corrected.
  - .5 3 months after Substantial Performance, attend a question and answer session(s) with the Contractor to answer any questions and concerns related to commissioning work from the Owner's operating personnel.

### **3.7 Responsibilities of the Consultant**

- .1 **Construction Phase:** Responsibilities of the Consultant are as follows:
- .1 Review the Contractor's shop drawing/product data submissions for general conformance requirements of the Contract, and add any review comments made by the Commissioning Agent as applicable.
  - .2 Review the Contractor's delivery schedule and installation program to ensure that the installation sequences have been coordinated with the construction schedule.
  - .3 Monitor and inspect the mechanical work throughout the construction stages to ensure that the work is in accordance with requirements of the Contract, witness tests, note deficient work, and ensure that deficient work is corrected.
  - .4 Attend site commissioning meetings requested by the Commissioning Agent and arranged by the Contractor.
  - .5 When informed by the Contractor that work is essentially complete, inspect the equipment and systems, issue deficiency reports, and ensure that deficiencies are corrected in a timely manner.
  - .6 With the Commissioning Agent, review the Commissioning Plan to ensure that proposed tests and the sequencing and methods of tests conform to Contract requirements, and that the testing and commissioning sequences coincide with the construction schedule.
  - .7 With the Commissioning Agent, certify completion of the commissioning.

### **3.8 Responsibilities of the Contractor**

- .1 **Construction Phase:** Responsibilities of the Contractor during the construction phase are as follows:
- .1 Prepare and submit an installation schedule which shall include the time schedule for each activity with lead and lag time allowed and indicated, shop drawing/product data

- and working detail drawing submissions, and major equipment factory testing and delivery dates.
- .2 Prepare and submit a commissioning schedule which shall include a time schedule coordinated with the installation schedule referred to above, and allowances for additional time for re-tests as may be required, and update the schedule on a monthly basis as required.
  - .3 When requested by the Commissioning Agent, arrange site commissioning meetings with the Owner, Consultant, and applicable subcontractors present, to be chaired by the Commissioning Agent who will also prepare and distribute meeting minutes.
  - .4 Promptly correct all reported deficient work, and report when corrective work is complete.
  - .5 Where required by Codes and/or the Specification, retain equipment manufacturers/suppliers or independent third parties to certify correct installation of equipment/systems.
  - .6 Under the supervision of equipment manufacturers/suppliers, start-up and adjust all equipment to design requirements, and submit start-up sheets which include all equipment data such as manufacturer and model number, serial number where applicable, and performance parameters, all signed by the equipment manufacturer/supplier and the Contractor.
  - .7 Complete the Commissioning Agent's commissioning data sheets for all multiple items of smaller equipment such as air terminal boxes, fan coil units, backflow preventers, etc., submit the sheets to the Commissioning Agent, accompany the Commissioning Agent for an on-site check of 30% of the data sheet information for each type of equipment, and perform any corrective action required as a result of the site checks.
  - .8 Perform system testing, adjusting and balancing and, when complete, issue a copy of the final report to the Commissioning Agent for review and a site check of results, and perform any corrective work required as a result of site checks by the Commissioning Agent.
  - .9 In accordance with the updated commissioning schedule and actual progress at the site, certify in writing to the Consultant and the Commissioning Agent that equipment and/or systems are complete, have been checked, started and adjusted, successfully operationally performance tested and documented, and are ready for functional performance testing and the commissioning procedures, giving the Consultant and Commissioning Agent a minimum of 5 working days notice.
  - .10 Perform system and subsystem functional performance testing in the presence of the Commissioning Agent and under the supervision of the Commissioning Agent, and submit to the Consultant and Commissioning Agent, completed and signed functional performance testing and commissioning data sheets (issued by the Commissioning Agent) and also signed by the Commissioning Agent.
- .2 **Post Construction Phase:** Responsibilities of the Contractor during the post construction phase are as follows:
- .1 Optimize system operation in accordance with the building's occupant's needs and comments using the System Operation Manual prepared by the Commissioning Agent as reference.
  - .2 Complete all commissioning procedures, activities, and performance verification procedures that were delayed or not concluded during the construction phase.
  - .3 Accompanied by the Commissioning Agent, complete system checks and "fine tuning" with signed documentation as follows.
    - .1 Once during the 1st month of building operation.
    - .2 Once during the 3rd month of building operation.
    - .3 Once between the 4th and 10th months in a season opposite to the 1st and 3rd month visits.
  - .4 Correct all deficiencies revealed by the system checks described above, and, where required, involve equipment manufacturers/suppliers during corrective actions, and report completion of corrective work.
  - .5 Schedule for 3 months after Substantial Performance and conduct question and answer session(s) at the building with the Owner's operating and maintenance

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personnel, with the duration of the session(s) dictated by the number of questions and concerns that have to be addressed.

**END OF SECTION**

## 1 GENERAL

### 1.1 Application

- .1 This Section specifies mechanical system testing, adjusting, and balancing requirements that are common to mechanical work Sections of the Specification and it is a supplement to each applicable Section and shall be read accordingly.

### 1.2 Contractual Relationship with a Testing and Balancing Agency

- .1 Retain and pay for the services of a qualified testing and balancing agency to perform testing, adjusting and balancing work specified in this Section.

### 1.3 Submittals

- .1 **Name and Qualifications of Testing and Balancing Agency:** within 30 days of work commencing at the site, submit the name and qualifications of the proposed testing and balancing agency in accordance with requirements of the article below entitled Quality Assurance.
- .2 **Drawing Evaluation Report:** Submit a report by the Agency to indicate the Agency's evaluation of the mechanical drawings with respect to service routing and location or lack of balancing devices. Include the set of drawings used and marked-up by the Agency to prepare the report.
- .3 **Draft Report:** Submit a draft report, as specified in Part 3 of this Section.
- .4 **Final Report:** Submit a final report, as specified in Part 3 of this Section.
- .5 **Post Construction Site Visit Reports:** Submit reports listing observations and results of post construction site visits as specified in Part 3 of this Section.

### 1.4 Definitions

- .1 The following are definitions of words used in this Section:
  - .1 "TAB" – means testing, adjusting, and balancing to determine and confirm quantitative performance of equipment and systems and to regulate the specified fluid flow rate and air patterns at the terminal equipment, e.g., reduce fan speed, throttling, etc.
  - .2 "Air systems" – includes all outside air, supply air, return air, exhaust air, and relief air systems.
  - .3 "Flow rate tolerance" – means the allowable percentage variation, minus to plus, of actual flow rate values in the Contract Documents.
  - .4 "Report forms" – means test data sheets arranged for collecting test data in logical order for submission and review, and these forms, when reviewed and accepted, should also form the permanent record to be used as the basis for required future testing, adjusting and balancing.
  - .5 "Terminal" – means the point where the controlled fluid enters or leaves the distribution system, and these are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
  - .6 "Main" – means the duct or pipe containing the system's major or entire fluid flow.
  - .7 "Sub-main" – means the duct or pipe containing part of the systems' capacity and serving two or more branch mains.
  - .8 "Branch main" – means duct or pipe servicing two or more terminals.
  - .9 "Branch" – means duct or pipe serving a single terminal.

### 1.5 Quality Assurance.

- .1 **Testing and Balancing Agency:** The testing, adjusting and balancing agency shall have successfully completed testing, adjusting and balancing of mechanical systems for a minimum of 5 projects similar to this Project within the past 3 years, and shall be certified as an independent agency **in all required categories** by 1 of the following:
  - .1 AABC - Associated Air Balance Council.

.2 NEBB - National Environmental Balancing Bureau.

.2 **Standards:** Testing, adjusting, and balancing of the complete mechanical systems shall be performed over the entire operating range of each system in accordance with 1 of the following publications:

.1 National Standards for A total System Balance published by the Associated Air Balance Council.

.2 Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems published by the National Environmental Balancing Bureau.

.3 Chapter 37, Testing, Adjusting, and Balancing of ASHRAE Handbook HVAC Applications.

## 2 PRODUCTS

2.1 NOT APPLICABLE

## 3 EXECUTION

### 3.1 Scope of Work

.1 The TAB Agency shall perform total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications and comfort conditions, and recording and reporting the results.

.2 Mechanical systems to be tested, adjusted, and balanced include:

.1 **Heating Systems:** TAB of heating systems shall include all piping and equipment fluid temperatures, flows and control, and if TAB is not done during the heating season, a follow-up site visit during the heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".

.2 **Air Handling Systems:** TAB of air handling systems shall include all equipment and ductwork air temperatures, capacities, and flows.

### 3.2 Testing, Adjusting and Balancing

.1 **General Requirements:** Conform to the following requirements:

.1 As soon as possible after award of Contract, the Agency shall carefully examine a white print set of mechanical drawings with respect to routing of services and location of balancing devices, and shall issue a report listing the results of the evaluation.

.2 The set of drawings examined by the Agency shall be returned with the evaluation report, with red line mark-ups to indicate locations for duct system test plugs, and required revision work such as relocation of balancing devices and locations for additional devices.

.3 Testing, adjusting, and balancing is not to begin until:

.1 Building construction work is substantially complete and doors have been installed.

.2 Mechanical systems are complete in all respects, and have been checked, started, and adjusted.

.4 All mechanical systems to be tested, adjusted, and balanced are to be maintained in full, normal operation during each day of testing, adjusting and balancing.

.5 Obtain copies of reviewed shop drawings of all applicable mechanical plant equipment and terminals, and temperature control diagrams and sequences.

.6 The Agency shall walk each system from the system "head end" equipment to terminal units to determine variations of installation from design, and the system installation trades will accompany the Agency.

.7 The Agency shall check all valves and dampers for correct and locked position, and temperature control systems for completeness of installation before starting equipment.

.8 Wherever possible, the Agency shall lock all balancing devices in place at the proper setting, and permanently mark settings on all devices.

- .9 For belt-driven equipment, the Agency shall report any situation where fan drive sheaves have to be replaced to suit testing and balancing, and replacements are to be done by the Contractor at no cost.
- .10 **Noise:** the Agency shall balance all systems with due regard to objectionable noise which shall be a factor when adjusting fan speeds and performing terminal work such as adjusting air quantities, and should objectionable noise occur at the design conditions, the Agency shall immediately report the problem and submit data, including sound readings, to permit an accurate assessment of the noise problem to be made.
- .11 **Stratification:** the Agency shall check all supply air handling system mixing plenums for stratification, and where the variation of mixed air temperature across coils is found to be in excess of  $\pm 5\%$  of design requirements, the Agency shall report the problem and issue a detail sketch of plenum baffle(s) required to eliminate the stratification.
- .12 **Tolerances:** the Agency shall perform testing, adjusting and balancing to within  $\pm 5\%$  of design values, and make and record measurements which are within  $\pm 2\%$  of actual values.
- .13 **Filters** for all air handling systems equipped with air filters, test and balance the systems with simulated 50% loaded (dirty) filters by providing a false pressure drop.
- .14 **Seasonal requirements:** test, adjust and balance air conditioning systems during the summer season and heating systems during winter season, including at least a period of operation at outside conditions within  $2.8^{\circ}\text{C}$  ( $5^{\circ}\text{F}$ ) wet bulb temperature of maximum summer design condition, and within  $5.5^{\circ}\text{C}$  ( $10^{\circ}\text{C}$ ) dry bulb temperature of minimum winter design condition, and take final temperature readings during seasonal operation.
- .2 **Preparation of Reports:** Prepare reports as indicated below.
  - .1 **Draft Reports:** Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on AABC or NEBB forms. Draft reports may be handwritten, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
  - .2 **Final Report:** Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. Use units of measurement (SI or Imperial) as used on the Project Documents. The final report is a prerequisite to Substantial Performance.
  - .3 **Report format:** Report forms are to be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, 3-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the divisions listed below, separated by divider tabs:
    - .1 General Information and Summary.
    - .2 Hydronic Systems.
  - .4 **Report Contents:** The Agency shall provide the following minimum information, forms, and data:
    - .1 Inside cover sheet to identify the Agency, the Contractor, and Project, including addresses, and contact names and telephone numbers and a listing of the instrumentation used for the procedures along with the proof of calibration.
    - .2 The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard AABC or NEBB report forms prepared for each respective item and system.
    - .3 The Agency shall include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "as-built" diagram indicating and identifying all equipment, terminals, and accessories.
    - .4 The Agency shall include report sheets indicating building comfort test readings for all rooms.

- .3 **Verification of Reports:** After the final testing and balancing report has been submitted, the Agency shall visit the site with the Contractor and Consultant to spot check results indicated on the balancing report. The Agency shall supply all labour, ladders, and instruments to complete spot checks. Note that if results of spot checks do not, on a consistent basis, agree with the final report, the spot check procedures will stop and the Agency shall then rebalance the systems involved, resubmit the final report, and again perform spot checks with the Contractor and Consultant.
- .4 **Certification:** When the final report has been accepted, the Contractor shall submit to the Owner, in the name of the Owner, a certificate equal to the AABC National Guaranty Certification or a NEBB Quality Assurance Program Bond.

**Post Balancing Site Visits:** Include for two 8-hour day site visits after Total Performance of the work. During each return visit and accompanied by the Owner's representative, the Agency shall spot rebalance terminal units as required to suit building occupants and eliminate complaints.

**END OF SECTION**

## 1 GENERAL

### 1.1 Application

- .1 This Section specifies fire stopping and smoke seal requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and shall be read accordingly.

### 1.2 Submittals

- .1 **Firestop & Smoke Seal System Samples:** at least four weeks prior to work commencing, submit a sample of each type of firestop and smoke seal system in applied form, for approval. Submittal shop drawing to include proposed asbestos free material, anchorage construction details and method of installation. Identify each system with the manufacturer's name and type, the ULC designation, and the proposed use. When the samples are approved, all work shall conform to the approved samples.
- .2 **Product Data & WHMIS Sheets:** Submit a product data sheet and a WHMIS sheet for each firestopping and smoke seal product.
- .3 **Name & Experience of Proposed Applicator:** Submit for approval the full company name and experience of the proposed firestopping and smoke seal system applicator.
- .4 **Letter of Certification:** Submit a letter of proper firestopping and smoke seal certification as specified in Part 3 of this Section.

### 1.3 Quality Assurance

- .1 **Applicator:** The applicator shall have a minimum of 3 years of successful experience on projects of similar size and complexity, and shall be approved by the Consultant.
- .2 **Environment Conditions:** Comply with the firestopping and smoke seal product manufacturer's recommendations regarding suitable environment conditions for product installation.

## 2 PRODUCTS

### 2.1 Firestopping and Smoke Seal System Materials

- .1 Asbestos-free elastomeric materials tested, listed and labelled by ULC in accordance with CAN4-S115, Standard Method of Fire Tests of Firestop Systems and CAN/ULC-S101, Standard Method of Fire Endurance Tests of Building Construction and Materials for installation in ULC designated firestopping and smoke seal systems to provide a positive fire, water and smoke seal, and a fire-resistance rating (flame, hose stream and temperature) not less than the fire resistance rating of surrounding fire rated construction.
- .2 Materials are to be compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices in accordance with the firestopping manufacturer's recommendations and the ULC tested assembly.
- .3 Pipe insulation forming part of a fire and smoke seal assembly is specified in the Mechanical Insulation Section.
- .4 Fire resistance rating of the installed product shall not be less than the surrounding rating in walls and floors for which the fire stopping material is applied and be an effective barrier against flame, smoke and gases.

### 2.2 Base Bid and Acceptable Manufacturers

- .1 Refer to the article entitled Base Bid and Acceptable Manufacturers in the Section 20 05 10 – Basic Mechanical Materials and Methods.

3 EXECUTION

3.1 Installation of Firestopping and Smoke Seal Materials

- .1 Where mechanical work penetrates fire rated construction, provide ULC listed and labelled firestopping and smoke seal materials installed in accordance with requirements of CAN4-S115 (ratings F, FT, FH, and FTH as required), CAN/ULC-S101, and all other governing authorities to seal the penetrations.
- .2 **Preparation:** Abide by the following requirements:
  - .1 Examine substrates, openings, voids, adjoining construction, and conditions under which the firestop and smoke seal system shall be installed, and confirm compatibility of surfaces.
  - .2 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
  - .3 Ensure that substrates and surfaces are clean, dry and frost free.
  - .4 Maintain insulation around pipes and ducts penetrating a fire separation without interruption to the vapour barrier.
  - .5 Verify penetrating items are securely fixed and properly located with the proper space allowance between penetrations and surfaces of openings.
  - .6 Report any unsuitable or unsatisfactory conditions to the Contractor and Consultant in writing, prior to commencement of work, and note that commencement of work will mean acceptance of conditions and surfaces.
  - .7 Mask where necessary to avoid spillage and over coating onto adjoining surfaces, and remove stains on adjacent surfaces.
- .3 **Application:** Conform to the following application requirements:
  - .1 Use an experienced applicator approved by the manufacturer of the firestopping material manufacturer.
  - .2 Prime substrates in accordance with the product manufacturer's written instructions.
  - .3 Provide temporary forming as required and remove only after materials have gained sufficient strength and after initial curing.
  - .4 Tool or trowel exposed surfaces to a neat, smooth, consistent finish.
  - .5 Remove excess compound promptly as work progresses and upon completion.
  - .6 At all fusible link damper locations, seal the perimeter of the angle iron framing on both sides of the wall or slab with ULC listed and labelled sealant materials to provide a positive smoke seal.
- .4 **Inspection:** Notify the Consultant when the work is complete and ready for inspection, and prior to concealing or enclosing firestopping and smoke seal materials and service penetration assemblies. Arrange for final inspection of the work by the Municipal Building Inspector prior to concealing or enclosing work. Make any corrections required.
- .5 **Certification:** On completion of the firestopping and smoke sealing installation submit a letter of assurance to the Consultant certifying that the firestopping and smoke sealing installation has been carried out throughout the building to all mechanical service penetrations and that the installation has been done in strict accordance with the requirements of the Provincial Building Code, any applicable local Municipal Codes, ULC requirements, and the manufacturer's instructions.

END OF SECTION

## 1 GENERAL

### 1.1 Submittals

- .1 **Product Data:** Submit product data sheets for all products specified in Part 2 of this Section except for pipe and fittings. Ensure that product data sheets confirm that products proposed meet all requirements of the Contract Documents.
- .2 **Refrigerant Piping Schematics:** Submit, in shop drawing form, a schematic piping diagram for each refrigerant piping system indicating pipe sizes, slopes, valves, traps, and piping specialties. Piping schematics must be reviewed, approved, and signed by the refrigeration equipment manufacturers prior to being submitted to the Consultant for review.
- .3 **Certification Reports:** Submit letters from equipment suppliers certifying proper installation and start-up of the piping systems and equipment as specified in Part 3 of this Section.

### 1.2 Quality Assurance

- .1 **Codes and Standards:** Refrigerant piping systems are to be in accordance with CSA B52, Mechanical Refrigeration Code, Ozone Depleting Substances and Other Halocarbons, and any applicable local Codes and Regulations.
- .2 **Installation Personnel:** Refrigerant piping and direct expansion refrigeration equipment must be installed by or under direct on site supervision of TSSA certified and licensed journeyman refrigeration mechanics.

### 1.3 Seismic Control and Restraint

- .1 Seismic control and restraint is a requirement for this Project. Refer to the mechanical work Seismic Control and Restraint Section, and ensure that appropriate seismic control and restraint hardware is supplied with equipment specified in this Section.

## 2 PRODUCTS

### 2.1 Pipe, Fittings and Joints

- .1 Type ACR hard drawn seamless copper refrigerant tubing to ASTM B280, Standard Specification for Seamless Copper Tubing for Air Conditioning and Refrigeration Field Service, factory degreased, deburred, dehydrated, pressurized with nitrogen and capped, complete with factory washed and bagged wrought copper soldering fittings to ASME B16.22, and brazed joints made with high melting point silver brazing alloy conforming to AWS Classification BcuP-5.

### 2.2 Piping Line Sets

- .1 Equal to Great Lakes Copper Inc. "EZ-Roll" soft annealed copper to ASTM B280, suitable for use with the refrigerant involved, factory cleaned, pressurized with nitrogen and capped, and with sizes and lengths as required.
- .2 **Pre-insulated Line sets** are not acceptable.

### 2.3 General Re: Valves and Piping Specialties

- .1 All refrigerant valves and piping specialties specified below are to factory cleaned, degreased, and supplied to the site with capped ends.
- .2 Unless otherwise specified, acceptable manufacturers are:
  - .1 Mueller Industries Inc.
  - .2 Sporlan Valve Co.
  - .3 Superior Refrigeration Products/Sherwood

## 2.4 Shut-Off Valves

- .1 **Ball Valves:** Mueller Industries Inc. "Ballmaster", ¼ turn, CSA certified forged brass ball valves, each suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with carbon filled Teflon ball seals, two O-ring stem seals, a gasketed seal cap, a flow direction arrow cast into the body, a ball position indicator on the stem, and extended copper tube connections to permit brazing the valve into the line without disassembling the valve.
- .2 **Diaphragm Valves:** Mueller Industries Inc. "Linemaster" forged brass, frost-proof, Type 1 Series, CSA certified packless diaphragm valves, each suitable for a 3445 kPa (500 psi) working pressure and complete with an O-ring to prevent moisture from entering the diaphragm chamber, one phosphor bronze and two stainless steel diaphragms, and extended copper tube brazing connections.

## 2.5 Check Valves

- .1 Mueller Industries Inc. "Checkmaster" straight through type for valves 6.4 mm to 16 mm (¼" to ⅝") diameter, globe type for valves 22 mm (⅞") diameter and larger, each complete with extended tubing for brazing connections, and as follows:
  - .1 Straight through type check valves are to be complete with a machined brass gasketed body, phosphor bronze spring, and neoprene seat
  - .2 Globe type check valves are to be complete with a cast bronze body, forged brass cap, phosphor bronze spring, Teflon seat disc, and neoprene O-ring seal

## 2.6 Piping Traps

- .1 Mueller Industries Inc. Style No. WE-554P brazing end copper "P" traps.

## 2.7 Pressure Vessel Relief Valves

- .1 Mueller Industries Inc. "Safetymaster", factory set pressure relief valves, straight through or angle type as required, each constructed in accordance with requirements of ANSI Code B9.1 and the ASME Code for Unfired Pressure Vessels, and each complete with a brass body, neoprene seat disc, and lead seal and locking wire.

## 2.8 Refrigerant Liquid Moisture Indicators

- .1 Mueller Industries Inc. "Vuemaster", forged brass, triple sealed, CSA certified liquid moisture indicators, each suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with a liquid indicator which shows "FULL" when the system is fully charged with refrigerant and remains blank when there is a restriction or shortage of refrigerant in the liquid line, a moisture indicator which changes colour from blue to pink when moisture is present in the system, a plastic dust cover, and extended copper tube brazing connections.

## 2.9 Liquid Line Filter-Drier

- .1 Mueller Industries Inc. "Drymaster Micro-Guard" CSA certified filter-driers, each suitable for a maximum 3445 kPa (500 psi) working pressure and complete with a combination of desiccants in a fluted briquette for drying, and a fluted briquette type filter.

## 2.10 Flexible Piping Connections

- .1 Senior Flexonics Canada "VIBRA-SORBERS" phosphor bronze construction, factory cleaned, dried, and sealed flexible piping connections with copper tube brazing ends. Acceptable manufacturers are:
  - .1 Senior Flexonics Canada
  - .2 The Metraflex Co.
- .2 Flared Fittings shall not be used

## 2.11 Thermostatic Expansion Valves

- .1 Factory tested, balanced port design thermostatic expansion valves, with exact selection to suit the application and refrigerant used, each complete within a replaceable stainless steel

diaphragm and welded element construction thermostatic element charged with hydraulic fluid, and removable inlet strainer.

## 2.12 Refrigerant

- .1 Refrigerant is to be R410a/134a/R407c/....

## 3 EXECUTION

### 3.1 Installation of Refrigerant Piping, Valves & Specialties

- .1 Provide all required refrigerant piping. Piping is to be type ACR copper with wrought copper fittings. Install piping in accordance with requirements of reviewed refrigerant piping schematics referred to in Part 1 of this Section.
- .2 Make all refrigerant piping joints using a light coat of approved brazing flux applied to both pipe and fitting. Do not use acid flux. During the brazing process, ensure that the pipe and fittings are kept full of nitrogen or carbon dioxide to prevent scale formation inside the pipe and fitting.
- .3 Where shown or specified, use soft copper refrigerant piping line sets.
- .4 Provide shut-off valves to isolate each piece of equipment if shut-off valves are not supplied integral with the equipment. Shut-off valves inside the building are to be ball or diaphragm type. Shut-off valves outside the building are to be diaphragm type.
- .5 All bends shall be don't with appropriate bending tools, hand bends shall not be used. Where necessary long sweeps may be used.
- .6 Provide weather heads/goosenecks where refrigerant lines go through roofs, plumbing jack and putty is not acceptable.
- .7 Provide oversized hangers to allow for continuous insulation on line sets.
- .8 Provide a refrigerant charging valve for each system if such a valve is not supplied integral with the equipment.
- .9 Provide all refrigerant piping accessories shown and/or required and install in accordance with the manufacturer's recommendations.
- .10 Provide all required refrigerant.
- .11 Provide flexible connections at piping connections to roof mounted condensing units. Install in accordance with the manufacturer's instructions.
- .12 Provide expansion valves where shown and/or required, each matched to the coil and installed in accordance with the manufacturer's instructions.
- .13 All exposed refrigerant piping to be insulated and covered with aluminum jacket or line guard with UV stabilized covers.
- .14 After installation of piping contact consultant to review prior to insulation being applied. Contractor to give 3 days notice prior to insulating any refrigerant lines.

**END OF SECTION**

## 1 GENERAL

### 1.1 Submittals

- .1 **Product Data:** Submit product data sheets for all products specified in this Section except shop fabricated ductwork and fittings.
- .2 **Test Data:** Submit duct leakage test data prior to ductwork being covered from view.

### 1.2 Quality Assurance

- .1 Ductwork shall be in accordance with requirements of the following Standards:
  - .1 ASTM A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Coated (Galvannealed) by the Hot-Dip Process.
  - .2 ANSI/SMACNA HVAC Duct Construction Standards- Metal and Flexible.
  - .3 NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilation Systems.
  - .4 CAN/ULC-S110, Standard Methods of Test for Air Ducts.
  - .5 CAN/ULC-S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

## 2 PRODUCTS

### 2.1 Galvanized Steel Ductwork

- .1 **General:** Galvanized steel sheet shall be hot dipped in accordance with requirements of ASTM A653. Galvanizing for bare uncovered duct to be finish painted shall be G60. All other galvanizing shall be G90.
- .2 **Rectangular:** Lock forming grade hot dip galvanized steel, ASTM A653, shop fabricated, minimum #26 gauge.
- .3 **Round:** Factory machine fabricated, spiral, mechanically locked flat seam, single wall duct, fittings, and couplings.

### 2.2 Metal Duct System Joint Sealant

- .1 ULC listed and labelled, premium grade, grey colour, water base, low VOC, non-flammable duct sealer, brush, or gun applied, with a CAN/ULC S102 maximum flame spread rating of 15 and smoke developed rating of 20.
  - .1 Robson Thermal Duct Seal
  - .2 Duro Dyne Duct Sealer

### 2.3 Acoustic Lining

- .1 Minimum 25 mm (1") thick acoustic lining material meeting NFPA 90A requirements and flame spread and smoke developed fire hazard ratings of CAN/ULC-S102, flexible for round ducts, board type for rectangular ducts, consisting of a bonded fiberglass mat coated on the inside (airside) face with a black fire-resistant coating.

## 3 EXECUTION

### 3.1 Demolition

- .1 Do all required special system ductwork system demolition/revision work. Refer to demolition requirements specified in the mechanical work Section entitled Demolition and Revision Work.

### 3.2 Fabrication and Installation of Galvanized Steel Ductwork

- .1 Provide all required standard galvanized steel ductwork, rectangular and/or round and/or flat oval as shown. **Note** that where rectangular ductwork is shown, round or flat oval ductwork of equivalent cross-sectional area is acceptable.
- .2 **Duct Routing and Dimensions:** Confirm the routing of all ductwork at the site and site measure ductwork prior to fabrication. Note that duct dimensions may be revised to suit site

routing and building element requirements, if dimension revisions are reviewed with and approved by the Consultant. Duct routing and/or dimension revisions to suit conditions at the site are not grounds for a claim for an extra cost.

- .3 **Rectangular Duct Support Inside Building:** Support horizontal rectangular ducts inside the building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but, unless otherwise specified, use trapeze hangers with galvanized steel channels, and galvanized steel hanger rods for all ducts that are exposed, and all concealed ducts wider than 500 mm (20").
- .4 **Round Duct Support Inside Building:** Support round ducts inside the building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but, unless otherwise specified, for both uninsulated and insulated ducts exposed in finished areas, use bands and secure at the top of the duct to a hanger rod, all similar to Ductmate Canada Ltd. type "BA". If the duct is insulated, size the strap to suit the diameter of the insulated duct.
- .5 **Watertight Ductwork:** Where watertight horizontal ductwork is required, construct the ducts without bottom longitudinal seams. Solder or weld the joints of bottom and side sheets. Seal all other joints with duct sealer. Slope horizontal duct to hoods, risers, or drain points. Provide the drain points. Provide watertight ductwork for:
  - .1 All galvanized steel ductwork outside the building or otherwise exposed to the elements.
  - .2 Fresh air intakes.
- .6 **Connection of Dissimilar Metal Ducts:** Where dissimilar metal ducts are to be connected, isolate the ducts by means of flexible duct connection material as specified in the Section entitled Duct System Dampers and Accessories.
- .7 **Cleanliness of Installed Ductwork:** Maintain all new ductwork in a clean condition. If, at Substantial Performance, in the Consultant's opinion, new ductwork is not in a clean condition, retain and pay for a certified duct cleaning company to clean all new ductwork using compressed air and vacuum cleaning equipment.
- .8 **Counterflashing Duct Roof Curbs:** Do all required counterflashing work for roof curbs for ductwork penetrating the roof. Counterflashing materials are to match roof flashing materials provided as part of the work of Division 07. Caulk around the top edge of the counterflashing, and attach vertical counterflashing to the curb using non-ferrous screws with coloured heads to match counterflashing if coloured material is used. Counterflashing work shall be watertight.
- .9 **Seismic Requirements:** In addition to ANSI/SMACNA duct construction standards specified above, ductwork shall be constructed and installed to meet seismic requirements of the Building Code and ANSI/SMACNA The Seismic Restraint Manual: Guidelines for Mechanical Systems.

### 3.3 Installation of Acoustic Lining

- .1 Provide acoustic lining in ductwork in locations as follows:
  - .1 Wherever shown and/or specified on the drawings.
  - .2 Supply ductwork downstream of air terminal boxes for a distance of 2.4 m (8') measured along the duct and outward from the box in all directions.
  - .3 Supply ductwork downstream of air handling units or fan coil units for a distance of 2.4 m (8') measured along the duct and outward from the unit in all directions.
  - .4 Return ductwork upstream downstream of air handling units or fan coil units for a distance of 2.4 m (8') measured along the duct and outward from the unit in all directions.
  - .5 Exhaust ductwork at roof or wall discharge locations for a distance of 2.4 m (8') measured along the duct and inward from the wall or roof penetration.
  - .6 Exhaust ductwork downstream of fan connection for a distance of 2.4 m (8') measured along the duct.
  - .7 For all transfer air ducts.

- .2 Install lining in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, for all installations regardless of velocity, at leading and trailing edges of duct liner sections, provide galvanized steel nosing channel as per the detail entitled Flexible Duct Liner Installation found in the ANSI/SMACNA manual referred to above.

### **3.4 Duct System Protection, Cleaning and Start-Up**

- .1 Temporarily cover all open ends of new ducts during construction.
- .2 Vacuum all dirt and foreign matter from the entire duct systems and clean duct system terminals and the interior of air handling units prior to operating fans.
- .3 Prior to starting any supply air handling system provide 50 mm (2") thick glass fibre construction filters at fan equipment in place of permanent filters.
- .4 Provide cheesecloth over all duct system inlets and outlets and run the system for twenty-four hours, after which remove the cheesecloth, the construction filters, and install new permanent filters.
- .5 Include all labour for a complete site walk-through with testing and balancing personnel following the route of all duct systems to be tested, adjusted and balanced for the purpose of confirming the proper position and attitude of dampers, the location of pitot tube openings, and any other work affecting the testing and balancing procedures. Perform all corrective work required as a result of this walk-through.

### **3.5 Testing, Adjusting, and Balancing**

- .1 When work is complete and equipment is operating as intended, test, adjust and balance air flows and temperatures in accordance with requirements specified in the mechanical work Section entitled Testing, Adjusting, and Balancing.

**END OF SECTION**

## 1 GENERAL

### 1.1 Submittals

- .1 **Preliminary Inspection Report:** Submit 2 copies of a preliminary duct system inspection report as specified in Part 3 of this Section.
- .2 **Final Inspection Report:** Submit 2 copies of a final duct cleanliness inspection report as specified in Part 3 of this Section.
- .3 **Video Tapes:** Submit 2 identified copies of video tapes with each report as specified in Part 3 of this Section.
- .4 **MSDS:** Submit MSDS for all cleaning products, as applicable, and maintain a copy of the sheets on-site during the duct system cleaning work.
- .5 **Cleaning Plan Drawing(s):** Submit cleaning plan drawing(s) as specified in Part 3 of this Section.
- .6 **Laboratory Qualifications:** Submit documented proof of the experience and expertise of the laboratory selected to do sample analysis work.

### 1.2 Quality Assurance

- .1 **Duct Cleaning Standard:** Duct cleaning shall be in accordance with requirements of the National Air Duct Cleaners Association (NADCA) General Specification for the Cleanliness of Commercial Heating and Ventilation Systems, and requirements specified in this Section.
- .2 **Duct Cleaning Company:** The company retained to perform the duct cleaning work shall be a current member in good standing of the NADCA, with a minimum of 5 years of experience on projects equal to the size of this Project. Acceptable companies are:
  - .1 VentCare Inc.
  - .2 Power Vac Services.
  - .3 Kleen-Flo Corp.
  - .4 Integrated Clean Air Services Inc.
- .3 **Duct Cleaning Personnel:** Duct cleanliness inspections are to be performed by NADCA Certified Ventilation Inspector (CVI) who shall be in possession of a NADCA photo ID card while on-site. Duct system cleaning work shall be done by or under direct on-site supervision of a NADCA Air Systems Certified Specialist (ASCS).

## 2 PRODUCTS

### 2.1 Duct Access Patches

- .1 Manufactured sheet metal patches constructed of the same material as the ductwork, cross-broken, hemmed, and pre-drilled. Patches for insulated ducts are to be insulated and finished to the same standard as the duct.

### 2.2 Cleaning and Sealing Chemicals

- .1 Chemicals specifically manufactured for the purpose and in accordance with NFPA requirements, as follows:
  - .1 **Duct sealer:** Non-toxic, water based, meeting flame spread and smoke developed ratings of CAN/ULC-S102.
  - .2 **Disinfectant and cleaner:** Equal to H. B. Fuller Construction Products "Foster 40-80" disinfectant and cleaning solution.
  - .3 **Fungicidal protective coating:** Equal to H. B. Fuller Construction Products "Foster 40-20" fungicidal protective coating specifically formulated for long-term fungicidal activity.

### 2.3 Ductwork Cleaning and Inspection Equipment

- .1 Current, well maintained calibrated/adjusted equipment supplied by the duct cleaning company, and generally as follows:

- .1 **Robotic video camera:** Super VHS format, dust-tight, wheeled or tracked, remote controlled, self-propelled camera with a minimum of 400 lines of resolution, capable of entering a duct as small as 175 mm x 175 mm (7" x 7") or 175 mm (7") diameter without any loss of manoeuvrability or control, able to continually provide video coverage of the duct or duct system component being inspected, and with features as follows:
  - .1 Capable of being mounted on a probe of up to 3 m (10') long and enter a duct as small as 100 mm x 100 mm (4" x 4") or 100 mm (4") diameter.
  - .2 A low voltage halogen light capable of illuminating the entire viewing area of the camera without causing "hot spots" or shadowed edges or corners on the monitor.
  - .3 Capable of simultaneously carrying and operating cleaning equipment.
- .2 **Robotic brush:** remote controlled, self-propelled vehicle with an adjustable rotary action robotic brush of the same material as all other brushes mounted on a shaft at right angles to the longitudinal axis of the duct surface and complete with a video camera device to monitor and video tape the cleaning process at all times.
- .3 **Self-propelled full contact brush:** specially made and shaped robotic or self-propelled brush of nylon, polypropylene or other non-metallic material to ensure continuous full contact and scrubbing action, with a capacity to clean 80 mm<sup>3</sup> to 500 mm<sup>3</sup> ducts, equipped with an integral propulsion motor or drive powerful enough to continue to propel the brush even when the bristles have been severely distorted.

### 3 EXECUTION

#### 3.1 Extent and Scope of Duct System Cleaning

- .1 After all ductwork system revision work is complete, but prior to air quantity testing, adjusting and balancing work, perform rotary brush and vacuum cleaner duct system cleaning work. The extent of ductwork to be cleaned is indicated on the drawings. Cleaning work shall include:
  - .1 A preliminary inspection both manually (visually) and by means of a remote controlled and self-propelled video camera.
  - .2 Submittal of copies of the report with copies of the video tape(s) as specified in Part 1 of this section.
  - .3 Duct system cleaning and videotaping operations.
  - .4 An inspection after cleaning work is complete.
  - .5 Submittal of copies of the post cleaning inspection report and copies of the video tape(s) as specified in Part 1 of this section.
  - .6 Collection of samples taken from the interior surfaces of the duct system and laboratory analysis of the samples, and submittal of copies of the laboratory report as specified in Part 1 of this section.
- .2 Carefully and neatly cut openings in ducts where required, and when cleaning work is complete, patch the openings air-tight.
- .3 Vacuum cleaners are to be used to supplement brush cleaning, and brush cleaning operations are not to commence until vacuum cleaning equipment is in place and operational.
- .4 Schedule all duct cleaning work and air handling system shut-downs with the Owner and Contractor, and confirm duct cleaning times with the Contractor during the bidding period.
- .5 Where samples are taken for laboratory analysis, sample locations are to be marked on the cleaning plan drawing(s) and after cleaning is complete, samples from the same locations are to be sent to the laboratory for analysis and the laboratory report shall be included with the final inspection report.

#### 3.2 Preliminary Inspection and Report

- .1 Perform a preliminary manual (visual) and self-propelled video camera inspection of a minimum of 10% of the ductwork to be cleaned with proportionate representative samples

of main supply and return ducts as well as branch ducts and components, all to reasonably ascertain the state and cleanliness of the ductwork system, type(s) of internal features, and potential problem areas. If additional preliminary inspection work is deemed necessary it shall be performed at no additional cost.

- .2 Take samples for laboratory particulate analysis and microbial growth evaluation. Include the laboratory report with the preliminary inspection report.
- .3 During the preliminary inspection, prepare, on plan drawings the same size and scale as the Contract Drawings, the layout and plan for the cleaning and video inspection on a section-by-section basis taking into account all fittings, changes in shape or direction, and internal features. Submit a copy of the plan drawing(s) with the preliminary inspection report.
- .4 The duct system state of cleanliness shall be determined by the following methods:
  - .1 Visual inspection, both manually and by means of robotic video camera.
  - .2 Particulate analysis, with random samples taken at identified locations by means of sterile wipes and/or containers, and laboratory analysis of the samples.
  - .3 Microbial growth evaluation, with random samples as above but taken using Rodac plates properly packaged and sent to the laboratory for analysis.
- .5 Submit the preliminary inspection report with cleaning plan and laboratory reports on sample analysis.

### **3.3 Duct System Cleaning**

- .1 Clean all surfaces of the ductwork system(s), including fan equipment, turning vanes, grilles, diffusers and registers, filter racks, control components including sensors, branch take-offs, and dampers of all kinds.
- .2 Prior to starting the cleaning work, mark and record the position of all duct system balancing devices, including grille/diffuser dampers, so that if disturbed the devices can be reset to their original position.
- .3 Isolate sections of ductwork 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. Clean the component in place only if there is no hazard to the surroundings.
- .7 Cleaning of acoustically-lined ductwork and components is only to be performed by the use of specially designed apparatus filled with a flailing device and 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 or breaks.
- .8 Coils, elements, and heat exchange surfaces are to be brushed, vacuumed and, where necessary, low-volume pressure washed in place. Make all provisions and supply all materials necessary to accomplish this.
- .9 Cleaning operations performed by hand are acceptable only for the purpose of cleaning individual components of the system such as blades, dampers, controls, turning vanes, etc.

Manual or hand cleaning is not to be used for cleaning of ductwork except in isolated instances and only when specifically agreed to by the Consultant.

- .10 Carry out cleaning procedures on a section-by-section basis. Repeat the cleaning procedures as many times as necessary to achieve the state of cleanliness defined in this Specification.
- .11 Follow the above method until the entire duct system is cleaned, including all components and associated fittings and controls.
- .12 Perform secondary inspection in the same locations as the first sampling to permit a comparison of values before and after cleaning.
- .13 **Cleaning Standards:** The ductwork system(s) and components are to be cleaned to the following standards which are described under Laboratory Analysis below:
  - .1 **Supply ductwork and components:** particulate, Scale rating of 1, and microbial growth: Scale rating of 1.
  - .2 **Exhaust and return ductwork and components:** particulate, Scale rating of 2 or less, and, microbial growth, Scale rating of 2 or less.

### **3.4 Post Cleaning Inspection**

- .1 This post cleaning inspection is only to take place after all systems and components have been cleaned.
- .2 Follow the same video survey plan that was used for the preliminary survey.
- .3 Perform the video survey of the same sections, features and points as were previously recorded for purposes of comparison.
- .4 Use the same methods of inspection in the same sections and locations as were used in the preliminary survey, i.e. if a location was visually inspected before cleaning, perform a visual inspection after cleaning, etc.
- .5 Perform visual inspections throughout as well as Microbial Growth Evaluation wherever this method was used in the preliminary examination.
- .6 Incorporate all data, observations, recommendations, and laboratory analysis into the final report as described elsewhere in this Specification.

### **3.5 Laboratory Analysis**

- .1 Retain and pay for the services of an accredited laboratory to perform sample analysis. Submit proof of the experience and expertise of the laboratory.
- .2 Three methods of duct-contaminant evaluation are to be used both before and after the duct cleaning has been performed, as follows:
  - .1 Visual inspection using remote controlled robotic or other self-propelled video camera
  - .2 Particulate analysis using a Super Electron Microscope (SEM): samples are to be taken using sterile wires for subsequent laboratory testing. The following descriptions provide the basis for scaling the samples:

<b>Particulate Scale No.</b>	<b>Description</b>
1	Optically clean when examined by the unaided eye under a bright light (i.e. 100W or more)
2	Slight film of particulate on the bottom of duct, evenly dispersed across surface, with a maximum depth at any point of less than 1 mm and with no localized accumulations anywhere
3	Evenly dispersed build-up of 1 to 2 mm thickness with some localized accumulations
4	Thicker accumulations than for scale 3, or the same

as scale 2 or 3 above if particulate analysis reveals asbestos, or material content deemed to be hazardous by the Consultant

- .3 **Microbial growth evaluation:** samples from the system interior surfaces are to be taken and analysed using a Super Electron Microscope (SEM), the following descriptions provide the basis for scaling the samples:

Particulate Scale No.	Description
1	After incubation, maximum 1 colony per spare cm
2	After incubation, maximum 2 colonies per spare cm
3	After incubation, maximum 3 or more colonies per spare cm

- .4 Microbial growth evaluation shall be supplemented by doing a gram stain test if deemed necessary. If a gram negative condition exists, a special note shall be made and the Consultant shall be notified immediately.

### 3.6 Reports AND VIDEO TAPES

- .1 Reports specified herein are to include the following:
- .1 Name of the facility and address.
  - .2 Name and address of cleaning contractor.
  - .3 Description of the ductwork system(s) with drawing(s) 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 Where samples were analysed and type of analysis used.
  - .6 Copy of scale chart showing scaling criteria.
  - .7 Description and location of problem areas encountered and special or unusual situations or conditions and any comments or recommendations.
  - .8 Results or analysis for all samples complete with corresponding scale rating.
  - .9 Comments complete with photos illustrating each sampling location and other observed features of the system.
  - .10 Super VHS format video tapes 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 system cleaned.
- .2 Submit 2 copies of video tapes with each report. Reports are to be bound into binders, complete with index and title page. Further to requirements above the reports are to include the following:
- .1 **Preliminary Report:** Video tape with written description with locations of special internal features or potential problems such as broken or damaged controls or components, and recommended course of action with co-ordination that may be required, i.e. for sheet metal work, repair work, etc.
  - .2 **Final Report:** Similar to the preliminary report, but reflecting more in-depth knowledge of systems after cleaning procedures have been completed.

**END OF SECTION**

## 1 GENERAL

### 1.01 SUBMITTALS

- .1 **Product Data:** Submit shop product data sheets for silencers. Include all construction, acoustic and aerodynamic performance data, and details with the submission. Acoustical data is to demonstrate that duct systems with silencers will reduce mechanical fan system noise to required levels in occupied spaces.
- .2 **Silencer Test Data:** Submit manufacturer's test data to indicate results of factory tests on the silencers prior to shipment.
- .3 **Silencer Manufacturer's Laboratory Accreditation:** Submit a copy of the silencer manufacturer's National Voluntary Laboratory Accreditation Program (NVLAP) accreditation certificate for ASTM E-477 test standards.
- .4 **Manufacturer's Certification Letter:** Submit an installation certification letter from the manufacturer of the silencers as specified in Part 3 of this Section.

### 1.02 QUALITY ASSURANCE

- .1 Silencer performance must be substantiated by laboratory testing in a duct-to-reverberant room test facility according to ASTM E477, Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Material and Prefabricated Silencers.
- .2 Silencer acoustic media and any lining/wrapping material must have a maximum flame spread rating of 25 and a smoke developed rating of 50 when tested in accordance with CAN/ULC-S102, Surface Burning Characteristics of Building Materials, and Accessories.
- .3 All silencer surfaces in contact with the airstream are to be in accordance with ANSI/ASHRAE 62.1, Ventilation for Acceptable Indoor Air Quality.
- .4 Acceptable silencer manufacturers are:
  - .1 Vibro-Acoustics Ltd.
  - .2 Kinetics Noise Control Vibron Products Group
  - .3 Price Industries Inc.

## 2 PRODUCTS

### 2.01 GENERAL RE: SILENCERS

- .1 Silencers are to be factory fabricated by the same manufacturer and are to be in accordance with the drawing schedule.
- .2 Silencer inlet and outlet dimensions are to be equal to duct sizes shown on the drawings. Unless otherwise shown or specified, transitions will not be permitted.

- .3 Silencers are to be constructed in accordance with SMACNA HVAC Duct Construction Standards, Metal, and Flexible, to suit the duct system pressure and velocity classification. Unless otherwise specified, all casing seams and joints are to be lock-formed and sealed or stitch welded and sealed, and silencers are to be constructed so as not to fail when subjected to an internal static pressure of 3.9 kPa (8" wg).
- .4 All perforated steel is to be adequately stiffened to ensure flatness and form, and all welds are to be shop painted with zinc rich paint.
- .5 Silencers are to be shipped with factory installed end caps.
- .6 Galvanized steel is to be in accordance with ASTM A653.

## 2.02 OUTER CASING MATERIALS

- .1 **Rectangular Straight and Transitional Straight Silencers:** Minimum #22 gauge lock forming quality galvanized steel.
- .2 **Elbow and Transitional Elbow Silencers:** Minimum #18 gauge for elbow lock forming quality galvanized steel.
- .3 **High Transmission Loss (HTL) Rectangular and Elbow Silencers:** No. 16 or #10 gauge stitch-welded and caulked galvanized steel as per the drawings schedule.
- .4 **Circular Silencers:** Lock forming quality galvanized steel with minimum gauges as follows:
  - .1 300 mm to 660 mm (12" to 26") diameter - #22 gauge
  - .2 675 mm to 1.52 m (27" to 60") diameter - #18 gauge
  - .3 1.55 m to 2.13 m (61" to 84") diameter - #16 gauge

## 2.03 INTERIOR BAFFLE-LINER-BULLET MATERIAL

- .1 Minimum #22 gauge lock forming quality galvanized steel.

## 2.04 INTERIOR BAFFLE TRANSITION

- .1 Transitioning for interior transition silencers is to occur internal to the silencer such that the height of the air passage is uniformly changing with the length of the air passage.

## 2.05 ACOUSTIC MEDIA MATERIAL

- .1 Except for no media silencers, and unless otherwise specified, inert, inorganic glass fibre of a density to obtain the specified acoustic performance, packed under not less than 5% compression to eliminate voids due to vibration and settling.
- .2 For silencers as specified and/or scheduled, acoustic quality insulation which does not contain any formaldehydes, phenolic resins, or volatile organic compounds that can off-gas, but containing cotton fibres treated with an EPA registered non-toxic borate solution, "flash dried" to actively inhibit the growth of mould, mildew, bacteria, and fungi.

## 2.06 ACOUSTIC MEDIA PROTECTION MATERIAL

- .1 Material for lining/wrapping acoustic media to help prevent shedding and erosion, as per the drawing schedule, is to be:
  - .1 polymer film material separated from the perforated metal liner with a 12 mm (½") thick acoustically transparent spacer
  - .2 glass fibre cloth

## **2.07 HIGH TRANSMISSION LOSS CASINGS**

- .1 High transmission loss casings for silencers as scheduled are to be externally shop applied, and completely sealed to the silencer casing. The HTL walls are to consist of media, air space, mass, and an outer protective metal skin as required to obtain room noise criteria.

## **2.08 ALTERNATIVE SILENCER MATERIALS**

- .1 Where indicated on the drawing silencer schedule, types 304 or 316 stainless steel or aluminum silencer material is to be used.

# **3 EXECUTION**

## **3.01 INSTALLATION OF SILENCERS**

- .1 Provide silencers where shown. Ensure that silencers are installed with airflow arrows in the direction of airflow.
- .2 Support each silencer independent of connecting ductwork.
- .3 Properly layout ductwork for silencer locations to provide a minimum of five diameters of straight duct upstream of the silencer and ten diameters of straight duct downstream of the silencer.
- .4 Unless otherwise shown, do not install silencers in walls or slabs.
- .5 Where cross-talk silencers penetrate partition walls, seal the joint between the perimeter of the silencer and the wall, on both sides of the wall, with proper acoustic caulking.
- .6 Seal all silencer connections to ducts with proper fire/smoke rated duct sealer.
- .7 When silencer installations are complete, arrange and pay for the silencer manufacturer to examine the silencer installations. Do any corrective work required by the manufacturer, then obtain from the manufacturer and submit a signed letter certifying proper installation and operation of all silencers. Refer to the article entitled Equipment and System Manufacturer's Certification in the Mechanical Work General Instructions Section.

**END OF SECTION**

## 1 GENERAL

### 1.1 Submittals

- .1 **Product Data:** Submit product data sheets for all products specified in this Section.
- .2 **Spare Filters:** Prior to Substantial Performance submit a set of spare filters in original identified packaging for each air handling unit requiring filters. Store filters on the site where directed by the Consultant or Owner.

## 2 PRODUCTS

### 2.1 General

- .1 Unless otherwise specified or noted, filters are to be synthetic and/or glass fibre disposable media type in accordance with the drawing schedule(s).
- .2 Minimum Efficiency Reporting Values (MERV) ratings are to be as per ASHRAE Standard 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Sizes.
- .3 Unless otherwise specified or noted, filters are to be in accordance with UL Standard 900, Air Filter Units.
- .4 Acceptable filter manufacturers are:
  - .1 AAF International.
  - .2 Camfil Farr Inc.
  - .3 Modern Air Filter Corp.

### 2.2 Construction Filters

- .1 Roll type, disposable, MERV 7 to 9 woven glass fibre media.

## 3 EXECUTION

### 3.1 Installation of Construction Filters

- .1 Provide roll type medium efficiency disposable media filter(s) across the entire filter bank of each supply air handling unit, either at the factory where the fan is produced or at the site as soon as the fan is installed. Secure the media in place so it will not be dislodged by fan operation. Replace the roll media periodically if it becomes loaded and clogged.
- .2 For exhaust systems, secure the filter media across exhaust air openings and ductwork to prevent construction dirt and dust from fouling the fan
- .3 Leave the media in place until fan start-up, at which time remove and dispose of the construction media.

### 3.2 Installation of Filters

- .1 Provide all required filter media when fan equipment is ready for start-up and performance testing. Provide any required filter framing/racks.
- .2 Prior to Substantial Performance supply a complete spare set of filter media in original packaging and clearly identified as to the applicable system for each air handling system with filters. Store the filters at the site where directed by the Owner.

**END OF SECTION**

## 1 GENERAL

### 1.1 Submittals

- .1 **Product Data:** Submit product data for all units to confirm compliance with requirements of the Contract Documents. Include:
  - .1 Certified fan performance curves.
  - .2 Estimated sound power levels to be expected across individual octave bands in db.
  - .3 Certified power and control wiring diagrams which differentiate between factory and site wiring.
  - .4 Dimensioned layouts, including dimensioned curb layouts and duct penetrations, as applicable.
  - .5 Product data for fan motors and drives.
  - .6 All items shipped loose for site installation.
- .2 **Factory Inspection and Test Report:** Submit with delivery of each unit a copy of the factory inspection and fire test report, and include a copy of each report with O & M Manual project close-out data.
- .3 **Site Inspection and Start-Up Report:** Submit a site inspection and start-up report from the manufacturer's representative as specified in Part 3 of this Section.
- .4 **Spare Air Filters:** Submit spare air filters as specified in Part 2 of this Section.
- .5 **Roof Opening Coordination:** Supply reviewed copies of curb assembly shop drawings or product data sheets to the trade who will cut the roof openings for ductwork, and ensure that the openings are properly sized and located.
- .6 **Extended Warranties:** Submit signed copies of the manufacturer's extended warranties as follows:
  - .1 Stainless steel gas fired unit heat exchanger: 10 years.
  - .2 Refrigerant compressor(s): 5 years.
  - .3 Integrated modular control: 3 years.

### 1.2 Quality Assurance

- .1 Heating and air conditioning equipment shall be rated (capacity, performance, efficiency, and sound) and certified in accordance with requirements of the following Air-Conditioning and Refrigeration Institute Standards:
  - .1 ARI 210/240, Performance Rating of Unitary Air Conditioning, and Air-Source Heat Pump Equipment.
  - .2 ARI 270, Sound Rating of Outdoor Unitary Equipment.
  - .3 ARI 340/360, Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
- .2 Heating and air conditioning equipment is also to be in accordance with requirement of the following Codes, Standards, and Regulations:
  - .1 CSA B52, Mechanical Refrigeration Code.
  - .2 CAN/CSA-C22.2 No. 236/UL 1995, Heating and Cooling Units.
  - .3 ASHRAE 90.1, Energy Standard for Buildings.
  - .4 CSA or ETL certification and labelling for all electrical components.
- .3 Acceptable manufacturers are:
  - .1 Lennox Industries Inc.
  - .2 Carrier Corp.
  - .3 Trane Canada Corp.
  - .4 Johnson Controls York.

**2 PRODUCTS****2.1 Outdoor Air Conditioning Units**

- .1 Package type, factory tested, outdoor, weatherproof heating and air conditioning units as per the drawing schedule.
- .2 **Cabinet:** Constructed of minimum #18 gauge galvanized steel panels erected on full perimeter minimum #14 gauge galvanized steel base rails with lifting lugs, finished with two coats of baked exterior enamel paint on primer, arranged and constructed for airflow configurations as shown, and complete with collars for electrical power and duct connection openings, and the following:
  - .1 A fully insulated base, and insulation for all panels adjacent to conditioned air, with 50 mm (2") thick neoprene faced, 32 kg/m<sup>3</sup> (2 lb/ft<sup>3</sup>) density insulation meeting flame spread and smoke developed rating requirements of CAN/ULC S102 and secured in place such that insulation will not sag and fibres will not erode or enter the airstream.
  - .2 Hinged access panels, each air and water sealed and equipped with ¼ turn latching handles, and provided for compressor/controls/heating areas, blower access, and air filter and economizer access.
- .3 **Compressor/Condenser & Refrigeration:** Vibration isolated scroll type hermetically sealed compressor(s) with direct drive vertical discharge propeller type condenser fan(s) and copper tube/aluminium fin factory leak and pressure tested condenser coil(s), and equipped with the following:
  - .1 PVC coated condenser fan guard and condenser coil guard.
  - .2 Permanently lubricated totally enclosed, resiliently mounted, overload protected condenser fan motor(s) conforming to requirements of the Basic Mechanical Materials and Methods Section, totally enclosed from the weather.
  - .3 A refrigeration system capable of operating down to -17°C (0°F) without installation of additional controls, complete with self-sealing discharge, suction and liquid line service gauge ports, freeze-stats, expansion valves, copper refrigerant tubing and insulation where required, liquid line filter drier, a full charge of R410a refrigerant, automatic reset high and low pressure compressor circuit controls, and fan control for -34°C (-30°F) low ambient operation.
  - .4 Copper tube/aluminium fin factory tested evaporator coil with thermal expansion valve with adjustable superheat and external equalizer, and non-corrosive condensate drain pan removable for cleaning, designed to prevent standing water and equipped with a drain connection with deep seal trap.
- .4 **Cooling Controls:** Cooling controls are to include the following:
  - .1 Smoke detectors in both supply and return air streams.
  - .2 Motorized normally closed fresh air and exhaust air dampers and normally open return air damper (equal to T. A. Morrison Tamco Series 1000 for return air and Series 9000 for fresh air and exhaust air), with 24 volt spring return Belimo or equal operators and a control package to automatically vary the outside air quantity.
  - .3 Adjustable mixed air controls to maintain 13°C (55°F or as indicated) mixed air temperature.
  - .4 Up to four stages of cooling control.
  - .5 Controls for blower on delay of up to sixty seconds after a cooling demand has been received, with a default value of zero, and controls to allow blower off delay of up to two hundred and forty seconds after cooling demand has ended, with a default value of zero.
  - .6 Minimum compressor on and off time of three hundred seconds, both adjustable between sixty and five hundred and ten seconds.
  - .7 Default maximum high pressure switch trip occurrence during cooling or dehumidification cycle of three (adjustable between one and eight occurrences), with compressor lock-out if maximum occurrence limit is reached, and digital output for service activated.
  - .8 Low pressure trip read delay of five minutes (adjustable between zero and thirty-four minutes) if compressor off time has been less than four hours (adjustable between

- one and six hours) and the outdoor temperature is less than 21°C (70°F), adjustable between -12°C and 38°C.
- .9 Low pressure trip read delay of fifteen minutes (adjustable between zero and thirty-four minutes) if compressor off time has been less than four hours (adjustable between one and six hours) and the outdoor temperature is less than 21°C (70°F), adjustable between -12°C and 38°C.
  - .10 Low pressure trip read delay of two minutes (adjustable between zero and thirty-four minutes) if the compressor off time has been less than four hours and the outdoor air temperature is 21°C (70°F) or greater.
  - .11 Low pressure trip read delay of eight minutes (adjustable between zero and thirty-four minutes) if the compressor off time has been four hours and the outdoor air temperature is 21°C (70°F) or greater.
  - .12 Each pressure switch trip occurrence (either high or low) to record an error in non-volatile memory and identify the compressor circuit.
  - .13 Low outdoor air temperature compressor lockout set-point of -18°C (0°F) for each compressor circuit, individually adjustable from 27°C (80°F) to -34°C (-30°F).
  - .14 Maximum allowable evaporator freeze-stat trip occurrence of three (adjustable between one and four occurrences) during cooling demand, with circuitry to shut-off the compressor each time a freeze-stat trip occurs and record an error in non-volatile memory, and if the maximum limit is reached, the compressor shall be locked-out and a digital output for service shall be displayed.
  - .15 Condenser fan control including:
    - .1 Six second (adjustable between zero and sixteen seconds) between condenser fan shut-off and restart to prevent reverse rotation of the fans(s).
    - .2 Cooling stage low outdoor temperature set-point control (4 to 13°C (40 to 55°F) depending on number of fans and adjustable between 16°C and -12°C (60°F and 10°F) to reduce airflow through the condenser by turning off some or all fans, depending on the number of condenser fans.
  - .5 **Filters:** Roll type glass fibre mesh construction filter media factory installed when the unit is shipped, and disposable, 50 mm (2") thick, pleated MERV 7 rated, metal framed filters with an initial loading of filters, and a spare set of filters for each unit, supplied loose in sealed containers.
  - .6 **Gas Heating Section (Dual Fuel Unit):** The heating section has a progressive tubular heat exchanger design using stainless steel burners and corrosion resistant steel throughout. An induced draft combustion blower is used to pull the combustion products through the firing tubes. The heater uses a direct spark ignition (DSI) system, on initial call for heat, the combustion blower purges the heat exchanger for 20 seconds before ignition. After three unsuccessful ignitions attempts, the entire heating system will be locked out until manually reset at the thermostat / zone sensor.
    - .1 Gas heating section shall only run at temperatures < 3°C per Fortis grant requirements.
  - .7 **Supply Air Blower:** Centrifugal, statically and dynamically balanced, removable (slide-out) blower assembly complete with:
    - .1 Motor, drive assembly and guard conforming to requirements specified in the Basic Mechanical Materials and Methods Section.
  - .8 **Modular Controller:** Integral solid-state control board to operate the unit, compatible in all respects with the building automation system, and with built-in functions as follows:
    - .1 Blower on/off delay.
    - .2 Control parameter defaults.
    - .3 Service relay output.
    - .4 Dirty filter switch input.
    - .5 Dehumidistat input.
    - .6 Economizer control.
    - .7 Gas valve delay between stages.

- .8 Unit diagnostics.
  - .9 Diagnostics code storage.
  - .10 Indoor air quality input.
  - .11 Low ambient controls.
  - .12 Minimum run time.
  - .13 Night setback mode.
  - .14 Smoke alarm mode.
  - .15 Low pressure control.
  - .16 Thermostat bounce relay.
  - .17 3-digit display and degrees F or C display.
  - .18 Heat/cool thermostat compatible with warm-up mode.
- .9 **Room Thermostat:** Surface wall mounting (on a recessed box) adjustable 24 volt thermostat supplied loose with the unit and equipped with a fan auto-on switch, off-heat-cool-auto switch, night set-back controls, and digital thermometer and set-point display.
- .10 **Roof Mounting Curb:** Minimum 450 mm (18') high prefabricated and insulated curb conforming to requirements of the National Roofing Contractors Association.
- .1 ***Provide curb adapter to transition from existing curb dimensions to new curb dimensions. Contractor to field measure existing curbs and provide custom curb adapters to suit replacement units.***
- .11 **Seismic Restraint Hardware:** Factory secured seismic restraint connection hardware.

### 3 EXECUTION

#### 3.1 Installation of Heating and Air Conditioning Units

- .1 Provide outdoor heating and air conditioning units where shown.
- .2 Provide all required rigging and hoisting/moving equipment required to move each unit to the required locations. Do all rigging/hoisting/moving in accordance with the unit manufacturer's directions and details.
- .3 Hand a curb for each roof mounted unit to the roofing trade on the roof for installation and flashing into the roof construction. Secure each unit in place on the roof curb. Provide continuous gasketing around the perimeter of each curb between the curb and the unit mounting frame.
- .4 Brace and secure each unit in accordance with requirements specified in the mechanical work Section entitled Seismic Control and Restraint.
- .5 Install all components shipped loose with the units. Install in accordance with the manufacturer's recommendations. Calibrate all control components requiring field calibration.
- .6 Extend condensate trapped drains to the roof or grade using Schedule 40 galvanized steel piping.
- .7 ***Replace existing thermostat with a new one and re-using existing wiring to RTU location. Confirm all locations on-site. Provide new labels for thermostats which indicate the corresponding RTU serving the space.***
- .8 Set up and program the thermostats in accordance with the Owner's requirements.
- .9 Carefully coordinate the installation of each unit with all other trades making connections to the unit power, interlock connections, and control connections.

- .10 **Equipment and System Manufacturer's Certification:** Refer to the article entitled Equipment and System Manufacturer's Certification in the Mechanical Work General Instructions Section.
- .11 **Start-Up:** Refer to the article entitled Equipment and System Start-up in the Mechanical Work General Instructions Section.
- .12 **Commissioning:** Refer to commissioning requirements specified in the Mechanical Work General Instructions Section.
- .13 **Demonstration and Training:** Refer to the article entitled Equipment and System O & M Demonstration & Training in the Mechanical Work General Instructions Section. Include for 4 hours of on-site operation demonstration and training for 2 groups of 6 people.

**END OF SECTION**

## 1 GENERAL

### 1.1 Submittals

- .1 **Product Data:** Submit product data sheets for fan coil units and accessories. Include motor data sheets.
- .2 **Site Inspection and Start-Up Report:** Submit a site inspection and start-up report from the manufacturer's representative as specified in Part 3 of this Section.

### 1.2 Quality Assurance

- .1 Fan coil units are to be CSA or ETL listed and labelled, factory assembled and tested, shipped to the site in one-piece, and are to be in accordance with requirements of the following Codes and Regulations:
  - .1 CAN/CSA-C22.2 No. 236, Heating and Cooling Equipment.
  - .2 UL/ANSI 1995, Heating and Cooling Equipment.
  - .3 ARI Standard 350, Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment.
  - .4 ARI Standard 440, Performance Rating of Room Fan-Coils.

## 2 PRODUCTS

### 2.1 Fan Coil Units

- .1 ARI rated and certified capacity fan coil units as per the drawing schedule and complete with components specified below.
- .2 **Cabinet Construction:** Heavy-gauge galvanized steel construction with all exterior panels insulated with minimum 15 mm (½") thick neoprene spray coated glass fibre lining material secured in place with adhesive and with all exposed edges treated and sealed to prevent any fibres from entering the airstream, all meeting NFPA 90A requirements and flame spread and smoke developed fire hazard ratings of CAN/ULC-S102. Each cabinet shall be complete with:
  - .1 **Filters:** an accessible galvanized steel filter holding frame and glass fibre, 25 mm (1") thick, disposable, 25-30% efficient MERV7 filters and complete with a cardboard frame.
  - .2 **Coils:** factory tested coils consisting of 12 mm (½") O.D. seamless copper tubes mechanically expanded into plate type aluminium fins and equipped with copper pipe headers, a manual air vent, and a drain plug.
  - .3 **Cooling coil drain pans:** full width, watertight stainless steel primary drain pans sloped for positive drainage and equipped with two 20 mm (¾") O.D. drain connections, and factory insulated with 25/50 rated closed cell insulation conforming to CAN/ULC-S102 and NFPA 90A requirements, with secondary drain pans, constructed and insulated as for primary drain pans, to be provided where required to collect condensate from pipe headers and field supplied valves.
- .3 **Fans:** Centrifugal, forward curved, double width and inlet galvanized steel fan wheel, each dynamically balanced, complete with a 3-speed, resiliently mounted, thermal overload protected, permanent split capacitor motor conforming to requirements specified in the Basic Mechanical Materials and Methods Section, and complete with a 3-speed plus "off" motor control switch with faceplate factory mounted in an electrical box which is secured to the unit in an accessible location and factory connected to the motor. Fan assemblies are to be accessible and easily removable.
- .4 **Horizontal Units:** Horizontal units are to be suspended, equipped with four top casing holes for hanger rod connections, and the following:
  - .1 Rubber-in-shear vibration isolation elements factory supplied with each unit for each suspension point.

- .2 A double deflection discharge grille or flanged discharge duct connection collar as indicated, and either a bottom or rear single deflection return air grille as shown.
  - .3 Removable bottom and side panels, and bottom access to the filter holding frame.
  - .4 For exposed units, a fused powder epoxy finish on the casing and grilles.
- .5 **Vertical Units:** Vertical units are to be, unless otherwise shown or specified, floor mounted on neoprene-steel-neoprene vibration isolation pads and complete with the following:
- .1 A condensate drain pan.
  - .2 "P" trap factory piped to the condensate drain riser.
  - .3 A shield to cover the entire fan assembly to prevent air by-pass and accidental contact with the fan.
  - .4 For exposed front units, a removable decorator front panel with architectural grade aluminium double deflection discharge grille and return air grille, all factory finished with heat cured acrylic powder epoxy enamel with colour as selected from the manufacturer's standard colour chart.
  - .5 For concealed units, a duct connection collar on the discharge.
- .6 **Seismic Restraint Hardware:** Seismic restraint connection hardware factory secured to each unit.
- .7 **Acceptable Manufacturers:** Acceptable fan coil unit manufacturers are:
- .1 Johnson Controls Co. "Enviro-Tec".
  - .2 Trane Canada.
  - .3 Carrier Corp.
  - .4 Greenheck Fan Corp.
  - .5 The Whalen Co.

### **3 EXECUTION**

#### **3.1 Installation of Fan Coil Units**

- .1 Provide all required fan coil units.
- .2 Secure each horizontal fan coil unit in place from the structure by means of galvanized steel hanger rods, and vibration isolation elements supplied with the fan coil units. Provide additional structural steel for fan coil unit installation support as required.
- .3 Unless otherwise shown or specified, secure each vertical fan coil unit in place on the floor, complete with vibration isolation pads supplied with the fan coil units.
- .4 Brace and secure each unit in accordance with requirements specified in the mechanical work Section entitled Seismic Control and Restraint.
- .5 Provide shut-off valves and install a control valve in piping for each coil. Refer to the drawing detail and piping schematic.
- .6 **Equipment and System Manufacturer's Certification:** Refer to the article entitled Equipment and System Manufacturer's Certification in the Mechanical Work General Instructions Section.
- .7 **Start-Up:** Refer to the article entitled Equipment and System Start-up in the Mechanical Work General Instructions Section.
- .8 **Commissioning:** Refer to commissioning requirements specified in the Mechanical Work General Instructions Section.

- .9 **Demonstration and Training:** Refer to the article entitled Equipment and System O & M Demonstration & Training in the Mechanical Work General Instructions Section. Include for 4 hours of on-site operation demonstration and training for 2 groups of 6 people.

**END OF SECTION**

## 1 GENERAL

### 1.1 Scope of work

- .1 **Control System Addition:** Provide a building automation system consisting of all required electronic panels, field devices, wiring, control valves, control dampers, programming and system graphics and user interface for the renovation/addition. The new system shall interface to the existing control system and the existing system graphics is to be updated with the new systems added. The system is to achieve the control, monitoring and diagnostics capability identified in this specification, the sequence of operation and points list.

### 1.2 Abbreviations and Definitions

- .1 Abbreviations used in this Specification are as follows:
  - .1 BAS Building Automation System.
  - .2 EMCS Energy Management Control System
  - .3 DDC Direct Digital Controls.
  - .4 LAN Local Area Network.
  - .5 PC Personal Computer.
  - .6 AI/AO Analog Input / Analog Output
  - .7 DI/DO Digital Input / Digital Output.
  - .8 BACnet Building Automation and Control Network.
  - .9 NC Normally Closed.
  - .10 NO Normally Open.
  - .11 OWS Operator Work Station.
  - .12 PID Proportional, Integral, and Derivative.
  - .13 SP Static Pressure.
  - .14 UPS Uninterruptible Power Supply.
  - .15 VAV Variable Air Volume.

### 2.1 Contractual Relationship and Scheduling

- .1 **The Controls Contractor will be retained and paid by the Mechanical Contractor. The Controls Contractor will be a sub-contractor to the Mechanical Contractor.**
- .2 The Controls Contractor shall cooperate and coordinate their control system installation work with the General, Mechanical, Electrical and other trade contractors on site.
- .3 The Mechanical Contractor's responsibility will be to coordinate the timing for the controls installation and expedite the mechanical system installation allowing sufficient time for the controls installation.
- .4 The control contractor is to communicate their installation and scheduling requirements to the mechanical contractor for coordination to ensure ample time for installation of the control system is provided prior to substantial completion.
- .5 The Mechanical Contractor shall resolve inter-contractor co-ordination problems. Where problems become apparent during the commissioning process, work at the identification and resolution of these problems.

### 3.1 Related Work

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts of the contract documents.
- .2 The controls contractor shall review all specified equipment being provided on this project and familiarize themselves with specific equipment terminal strips, control components, BACnet interface connections and other operating and control characteristics.

### 4.1 Electrical Work

- .1 Generally, this Sub-Contractor will provide all wiring to all mechanical controls except in the case of line voltage devices which directly control single phase motors such as unit heaters, cabinet heaters, etc., or unless included in the Electrical Specifications and plans.

- .2 If devices other than those indicated in the electrical specifications or drawings are used to interlock equipment by directly switching line voltage, it will be this Contractor's responsibility to wire these devices.
- .3 This sub-contractor will include for all power wiring required to energize valves, dampers, control panels, transformers, etc.
- .4 This Sub-Contractor's responsibility for connections of control to motor starters, unitary equipment, etc. will be from terminal section with the MCC (Motor Control Centre).
- .5 All main and communication wiring, line or low voltage, will be governed by this specification, the Electrical Specifications and all local governing codes.
- .6 All power supplies for controls are this Contractor's responsibility unless otherwise specified in the Electrical Specifications. All control transformers to be located in fan rooms or mechanical rooms only, alternate locations must be approved by Owners Representative.
- .7 Wiring of Hand-Off-Auto (H-O-A) switches on magnetic starters will be such that the hand position will by-pass controls which are used to automatically start and stop that particular piece of equipment with the exception of safety controls such as freeze stats. Interlocks will not be omitted in the hand position if unsafe or unacceptable conditions can be created.
- .8 Coordinate all Electrical, Fire, Communications, Security requirements with Division 16.
- .9 Additional low voltage wiring for equipment such as safety devices for boiler, low voltage wiring of infrared faucets, control wiring for remote condensing units and proprietary equipment thermostats will be included in the control contractors scope of work.

#### 4.2 Coordination With Other Trades

- .1 The Controls contractor shall coordinate the installation of the BAS with all other trades and the general contractor. This shall include providing cooperation and technical assistance to the trades in correctly locating controls elements that are installed the systems.
- .2 This shall include but not necessarily limited to the following;
  - .1 The location and placement of temperature sensor immersion wells.
  - .2 The location and placement of flow switches.
  - .3 The location and placement of turbine flow meters.
  - .4 The location and placement of pressure sensor taps.
  - .5 Pointing out the correct piping configuration of three way control valves.
  - .6 The location and placement of access doors for the installation of duct mounted temperature sensors,
  - .7 The location and placement of access doors for the installation of duct mounted pressure sensors,
  - .8 The location, placement, and installation requirements of air flow measuring stations and control dampers.
  - .9 Ensuring that free, clear, and unencumbered access is maintained to unit mounted controls devices on air handling equipment.

#### 5.1 Submittals

- .1 **Shop Drawings/Product Data:** Submit shop drawings/product data sheets for all BAS components as per section 20 05 05 and the following additional requirements.
  - .1 BAS network architecture, including all panel locations, network wiring locations and other required remote devices.
  - .2 Systems schematics, and flow diagrams for each major mechanical system which in general will result in a separate graphics system pages.
  - .3 Sequences of operation for the system and each major mechanical equipment with identification of global and system variables, set points and operating schedules.
  - .4 Points schedule for each point in the BAS, and for each building controller and application specific controller including point type, object name, expanded ID, display units, controller type, and address.
  - .5 **Samples of graphic display screen types and associated menus should be submitted for approval prior to building of the final graphic screens. .**
  - .6 A detailed Bill of Materials for each system or application, identifying quantities, part numbers, descriptions, and optional features.

- .7 Control damper schedule including a separate line for each damper and a column for each of the damper attributes including code number, fail position, damper type, damper operator, duct size, damper size, mounting and actuator type.
- .8 Control valve schedules including size, CV, pressure drop, flow, valve and actuator model #.
- .9 A room schedule including a separate line for each HVAC terminal unit indicating type, location, and address.
- .10 Details of all BAS interfaces and connections to other systems to be provided.
- .11 Product data sheets or marked catalogue pages including part number, photograph and description for all BAS hardware and software.
- .12 Long delivery items such as valves and dampers can be submitted as separate shop drawings to expedite delivery.**
- .2 **End to End Point Checks:** Submit a site report of all digital and analog input, output and system device checks to the consultant and commissioning agent during construction and prior to substantial completions. Refer to Commissioning section of this specification for additional details.

### 6.1 Description of the Building Automation System

- .1 In general the building automation system shall consist of a complete operational control system which will provide equipment and system control, in addition to monitoring and diagnostics information for the building operator. The new system will also be required to interface to any existing building automation systems currently installed in the building.
- .2 The building automation system shall consist of a modular, BACnet protocol, open architecture system incorporating direct digital control and monitoring of equipment and systems and consisting of all hardware, software and graphics required for the complete system.
- .3 The BAS shall be accessible through standard personal computers or laptops within the building through a wireless application protocol device, or remotely through the Internet or the WAN by means of a standard web browser.
- .4 The BAS shall be field expandable, with an architectural design to eliminate dependence upon any single device for alarm reporting and control execution. Failure of any single component or network connection is not to interrupt the execution of control strategies at other operational devices. The BAS shall maintain all settings and overrides through a system re-boot, and shall incorporate, as a minimum, the following integrated features, functions, and services:
  - .1 Operator information, alarm management, and control features.
  - .2 Enterprise-level information and control access.
  - .3 Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
  - .4 Diagnostic monitoring and reporting of BAS functions.
  - .5 Off-site monitoring and management access.
  - .6 Energy management.
  - .7 Standard applications for terminal HVAC systems.
  - .8 Trend logging of every input and output point in the system.
- .5 The BAS shall include, but not be limited to, the following:
  - .1 A personal computer-based operator work station with colour monitor for colour graphic displays, and a colour printer.
  - .2 A portable operator's terminal.
  - .3 Standalone network automation engine(s).
  - .4 Field equipment controllers.
  - .5 Input/output modules.
  - .6 Local display devices.
  - .7 Distributed user interfaces.
  - .8 Network processing, data storage and communication equipment.
  - .9 All other components required for a complete and operating BAS.

## 7.1 Quality Assurance

- .1 The BAS hardware and software shall be installed by experienced personnel employed and trained by the system equipment manufacturer/supplier. All system wiring shall be installed by journeyman electricians or under direct on-site supervision of journeyman electricians.
- .2 The BAS supplier/installer shall have a branch facility with parts within a 100 km radius of the building and have available complete maintenance and support services on a 24 hour, 7 day-a-week basis.
- .3 The control system shall be provided with a 2 year complete labour and material warranty from the date of substantial completion which will include 2 complete summers and winters operation. During the warranty period the control contractor will respond to any operational issues related to the control system.
- .4 The control contractor must respond to control related warranty items, such as device failures or temperature complaints within 48 hours. Any complete system failures or control panel failures must be responded to within 8 hours.
- .5 All building controllers, system controllers and application specific controllers to be provided with a 5 year full replacement warranty.
- .6 Codes and Standards:
  - .1 Worksafe BC Occupational Health and Safety Regulation
  - .2 Technical Safety BC
  - .3 British Columbia Building Code – Latest Edition
  - .4 British Columbia Electrical Code – Latest Edition
  - .5 ASHRAE/ANSI Standard 135 - BACnet -- A Data Communication Protocol for Building Automation and Control Networks
  - .6 EIA 485 – (Electronic Industry Alliance) Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems
  - .7 EIA / TIA 568B - Commercial Building Telecommunications Cabling Standard
  - .8 ANSI/TIA 568-C - Optical Fiber Cabling Components Standard
  - .9 TIA/EIA-604 - Fiber Optic Connector Intermateability Standard

## 8.1 System Performance

- .1 Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).
  - .1 Graphic Refresh. A graphic with 50 dynamic points shall update with current data within 5 sec. and shall automatically refresh every 10 sec.
  - .2 Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 5 sec.
  - .3 Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
  - .4 Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 45 sec.
  - .5 Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
  - .6 Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
  - .7 Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 sec of other workstations.
  - .8 Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.
  - .9 Control Stability: Control loops shall maintain measured variable at setpoint within tolerances listed in the table below:

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Controlled Variable	Control Accuracy	Range of Medium
Airflow	±10% of full scale	
Space Temperature	±1.0°C	
Duct Temperature	±1.5°C	
Humidity	±5% RH	0 – 100% RH

.10 Control Accuracy: Control sensors shall maintain the reported accuracies of the measured variable within tolerances listed in the table below:

Measured Variable	Reported Accuracy
Space Temperature	±0.5°C (±1°F)
Ducted Air	±0.5°C (±1°F)
Outside Air	±1.0°C (±2°F)
Airflow (terminal)	±10% of full scale (see Note 1)
Electrical	±1% of reading (see Note 3)

## 9 PRODUCTS

### 9.1 Building Automation System - General

- .1 **Control System Components:** Control system components (field devices) other than those specified in this Section are generally specified in the mechanical work Section entitled Automatic Control Systems. Components factory installed with equipment or supplied with equipment are specified in mechanical work Sections with the equipment.
- .2 **Acceptable BAS Manufacturers:** Refer to specification section 20 05 10 Basic Mechanical Material and Methods for a list of Acceptable BAS Manufacturers for this project.

### 9.2 BAS Controllers

- .1 Provide BAS controllers capable of complete operation as part of an integrated Building Management System (BMS). Use controllers with the latest stable firmware. If there are existing panels at the same site, upgrade them to the same revision of firmware. Use recently manufactured panels (not used or dated ones). Always ensure that upgrades do not compromise system operation; even in phased stages. At the end of this project (or phase), equipment will not be left manually On or Off (in software, electrically, jumpered out, pneumatically, or by any other means).
- .2 **Provide 10% spare capacity of inputs and outputs on all main system controllers located in the mechanical rooms.**
- .3 Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.
- .4 Building Controllers and Custom Application Controllers will be selected to provide the required I/O point capacity required to monitor all of the hardware points listed.
- .5 The control system must directly connect to the Detachment's Wide Area Network (WAN) with an Ethernet connect and utilizing TCP/IP communication protocols. The use of a host computer to act as an Ethernet gateway will not be accepted. The Main highway trunk will be native BACnet Ethernet or MSTP / RS485. It will not use a proprietary protocol, ARCnet or Modbus communications. Devices using Lon, Lontalk, and/or gateway translation modules are not acceptable.

- .6 Each DDC controller with an Ethernet connection will be provided with an IP address to be connected to the Detachment's network.
- .7 All control panels will communicate directly through peer-to-peer protocol.
- .8 **All digital outputs will be complete with a manual Hand – Off – Auto (HOA) switch. The controller will monitor the HOA status and the controller software will indicate Auto Mode, Manual Off Mode, and Manual On Mode.**
- .9 DDC panels will be mounted local to the equipment they are serving.
- .10 Control will be performed by a direct digital controller microprocessor based which incorporates DDC, and all necessary energy management functions.
- .11 Control algorithms will be available and resident in the direct digital controller to permit proportional, integral, derivative and two-position control modes in any combination to meet the requirements of the application.
- .12 Direct digital controller will have, but not be limited to, the following additional application programs:
  - .1 Trending of variables
  - .2 Runtime totalization
  - .3 Alarming
  - .4 Network
- .13 Each controller will contain ports to interface to a Personal Computer or laptop computer, and the high speed Local Area Network (LAN) to other controllers. Accessing any controller will provide access to ALL controllers on the network. Systems utilizing a Master / Slave or Gateway panel architecture will not be accepted.
- .14 Each controller will have the ability to directly interface to a Microsoft PC or compatible, and provide full capabilities, including programming.
- .15 A rechargeable battery or capacitor will retain the time of day and the RAM memory through a 72 hour power failure.
- .16 DDC Controllers will be provided that continuously calculates the position that a control point (such as a modulating hot water control valve) should be, in order to control an input point (such as hot water temperature).
- .17 The control panels MUST have a MINIMUM analog / Digital and digital / analog resolution of 10 bits.

### 9.3 BAS Architecture

- .1 **Automation Network:** The BAS shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards are to be standard "off-the-shelf" products available through normal PC vendor channels. The BAS shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication. The BAS shall be compatible with other enterprise-wide networks, and where indicated, the BAS shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.
- .2 **Control Network:** Network automation engines are to provide supervisory control over the control network and are to support the BACnet Standard MS/TP bus communication protocol (ASHRAE SSPC-135, Clause 9). The control networks are to provide either a "peer-to-peer", master-slave, or supervised token passing communications and are to operate at a minimum communication speed of 9600 baud. DDC controllers are to reside on the control network.
- .3 **Integration:** The BAS shall include appropriate hardware and software to allow BACnet bi-directional data communications between the BAS and building equipment/system control panels. The BAS shall receive, react to, and return information from the equipment and systems. All data required by the application shall be mapped into the automation engine's data base and shall be transparent to the operator. Point inputs and outputs from building equipment/system control panels shall have real-time inter-operability with BAS software features such as control software, energy management, custom process programming, alarm management, historical data and trend analysis, totalization, and local area network communications.
- .4 **Graphics Package:** As a minimum, the graphic screen shall consist of a the following:

- .1 Main Screen: Identifies the Site and has major transfer links to key graphical pages.
- .2 Thermographic Floor Plan Overview: Indicates the status of the site using colour backgrounds. Zones with a red background are over heating, zones with a blue background are too cold, zones with a green background are zones that are within comfort conditions, and zones with a white background indicates that the equipment serving the zone is not operating.
- .3 Floor Plans: Indicate the zones of each floor and include operating data such as zone temperature, active zone setpoint, lighting status.
- .4 Floor Plan Equipment Summaries: List equipment serving each zone and includes the operating data associated with each zone.
- .5 Floor Plan zones will link directly to the equipment, mechanical room and detailed equipment graphics.
- .6 Global Variables Page: List all global variables and operating mode switches. This enables the operating to quickly review and modify global variables that impact the entire building.
- .7 Central Air Handling Unit Schematic: Displays an "as-installed" schematic of the air handling unit and includes data and links required to monitor, troubleshoot, and modify the operating parameters that control the plant. Provide a separate graphic screen for each air-handling system.

#### 9.4 Dedicated Web Based User Interface

- .1 **User Interface:** User interface shall be dedicated web based by means of a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions including scheduling, history collection, and alarming shall be resident in the BAS network automation engines to facilitate greater reliability.

#### 11.1 Distributed Web Based User Interface

- .1 **Web Based User Interface:** All features and functions of the dedicated web-based user interface described above are to be available on any computer connected directly or via a wide area or virtual private network to the BAS network, which conforms to the following specifications:
  - .1 The software shall run on the Microsoft Internet Explorer (6.0 or higher) browser.
  - .2 Minimum hardware requirements are:
    - .1 256 MB RAM.
    - .2 2.0 GHz clock speed Pentium 4 microprocessor.
    - .3 40.0 GB hard drive.
    - .4 Keyboard with 83 keys minimum.
    - .5 SVGA 1024 x 768 resolution display with 64K colours and 16 bit colour depth.
    - .6 Mouse or other pointing feature.

#### 11.2 User Interface Application Components

- .1 **Operator Interface:** An integrated browser-based client application shall be used as the user operator interface program. The system shall employ an event-driven rather than a device polling methodology to dynamically capture and present new data to the user. Additional features are as follows:
  - .1 All inputs, outputs, set-points, and other parameters as defined in Part 3 of this Section, shown on the drawings, or required as part of the system software are to be displayed for operator viewing and modification from the operator interface software.
  - .2 The user interface software shall provide help menus and instructions for each operation and/or application.
  - .3 The system shall support customization of the user interface configuration and a home page for each operator.

- .4 The system shall support user preferences in alarm, trend, display, and applications screen presentations.
- .5 All controller software operating parameters are to be displayed for the operator to view/modify from the user interface, and these parameters are to include set-points, alarm limits, time delays, PID tuning constants, run times, point statistics, schedules, etc.
- .6 The operator interface shall incorporate comprehensive support for functions including but not limited to the following:
  - .1 User access for selective information retrieval and control command execution.
  - .2 Monitoring and reporting.
  - .3 Alarm, non-normal, and return to normal condition annunciation.
  - .4 Selective operator override and other control actions.
  - .5 Information archiving, manipulation, formatting, display and reporting.
  - .6 BAS internal performance supervision and diagnostics.
  - .7 On-line access to HELP menus.
  - .8 On-line access to current BAS as-built records and documentation.
  - .9 Means for controlling, re-programming, and re-configuration of the BAS operation and for the manipulation of the BAS database information in compliance with applicable Codes and Regulations for individual BAS applications.
- .7 The system shall support a list of application programs configured by the users that are called up by the tools Menu, hyperlinks within the graphic displays, and key sequences.
- .8 The operation of the control system shall be independent of the user interface, which shall be used for operator communication only.
- .2 **Navigation Trees:** The system shall have a minimum of five levels of nesting, and the capability of displaying multiple navigation trees to aid the operator in navigating throughout all systems and points connected, adding custom trees, defining any logical grouping of points and arranging them on a tree in any order, and nesting groups within other groups. The navigation trees are to be "dockable" to other displays such as graphics, meaning that the trees will appear as part of the display but can be detached and then minimized to the Windows task bar or closed altogether, however, a simple keystroke will reattach the navigation to the primary display of the user interface.
- .3 **Alarms:** Alarms are to be routed directly from network automation engines to PC's and servers, and it shall be possible for specific alarms from specific points to be routed to specific PC's and servers. The BAS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions annunciate application alarms as required by points lists and sequences, and as a minimum, permit four categories of alarm sounds customizable through user defined wav files. The alarm management segment of the user interface shall provide, as a minimum, the following alarm functions:
  - .1 Log, date, and time of alarm occurrence.
  - .2 Generate a "pop-up" window with audible alarm to inform a user that an alarm has been received.
  - .3 Permit a user with the appropriate security level to acknowledge, temporarily silence, or discard an alarm.
  - .4 Provide an audit trail on the PC hard drive for alarms by recording user acknowledgement, deletion or disabling of an alarm, the name of the user, the alarm, the action taken, and the time/date of the alarm.
  - .5 Facilitate the ability to direct alarms to an email address or alphanumeric pager, in addition to the pop-up window described above.
  - .6 Any attribute of any object in the system may be designated to report an alarm.
- .4 **Reports and Summaries:** Reports and summaries are to be generated and directed to the user interface displays with subsequent assignment to printers or discs. Summaries and reports are to be accessible via standard user interface functions, and selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary. The

system shall permit the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports. As a minimum the BAS shall provide the following reports and summaries:

- .1 All points in the BAS.
  - .2 All points in each BAS application.
  - .3 All points in a specific controller.
  - .4 All points in a user-defined group of points.
  - .5 All points currently in alarm.
  - .6 All points locked out.
  - .7 All BAS schedules.
  - .8 All user defined and adjustable variables, schedules, interlocks, etc.
- .5 **Schedules:** A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided, with weekly schedules for each group of equipment with a specific time use schedule, and it shall be possible to define one or more exception schedules for each schedule including reference to calendars, with monthly calendars provided to permit simplified scheduling of holidays and special days for a minimum of five years in advance, user selected with the pointing device or keyboard. Changes to schedules made from the user interface are to directly modify the network automation engine schedule database. Selection of a single menu item or tool bar button shall print any displayed schedule. As a minimum the following functions are to be provided:
- .1 Weekly schedules.
  - .2 Exception schedules.
  - .3 Monthly calendars.
- .6 **Passwords:** The BAS Shall be complete with multiple-level password access protection to permit the user/manager to user interface control and display, database manipulation capabilities deemed appropriate for each user, based on an assigned password. Password access protection features are to include:
- .1 Each user shall have a user name, a password, and access levels.
  - .2 Each user may change his or her password at any time.
  - .3 Operators are to be able to perform only those commands available for their respective passwords, and display of menu selections shall be limited to only those items defined for the access level assigned to the password of each user.
  - .4 The BAS shall automatically generate a report of log-on/log-off and system activity for each user, and any action that results in a change in the operation or configuration of the control system shall be recorded, including the acknowledgement and deletion of alarms.
  - .5 A minimum of five levels of access shall be supported individually or in any combination of the following:
    - .1 Level 1 – view data.
    - .2 Level 2 – command.
    - .3 Level 3 – operator overrides.
    - .4 Level 4 – database modification.
    - .5 Level 5 – database configuration.
    - .6 Level 6 – all privileges including password add/modify.
- .7 **Screen Manager:** The user interface shall be equipped with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of four active display windows plus a network of user defined navigation trees.
- .8 **Dynamic Colour Graphics:** The graphics application program shall be an integral part of the user interface and shall include a create/edit function and a runtime function, and the system architecture shall support an unlimited number of graphic documents (graphic definition files) to be generated and executed. The graphics are to be capable of displaying and providing animation based on real-time data that is acquired, derived, or entered. Additional features include the following:

- .1 **Graphics runtime functions:** a maximum of sixteen graphic applications are to be able to be executed at any one time on a user interface or workstation with four visible to the user, and each graphic application shall be capable of the following functions:
  - .1 All graphics are to be fully scalable.
  - .2 Graphics are to support a maintained aspect ratio.
  - .3 Multiple fonts are to be supported.
  - .4 A unique background shall be assigned on a per graphic basis.
  - .5 The colour of all animations and values on displays shall indicate the status of the object attribute.
- .2 **Operation from graphics:** it shall be possible to change values (set-points) and states in the system controlled equipment by using drop-down windows accessible via the pointing device.
- .3 **Graphic editing tool:** a graphic editing tool shall be provided to permit the creation and editing of graphic files, and the graphic editor shall be capable of performing/defining all animations, defining all runtime binding, and:
  - .1 In general, facilitate the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.
  - .2 Be capable of adding additional content to any graphic by importing backgrounds in the SVG, BMP, or JPG file formats.
- .4 **Aliasing:** many graphic displays representing part of the building and various building components are exact duplicates, with the exception that the various variables are bound to different field values, consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to physical field tags.
- .9 **Historical Trending and Data Collection:** Trend and change of value data shall be stored within the automation engines and uploaded to a dedicated trend database or exported in a selectable data format via a data export utility. Uploads to a dedicated database are to occur based on one of user-defined interval, manual command, or when the trend buffers are full. Exports are to be as requested by the user or on a time scheduled basis. The system shall be equipped with a configurable data storage sub-system for the collection of historical data which can be stored in either Microsoft Access or SQL database format. Each automation engine shall store, trend, and point history data for all analog and digital inputs and outputs as follows:
  - .1 Any point, physical or calculated, may be designated for trending, and methods of collection are to be defined time interval or a change of value.
  - .2 Each automation engine shall be capable of storing multiple samples for each physical point and software variable based on available memory, including an individual sample time/date stamp, and points may be assigned to multiple history trends with different collection parameters.
- .10 **Trend Data Viewing and Analysis:** A trend viewing utility with access to all data points and the capability of defining trend study displays to include multiple trends shall be provided, and shall include:
  - .1 The capability of retrieving any historical database point for use in displays and reports by specifying the point name and associated trend name.
  - .2 Displays which are able to be single or stacked graphs with on-line selectable display characteristics such as ranging, colour, and plot style.
  - .3 Display magnitude (zoom capability) and units selectable by the operator at any time without reconfiguration the processing or collection of data.
  - .4 Display magnitude shall be automatically scaled to show full graphic resolution of the data being displayed.
  - .5 Trend studies are to be capable of calculating and displaying calculated variables including highest value, lowest value, and time based.
  - .6 The display shall support the user's ability to change colours, sample sizes, and types of markers.
- .11 **Database Management:** The BAS shall be equipped with a database manager that separates the database monitoring and management functions by supporting two separate

- windows. Database secure access shall be accomplished using standard SQL authentication including the ability to access data for use outside of the BAS application. Additional features are as follows:
- .1 The database management function shall include summarized information on trend, alarm, event, and audit for backup, purge, and restore database management functions.
  - .2 The database manager shall support four tabs as follows:
    - .1 **Statistics**, which shall display database server information and trend, alarm (event), and audit information on the BAS database.
    - .2 **Maintenance**, which shall be an easy method of purging records from the BAS server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting the database, and allowing for the retention of a selected number of day's data.
    - .3 **Backup**, which shall provide the means to create a database backup file and select a storage location.
    - .4 **Restore**, which shall provide a restricted means of restoring a database by requiring the user to log into an Expert Mode in order to view the Restore screen.
  - .3 The status bar shall appear at the bottom of the BAS database manager tabs and shall indicate information on the current display activity with icons as follows:
    - .1 Ready.
    - .2 Purging Record from Database.
    - .3 Action Failed.
    - .4 Refreshing Statistics.
    - .5 Restoring Database.
    - .6 Shrinking a Database.
    - .7 Backing-Up a Database.
    - .8 Resetting Internet Information Services.
    - .9 Shutting Down theBAS Deice Manager.
    - .10 Action Successful.
  - .4 The database manager monitoring functions are to be accessed through the Monitoring Settings window and are to continuously read database information once after the user has logged in.
  - .5 The system shall advise the user via task bar icons and email messages when a database value has exceeded a warning or alarm limit.
  - .6 The Monitoring Settings window shall have the following sections:
    - .1 **General**, to allow the user to set and review scan intervals and start times.
    - .2 **Email**, to allow the user to create and review email and telephone text messages to be delivered when a Warning or Alarm is generated.
    - .3 **Warning**, to allow the user to define the warning limit parameters, set the Reminder Frequency, and link the email message.
    - .4 **Alarm**, to allow the user to define the alarm limit parameters, set the Reminder Frequency, and link the email message.
    - .5 **Database Login**, to protect the system from unauthorized database manipulation by creating a Read Access and Write Access for each of the trend, alarm (event), and audit databases as well as an Expert Mode required to restore a database.
  - .7 The Monitoring Settings taskbars to display the following informational icons:
    - .1 **Normal**, which indicates by colour and size that all databases are within their limits.
    - .2 **Warning**, which indicates by colour and size that one or more databases have exceeded their warning limit.
    - .3 **Alarm**, which indicates by colour and size that one or more databases have exceeded their alarm limit.
  - .8 The BASshall indicate via taskbar icons and email messages when a database value has exceeded a warning or alarm limit.

### 11.3 Network Automation Engines

- .1 Network automation engines are to be UL/ULC listed and labelled; BACnet Testing Labs certified and labelled, fully user programmable supervisory controllers to monitor a network of a minimum of one hundred distributed application-specific controllers for a global strategy and direction and to communicate on a peer-to-peer basis with other network automation engines.
- .2 **User Interface:** Each network automation engine shall have the ability to deliver a web based user interface as specified above, and all computers connected physically or virtually to the automation network are to have access to the web based user interface. Additional characteristics/requirements are as follows:
  - .1 The web-based user interface software shall be imbedded in each network automation engine.
  - .2 Each network automation engine shall support a minimum of four concurrent users.
  - .3 The user shall be capable of accessing all system data through one network automation engine.
  - .4 Remote users connected to the network through an internet service provider or by telephone dial-up are also to have total system access through one network automation engine.
  - .5 Each network automation engine shall be capable of generating web-based user interface graphics, and this capability shall be imbedded in the network automation engine.
  - .6 The user interface shall support the following functions using a standard version of Microsoft Internet Explorer:
    - .1 Configuration.
    - .2 Commissioning.
    - .3 Data archiving.
    - .4 Monitoring.
    - .5 Commanding.
    - .6 System diagnostics.
  - .7 Each network automation engine shall permit temporary use of portable devices without interrupting the normal operation of permanently connected modems.
- .3 **Processor:** Each network automation engine shall be a multi-tasking, multi-user, microprocessor based real time digital control processor sized to meet requirements of the system with a minimum word size of 32 bits, and standard operating systems.
- .4 **Memory:** Each network automation engine shall have sufficient memory to support its own operating system, databases, and control programs to provide supervisory control for all control level devices.
- .5 **Real Time Clock:** Each network automation engine shall include an integrated, hardware based real time clock.
- .6 **LED Indicators:** Each network automation engine shall be equipped with LED indicators to identify the following conditions:
  - .1 Power, On/Off.
  - .2 Ethernet Traffic, Ethernet Traffic/No Ethernet Traffic.
  - .3 Ethernet Connection Speed, 10 Mbps/100 Mbps.
  - .4 FC Bus A, Normal Communications/No Field Communications.
  - .5 FC Bus B, Normal Communications/No Field Communications.
  - .6 Peer Communication, Data Traffic Between Network Automation Engines.
  - .7 Run, NAE Running/NAE in Start-up/NAE Shutting Down/Software Not Running.
  - .8 Battery Fault, Battery Defective/Data Protection Battery Not Installed.
  - .9 24 VAC, 24 VAC Present/Loss of 24 VAC.
  - .10 Fault, General Fault.
  - .11 Modem RX, NAE Modem Receiving Data.
  - .12 Modem TX, NAE Modem Transmitting Data.

- .7 **Communications Ports:** Each network automation engine shall be equipped with ports for operation of operator input/output devices such as industry standard computers, modems, and portable operator's terminals. Ports are to be as follows:
  - .1 Two USB ports.
  - .2 Two URS-232 serial data communication ports.
  - .3 Two RS-485 ports.
  - .4 One Ethernet port.
- .8 **Diagnostics:** Each network automation engine shall continually perform self-diagnostics, communications diagnostics, and diagnostics of all pane components, and transmit both local and remote annunciation of any detected component failure, low battery condition, and repeated failures to establish communication.
- .9 **Power Failure:** In the event of loss of normal power each network automation engine shall continue to operate for a user adjustable period of up to ten minutes after which there shall be an orderly shut-down of all programs to prevent the loss of database or operating system software, and:
  - .1 During a loss of normal power the control sequences are to go to the normal system shutdown conditions, and all critical configuration data shall be saved into Flash memory.
  - .2 Upon restoration of normal power and after a minimum off-time delay the controller shall automatically resume full operation through a normal soft-start sequence without manual intervention.

#### 11.4 Field Equipment Controllers

- .1 Each field equipment controller shall be a fully user programmable BACnet Testing Labs certified and labelled digital controller that communicates via BACnet MS/TP protocol. Each controller shall be housed in a plenum rated plastic housing with removable base to permit pre-wiring of analog and binary input/output field points without the controller in place.
- .2 Each controller shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences, and are to be factory programmed with a continuous adaptive tuning algorithm that sense changes in the physical environment and continually adjusts loop tuning parameters appropriately.
- .3 Each field equipment controller shall:
  - .1 Include troubleshooting LED's to identify the following conditions:
    - .1 Power on.
    - .2 Power off.
    - .3 Download or Start-Up in Progress-Not Ready for Normal Operation.
    - .4 No Faults.
    - .5 Device Fault.
    - .6 Field Controller Bus-Normal Data Transmission.
    - .7 Field Controller Bus-No Data Transmission.
    - .8 Field Controller Bus-No Communication.
    - .9 Sensor Actuator Bus-Normal Data Transmission.
    - .10 Sensor Actuator Bus-No Data Transmission.
    - .11 Sensor Actuator Bus-No Communication.
  - .2 Support universal inputs, configured to monitor any of the following:
    - .1 Analog input, voltage mode.
    - .2 Analog output, current mode.
    - .3 Analog input, resistive mode.
    - .4 Binary input, dry contact maintained mode.
    - .5 Binary input, pulse counter mode.
  - .3 Support binary inputs configured to monitor either of the following:
    - .1 Dry contact maintained mode.
    - .2 Pulse counter mode.
  - .4 Support analog outputs configured to output either of the following:

- .1 Analog output, voltage mode.
- .2 Analog output, current mode.
- .5 Support binary outputs, 24 VAC Triac.
- .6 Support configurable outputs capable of the following:
  - .1 Analog output, voltage mode.
  - .2 Binary output mode.
- .7 Have the ability to reside on a master-slave/token-passing field controller bus supporting bacnet standard protocol as follows:
  - .1 Support communications, including input/output communications between the field controllers and the network automation engines.
  - .2 Support a minimum of one hundred input/output modules and field equipment controllers in any combination.
  - .3 Operate at a maximum distance of 4560 m (15,000') between the field controller and the furthest connected device.
- .8 Have the ability to monitor and control a network of sensors and actuators over a master-slave/token-passing sensor-actuator bus supporting bacnet standard protocol as follows:
  - .1 The bus shall support a minimum of ten devices per trunk.
  - .2 The bus shall operate at a maximum distance of 365 m (1200') between the field controller and the furthest connected device.
- .9 The capability of executing complex control sequences involving direct wired input/output points as well as input and output devices communicating over the field controller bus or sensor-actuator bus.
- .10 Support, but not limited to, the following:
  - .1 Hot water, chilled water/central plant applications.
  - .2 Custom air handling units for special applications.
  - .3 Terminal units.
  - .4 Special programs as required for systems control.
- .11 Support a password protected local controller LCD back-lit display with six key keypad as an integral part of the field controller or as a remote device communicating over the sensor-actuator bus to permit the user to view monitored points without logging into the system, and to view and change set-points, modes of operation, and parameters.

### 11.5 Input/Output Modules

- .1 Input/output modules to facilitate additional inputs and outputs for use in the field equipment controllers are to be similar to the field equipment controllers but less the display and with a minimum of four and a maximum of seventeen points.

### 11.6 System Configuration tools

- .1 **System Configuration tool:** The system configuration tool is a software package supplied with the BAS to enable a computer platform to be used as a stand-alone engineering configuration tool for a network automation engine and to permit programming of field equipment controllers. The configuration tool shall provide an archive database for the configuration and application data and shall have the same look and feel at the user interface regardless of whether the configuration is being done online or offline. Additional features and characteristics are as follows:
  - .1 The tool shall include:
    - .1 Basic system navigation tree for connected networks.
    - .2 Integration of system enabled devices.
    - .3 Customized user navigation trees.
    - .4 Point naming operator parameter setting.
    - .5 Graphic diagram configuration.
    - .6 Alarm and event message routing.
    - .7 Graphical logic connector tool for custom programming.
    - .8 Downloading, uploading, and archiving databases.
  - .2 The tool shall have the capability to automatically discover field devices on connected buses and networks.

- .3 The tool shall be capable of configuring from a library of standard applications, simulating to verify applications, and commissioning field equipment controllers and field devices.
- .4 The tool shall be complete with a Bluetooth Wireless Technology wireless access point to enable a wireless enabled portable computer to make a temporary Ethernet connection to the automation network.
- .2 **Wireless MS/TP Converter:** The Bluetooth Wireless Technology converter shall provide temporary wireless connection between the sensor-actuator bus or field-controller bus and a wireless enabled portable computer. The converter shall be powered through a connection to either the sensor-actuator bus or the field-controller bus and shall support downloading and troubleshooting field equipment controllers and field devices from the portable computer over the wireless connection. The converter shall be complete with LED indicators for the following conditions:
  - .1 Power: On/Off.
  - .2 Fault: Fault/No Fault.
  - .3 SA/FC Bus: Bus Activity/No Bus Activity.
  - .4 Bluetooth: Bluetooth Communication Established/Bluetooth Communication Not Established.

### 11.7 Wiring Materials

- .1 System wiring, conduit, boxes, and similar materials are to be in accordance with requirements specified in the appropriate Section(s) of the Electrical Work Division of the Specification.
- .2 See also wiring standards in this specification for network, input and output standards.

### 11.8 System Field Devices

- .1 **Flush mount room temperature sensor with stainless steel plate**
  - .1 The surface mounted, room temperature sensor shall consist of a 10K ohm thermistor epoxied to the back of a stainless steel cover plate
    - .1 The thermistor shall:
      - .2 Read 10K ohms at 25°C,
      - .3 Have a negative temperature coefficient,
      - .4 Have an accuracy over a 0°C to 70°C of  $\pm 02^\circ\text{C}$ ,
      - .5 Have a stability of  $\pm 013^\circ\text{C}$ ,
      - .6 Have an operating temperature range of -40°C to 150°C,
    - .2 The cover plate shall measure 699mm wide by 1143mm high
    - .3 The cover plate shall be pre-drilled for mounting on a standard electrical wall box
    - .4 The cover plate shall be lined with an insulated foam pad or cork gasket to prevent thermal conductivity of the wall.
  - .1 **Space Temperature Sensor C/W LCD Display and 4 Buttons**
    - .1 The surface mounted, room temperature sensor shall consist of a vented cover complete with 4 programmable buttons and an LCD display.
    - .2 Two of the buttons will be complete with up/down arrows which will be used to adjust room temperature set point.
    - .3 The room sensor shall display set point only.
    - .4 Other display elements such as room temperature display, occupied/unoccupied to be reviewed and approved by the Owner.
    - .5 The sensors are not to incorporate humidity, CO2 or motion sensors without the approval of the mechanical consultant and Owner.
  - .2 **Single Point Duct Temperature Sensor**
    - .1 The probe temperature sensor shall consist of a 10K ohm thermistor, a stainless steel probe jacket, and an electrical connection enclosure
    - .2 The electrical connection enclosure shall:

- .1 A plastic box rated for an environment up to 60 °C,
- .2 Measure 559mm wide by 1031mm high by 508mm deep,
- .3 Have 127mm electrical knock-outs and 2 mounting wing tabs for securing.
- .4 Have a foam pad mounted to the back of the box to dampen vibrations.
- .5 The wiring connection shall consist of pair of bare wire ends.
- .6 The probe shall:
  - .1 Be double encapsulated to avoid sensor failures caused by moisture infiltration.
  - .2 Manufactured from 635mm diameter stainless steel tubing that is sealed on both ends.
  - .3 Have the thermistor located in the tip of the probe.
  - .4 Be available in the following lengths: (102cm, 203cm, 305cm, 457cm)
- .7 The thermistor shall:
  - .1 Be epoxied into the tip of a stainless steel probe,
  - .2 Read 10K ohms at 25°C,
  - .3 Have a negative temperature coefficient,
  - .4 Have an accuracy over a 0°C to 70°C of  $\pm 02^\circ\text{C}$ ,
  - .5 Have a stability of  $\pm 013^\circ\text{C}$ ,
  - .6 Have an operating temperature range of -40°C to 150°C,
  - .7 Ave an operating humidity range of 0% to 90% RH, non-condensing,
  - .8 Have an interchangeability factor of  $\pm 02^\circ\text{C}$ ,
  - .9 Have a power dissipation constant of 3 mW/°C

### **.3 Power Transformers**

- .1 In general transformers shall be used to generate low voltage power for BAS devices and shall be located in mechanical rooms and all power wiring home run from the mechanical room. Additional transformers located in the ceiling space shall be avoided.
- .2 All power transformers shall be Class 2, low voltage transformers.
- .3 All transformers shall be the enclosed style. No open style transformers shall be acceptable.
- .4 Transformers shall contain internal thermal protection.
- .5 All power transformers shall be derated. The minimum derating factor shall be 25%.
- .6 Power transformers may have militia-tap secondary outputs.
- .7 Power supply secondary output loading shall be limited to a maximum of 4 amps.
  - .1 Each secondary output shall be protected by a resettable circuit breaker.
  - .2 Circuit breakers shall be mounted in an enclosure local to the transformer and be clearly marked with the transformer tag that it is serving.
  - .3 Circuit breakers shall NOT be mounted on the transformer enclosure.
- .8 The Controls contractor shall clearly indicate the type and location of the transformers panel enclosures on an architectural floor plan and include an AutoCAD copy of the floor plan in the Maintenance manuals.
- .9 Primary side power for power transformers is NOT to be taken from packaged equipment power sources unless the manufacturer's wiring diagram clearly indicates the termination and capacity for an auxiliary power source.

### **.4 DC Power Supplies**

- .1 DC power supplies shall be filtered, regulated, and full wave rectified.
- .2 The output voltage shall be field adjustable from 16Vdc to 32Vdc.
- .3 The power supply shall supply a minimum of 2 amps of low voltage power.
- .4 The power supply shall be complete with onboard, output fusing sized to protect the power supply.
- .5 The power supply shall be panel mounted.
  - .1 The use of "plug-in" style power supplies shall not be acceptable.
- .6 The power supply shall be CSA certified

### **.5 Circuit Breakers**

- .1 Circuit breakers shall be miniaturized single pole thermal circuit breaker.
- .2 The breaker shall be complete with a push-to-reset, tease free, trip-free, snap action mechanism.
- .3 The device shall be designed for panel mounting complete with a threaded neck, hexagonal and knurled nut.
- .4 Current ratings shall be available from 0.5 A to 10 A.
- .5 Voltage rating shall be 240VAC, 48 Vdc.
- .6 Circuit breakers shall be CSA certified.

#### **.6 Relays**

- .1 Note: Only one style of relay should be used for all relay-controlled applications throughout the project. The relay shall be a two-piece assembly consisting of a socket base and a relay head. The use of miniature relays, potted relays, or circuit board mounted relays will not be accepted.
- .2 Relays shall be the general purpose, power relays. Standard of acceptance:
  - .1 Relay: OMRON MK-S Series Plugin Relay Head MKS2PI00\*-\*
  - .2 Base: OMRON PF083A-E
- .3 Relays shall be socket mounted.
  - .1 The socket shall be DIN rail mountable.
  - .2 The socket terminals and contact points shall be rated for the maximum current carrying capacity of the relay with the highest current rating that will operate in that socket.
  - .3 Relay sockets shall have labeled screw terminal.
- .4 Relays used to switch line voltage motor loads shall be inductively rated for motor load applications and clearly indicate their contact switching horsepower rating. All relays shall have a minimum relay contact rating of 1/2 HP at 120 VAC.
- .5 Do not use relays with contacts designed for signal processing to switch inductive loads.
- .6 Relay coils shall be 24VAC or 12 Vdc.
  - .1 Relays that are switched directly by analogue outputs shall have a coil resistance low enough to be switched without overloading the analogue output.
- .7 Relays shall:
  - .1 Contain a mechanical flag indicator that signals when the relay contacts have been activated.
  - .2 Have built-in surge suppression.
  - .3 Be complete with a manual test button.
  - .4 Be CSA certified.

#### **.1 Uninterruptible Power Supply (UPS).**

- .1 **If an emergency power sequence of operation is specified, provide uninterruptible power supplies capable of supporting the BAS performance for a MINIMUM period (20 minutes) for all B.A.S. equipment.**
- .2 The UPS's may be centrally located, or may be distributed as required throughout the building in specific mechanical rooms.
- .3 The UPS shall be a wall mounted panel type such as RIB Functional devices model # PSH850-UPS-STAT and have the following characteristics.
  - .1 Total harmonic distortion less than 5%.
  - .2 Single frequency harmonic distortion less than 3%.
  - .3 Output frequency regulation better than 1%.
  - .4 Static output voltage regulation better than +/-2% over battery voltage range of 105 to 140 V.D.C..
  - .5 Dynamic output voltage regulation better than
  - .6 +/- 15% with a 50% load change, and
  - .7 +/- 30% with a 100% load change.
  - .8 Recovery rate faster than 3 Hertz after 100% load change.

- .9 Slew rate less than 2 Hertz per second.
- .10 Battery recharge time with full normal operating load, 8 hours from fully discharged state (105 V.D.C.) to full charge
- .11 Power factor better than 0.8.
- .12 Acoustical noise radiation at 1 metre (4 ft.) less than 65 dBa for supplies up to 30 kva.
- .13 Batteries to be maintenance free gel/cell type.
- .14 Batteries to be warranted for [three (3)] years.
- .4 Provide the following monitoring features:
  - .1 D.C. voltmeter and ammeter.
  - .2 A.C. output voltmeter and ammeter.
  - .3 Audible and visible alarm indications on front panel.
  - .4 Common alarm output dry contacts for remote monitoring.
  - .5 Controls Contractor to wire from contacts to B.A.S.

### 13.2 BAS Main Control Panel Enclosures

- .1 BAS controllers shall be mounted into dust proof, splash tight, lockable panel enclosures.
- .2 Wiring, powering, and terminating of the BAS panels shall be completed according to the manufacturer's instructions and best practices.
- .3 The panel enclosure shall be mounted no higher than two (2) meters above finished floor.
- .4 Panel shall NOT be mounted on mechanical system ductwork or equipment.
- .5 Where wall space is not available the Controls contractor shall construct a panel enclosure support out of Cantruss® and sheet it with 18mm plywood painted with intumescent paint. The top of the frame shall be fastened to the ceiling of the roof and the foot of the frame to the floor. The panel enclosure shall be mounted on the plywood.
- .6 The location of the panel enclosure support shall be coordinated with other trades to ensure that it does not interfere with or impede access to other equipment in the room.
- .7 Wiring within the panel enclosure shall be run inside pre-manufactured, slotted wiring duct (e.g.: PANDUIT PANELMAX™, Thomas & Betts Ty-Duct™ Wiring Duct, or equivalent) complete with cover.
- .8 All wiring terminations not ending on an EMCS panel shall be terminated on a labeled terminal block. The use of marrettes, butt splices, or compression connectors shall not be used inside panels.
- .9 Panel enclosures shall be labeled with a LAMACOID™ equipment tag indicating the Tag number and contents (e.g.: PNL-001, BAS PANELS). The lamacoid shall be black with white lettering. The lettering shall be 25mm high.

### 13.3 Auxiliary BAS Control Panel Enclosures

- .1 Relays, open coil transformers, DC power supplies, etc. shall be mounted into dust proof, splash tight panel enclosures.
- .2 The panel enclosure shall be mounted no higher than two (2) meters above finished floor.
- .3 Panels shall NOT be mounted in the spaces above T-bar ceilings.
- .4 Wiring within the panel enclosure shall be run inside pre-manufactured, slotted wiring duct (e.g.: PANDUIT PANELMAX™, Thomas & Betts Ty-Duct™ Wiring Duct, or equivalent) complete with cover.
- .5 All wiring terminations shall be terminated on a labeled terminal block. The use of marrettes, butt splices, or compression connectors shall not be used inside panels.
- .6 The Controls contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- .7 The Controls contractor shall clearly indicate the type and location of the auxiliary panel enclosures on an architectural floor plan and include an AutoCAD copy of the floor plan in the Maintenance manuals.
- .8 The panel shall be painted blue and clearly labeled as to its contents.
- .9 Panel enclosures shall be labeled with a LAMACOID™ equipment tag indicating the Tag number and contents (e.g.: PNL-003, CONTROLS RELAYS). The lamacoid shall be black with white lettering. The lettering shall be 25mm high.

## 15 EXECUTION

### 15.1 General Re: Installation of the BAS

- .1 Provide a complete building automation system installation in accordance with requirements of this Specification, sequences of operation and control system Points List.
- .2 Provide installation of communication backbone for the EMCS including MS/TP, Ethernet and Fiber.
- .3 Provide installation of the EMCS control panels and auxiliary control panels.
- .4 Provide installation of all field devices as per manufacturers recommendations and as per this specification.
- .5 Supply, installation, and termination of wiring required by the EMCS. This shall include low voltage wiring, line voltage wiring, and communications wiring to facilitate control.
- .6 Provide installation and wiring of third party devices.
  - .1 The Controls contractor is to install and wire sensors and actuators provided by other sections in the mechanical divisions (s). This shall include but not be limited to devices associated with:
    - .1 Boilers, Chillers, Heat Pumps,
    - .2 Packaged terminal equipment (air conditioning units, roof top units, etc.)
    - .3 Lighting controls interface,
    - .4 Domestic Hot Water Systems
- .7 Provide installation and wiring of third party communication and /or interface modules. This shall include but is not limited to BACnet and/or MODBUS communication modules for:
  - .1 Boilers, Chillers, Heat Pumps,
  - .2 Lighting Controls interface
  - .3 Fire Alarm, security alarm and generator status.
  - .4 Any other equipment that is provided with a communications interface module.
  - .5 Any other controls equipment that needs to be wired (E.g.: Electronic faucets)

### 15.2 Installation of Direct Digital Control System Components

- .1 Provide all required direct digital control hardware, software, accessories, and wiring for a complete BAS.
- .2 Provide installation of all control system remote components and mount as per manufacturers recommendations and any specific requirements of this specification.
- .3 Coordinate the installation with the general contractor and other trades on site and communicate with the commissioning agent as to the progress of the work to coordinate the commissioning process.
- .4 **All existing systems in the building to remain operational while the new control systems are being installed. Notify the Owner of any required shut downs and provide ample notice.**

### 15.3 Implementation of Energy Management Programs

- .1 Implement all energy management programs indicated for building equipment and systems.
- .2 Ensure that all energy management program adjustable parameters are accessible to and adjustable by the building operations personnel at the operator's work station.
- .3 Configure energy management programs so that they may be enabled/disabled on an individual basis for each system to which they apply.

### 15.4 Installation of Sensors

- .1 Mount sensors rigidly and adequately for environment within which the sensor operates.
- .2 Room temperature sensors will be installed on concealed junction boxes properly supported by wall framing. Room sensors shall be mounted at 1500mm above finished floor.

### 15.5 Control Wiring

- .1 All wiring and conduit shall be installed neat workman like manner in tight, parallel runs following the building lines.
- .2 All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be sub-fused.

- .3 All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- .4 Where a connection is required to equipment or hardware and the wiring cannot be continuous a terminal strip shall be provided and all connections at the terminal strip labelled.
- .5 Except as specified below, install all control wiring in conduit.
- .6 Unless otherwise specified the final 600 mm (2') connections to sensors, transmitters, and wherever conduit extends across flexible duct connections shall be liquid-tight flexible conduit. **Metal jacket flexible Bx shielding is not acceptable.**
- .7 Control wiring in ceiling spaces may be installed as plenum rated cable installed without conduit but neatly harnessed, secured, and identified using bridal rings.
- .8 Control wiring that is to be dropped down a wall or shaft is to be installed in conduit and the conduit and associated pull boxes to be identified.
- .9 Conduit:
  - .1 Conduit shall be run in all exposed areas,
  - .2 Conduit must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.
  - .3 Secure conduit with conduit clamps fastened to the structure and spaced according to code requirements. Conduit and pull boxes shall not be hung on flexible duct strap or tie rods. Conduit, junction boxes, pull boxes, and control panels shall not be run on or attached to ductwork.
  - .4 Conduit fill Shall not exceed 75% of the cross sectional area of the conduit for low voltage signal carrying conductors.
  - .5 Shall not mix voltage types within the same conduit. AC carrying conductors shall NOT be mixed in with DC carrying conductors.
  - .6 Signal wiring, data wiring, and power wiring shall not be run in the same conduit..
    - .1 Communication network wiring shall be run in a conduit dedicated to network communications.
    - .2 Power wiring shall run in a conduit dedicated to controller and device power.
    - .3 Sensor wiring shall be run in conduits dedicated to sensor wiring.
    - .4 Do NOT mix AC signal wiring with DC signal wiring in the same conduit.
  - .7 Junction or pull boxes shall be installed:
    - .1 Every 25 meters for 12mm conduit runs and every 30 meters for conduit greater than 12mm,
    - .2 All junction boxes shall be installed in accessible locations or made accessible.
    - .3 All junction boxes shall be painted blue to signify that it is used for controls and a vendor sticker/label provided on the junction box cover.

## 15.6 Cabling

- .1 Free air cabling installed in non-combustible rated buildings shall be fire rated cable with a minimum rating of FT-6.
- .2 Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- .3 EMCS data communications, EMCS input / output wiring, and EMCS or final control element power wiring shall be run in separate wiring cable bundles.
- .4 Ethernet cabling bundles shall be installed in a cable support system designed specifically for Ethernet cabling.
- .5 Cable supports shall be attached to the wall or ceiling of the area they are running through. Cable supports shall not be attached to:
  - .1 Electrical raceways, Duct work, Ceiling suspension systems, Piping, Wilson joists.
- .6 Cabling bundles shall be held in the cable support system using Velcro straps.
- .7 Cable bundles shall be identified every ten (10) meters. The following nomenclature shall be used:
  - .1 "CONTROLS DATA", "CONTROLS POWER" or "CONTROLS I/O" for bundles carrying EMCS input and output wiring.

### 15.7 Data Communication Cable:

- .1 All data cabling shall use 18 gauge stranded conductors. Solid core conductors shall not be accepted.
- .2 Data cabling shall be run separately from power and signal wiring,
- .3 Data cabling shall be clearly labeled as "CONTROLS DATA HIGHWAY" at the beginning, the end, every twenty (20) meters of the run,
- .4 Communication runs be one continuous run from end to end without splices or connections,
- .5 Cabling shall be colour coded with different colours for each conductor.
- .6 BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
  - .1 The maximum length of an MS/TP segment is 900 meters (with AWG 22 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
  - .2 The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
  - .3 An MS/TP EIA-485 network shall have no T connections.
- .7 BACnet Ethernet communications wiring shall be run in Category 6 Ethernet cable.
  - .1 Data cable shall be four twisted pair 24 AWG solid copper, Plenum Rated FT-6 / CMP or Riser Rated FT-4 / CMR (as required by local codes) unshielded twisted cable meeting EIA / TIA 568B.1 Category 5e classification.
  - .2 The maximum cable length for each run shall be limited to 90 meters.
  - .3 Cable Skew must be specified as 20Ns or less per 100 meters.
  - .4 Cables must display the manufacturer's stamp stating that the cable is included in the latest UL verified publication for Category 6 standards.
  - .5 All cabling installed in in-accessible areas, (above drywall ceilings, and crawl spaces), must be installed in conduit or cable tray. Conduit fill must not exceed 40%.
  - .6 Ethernet Cable Testing:
    - .1 The Controls Contractor is to use a Level III tester that is capable of testing the specified cable to the performance level(s) indicated in this document. The tester is to use the latest version of firmware and software to test the unshielded twisted pair (UTP) cabling system.
    - .2 Correct all cable faults. Splicing of any cables will not be permitted, for any reason, unless prior authorization is received in writing from the Consultant.

### 15.8 Fibre Optic Cabling

- .1 Fibre optic cabling shall be used for all Ethernet runs exceeding ninety (90) meters.
- .2 Each major mechanical room shall be interconnected using fibre optic cable.
- .3 Each fibre backbone for Data applications shall have a minimum of six (6) strands of multimode 50/125  $\mu$  distribution type fibre. The fibre cable must have the following attributes:
  - .1 Six (6) individual strands of multimode fibre each must be colour coded for easy identification and all fibres must be packaged within one larger outer jacket. The fibres must be reinforced with an Aramid yarn for strength.
  - .2 The fibre cable must be CMP/CMR rated (FT6/FT4).
- .4 All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.
- .5 All Fibre Backbone is to be terminated using a fibre patch panel on a communications rack. The six (6) strands of fibre must be installed in the fibre patch panel (compatible with standard 19" equipment racks) and placed in a communications rack in the Telecommunications Closet for that floor. The fibre patch panel should minimize the rack space used; it cannot exceed three (3) rack units in height (3U). The fibre patch panel must be serviceable from the front by allowing the fibre patch panel to slide or pivot away from the rack. The fibre patch panels are to be mounted at the upper most position on the racks of each floor. Low-density terminations must be used.
- .6 Provide all necessary accessories for a complete fibre patch panel including but not limited; to clear cover plates, mounting brackets and hardware, SC/ST duplex fibre bulkheads

(adapter sleeves-plates/couplers), SC/ST connectors and fibre cable management. The Cabling Contractor is responsible for supplying blank mounting plates for all unused openings.

- .7 The six (6) strands of fibre must be terminated using 50/125mm SC/ST connectors as is consistent with the fibre being installed. All 6-strand cables are to be terminated at both ends. The terminated fibres must be connected to SC/ST Duplex bulkheads in the fibre patch panels.
- .8 Fibre optic terminations shall:
  - .1 Be TIA/EIA-604 FOCIS-2 compliant connectors,
  - .2 Exceed TIA/EIA-568-B.3 requirements,
  - .3 Have insertion loss: 0.3dB average (multimode and single mode),
  - .4 Have return loss: >26dB (10Gig™ multimode), >20dB (multimode), >50dB (single mode),
  - .5 Have re-termination capability that provides yield rates approaching 100%,
  - .6 Have factory pre-polished fiber end face to eliminate time-consuming field polishing, to reduce installation costs, labor, scrap and the number of tools required,
  - .7 Have a cam activated fiber and buffer clamp mechanisms to provide superior fiber and buffer retention and have less sensitivity to fiber tensile loading,
  - .8 Fibre Optic Cabling Testing:
    - .1 The Controls Contractor shall use an Optical Loss Test Set to all fibre optical cable testing.

#### 15.9 Analog Input / Output Wiring:

- .1 All analog input cabling shall use stranded conductors. Solid core conductors shall not be accepted.
- .2 The minimum gauge for analogue input wiring shall be AWG 18 cable.
- .3 Cabling shall be colour coded with different colours for each conductor.
- .4 Analog input runs shall be one continuous run from end to end without splices or connections.
- .5 The maximum cable length for an analog input shall be one hundred thirty-five (135) meters.
- .6 The maximum cable length for an analog output shall be seventy-five (75) meters.
- .7 Twisted shielded wire shall have a 100% foil shield coupled with an 18 gauge drain wire.

#### 15.10 Digital Input / Output Wiring:

- .1 All digital input cabling shall use stranded conductors. Solid core conductors shall not be accepted.
- .2 The minimum gauge for digital input wiring shall be AWG 18 cable.
- .3 The minimum gauge wire for digital outputs using dry contacts shall be AWG 14 or larger wire.
- .4 The maximum length for digital inputs and outputs shall be seventy-five (75) meters.
- .5 Digital input runs shall be one continuous run from end to end without splices or connections.
- .6 Follow the manufacturer's engineering best practices in regards to using twisted-shielded wire.
- .7 Twisted shielded wire shall have a 100% foil shield coupled with an 18 gauge drain wire.
- .8 Digital outputs using dry contacts shall have a wire induced voltage drop of no greater than 5% of the voltage being switched.
- .9 All digital outputs that are switching line voltage loads shall have a buffer (pilot) relay installed between the output and the load.

#### 16.1 Identification and Labelling of Equipment and Circuits

- .1 Identify BAS equipment as follows:
  - .1 **Enclosures:** engraved laminated nameplates with lettering such as BAS Panel CP2, or BAS Relays, or BAS E/P Transformers, with all wording listed and approved prior to manufacture of the nameplates.

- .2 **Panel points:** a laminated weather-proof input/output layout sheet for each controller with the name of each point connected to the controller, and the associated wire labelling information.
- .3 **Wiring:** "Brady Sticker" labelled sleeves at each input and output connection with corresponding point name on the sleeve.
- .4 **Terminal strips, Ethernet switches, relays:** "Brady Sticker" labelled sleeves at each input and output connection with corresponding point name on the sleeve.
- .5 **Junction Boxes/Pull Boxes, Transformer Boxes, Relay Cabinets:** Provide Vendor label on the outside and identify the hardware in the box. Provide Brady Sticker and control wiring terminations. For transformers identify the panel and circuit breaker number feeding the panel.
- .6 **Luggage Tag Identification, Point Verification:** For each analog and digital input and output termination at the device provide a laminated luggage tag identifying the point name and panel location. These should be installed during the end to end checks after the point has been verified.
- .7 **Ceiling Data Dots:** At all locations of ceiling space mounted BAS equipment such as control valves, dampers, VAV box controllers, relays and other devices, provide a 10mm black data dot on the t-bar grid or access panel.
- .8 **Wall Mounted Devices:** For all wall mounted devices such as room temperature sensors, CO2 sensors and Override switches provide a point address label on the device.

#### 17.1 Start-Up and Commissioning of the BAS

- .1 The control contractor is responsible for the commissioning of the installation of the BAS system which includes end to end checks and functional verification of sequences of operation.
- .2 All commissioning shall be witnessed and signed off by the project's Commissioning Agency and submitted for review to the commissioning Authority.
- .3 BAS commissioning shall include the commissioning of the field control panels, field control devices and the graphical user interface.
- .4 The commissioning process shall be completed on the field control panels, field control devices and the graphical user interface **at the same time.**
- .5 General Sequence of Events is as follows;
  - .1 Panel Initialization:
    - .1 Verify that control wiring is properly connected and free of shorts and ground faults. Verify that terminations are tight.
    - .2 Confirm correct power, network, input, and output wiring connections.
    - .3 Power up panels.
    - .4 Configure panel networking parameters and load programs.
    - .5 Set up operators works station and install graphical user interface.
  - .2 End-to-end checks and point verification check sheets shall be completed for every point in the system. Check sheets shall indicate:
    - .1 Panel tag.
    - .2 Point number.
    - .3 Point mnemonic.
    - .4 Field device type.
    - .5 Field device model number.
    - .6 Date checked.
    - .7 Technician's initials.
    - .8 Notes describing issues that were resolved.
- .6 Field Device Calibration
  - .1 Field devices shall be calibrated. Follow the manufacturers' instructions for calibrating the field device. The following devices will need to have their calibration and/or sensitivity checked:
    - .1 Temperature transmitters

- .7 Functional testing of the sequence of Operation Verification:
  - .1 Simulate all operating conditions that each system will operate under and verify that the correct sequence of operation is followed.
  - .2 Document any issues that were found and describe what was or is required to be completed to resolve the issues.
  - .3 Document any outstanding deficiencies.
- .8 Loop tuning:
  - .1 All control loops shall be tuned. All loops shall respond with a dampened decay wave form to any change in set point.
  - .2 A multiple point trend log shall be created to verify the correct operation and tuning for every control loop in the system. The trend log sample rate shall be fast enough to indicate clearly the loop response to a set point and/or variable change.
  - .3 The trend log shall include the measured variable, the final control element output signal and the set point.
  - .4 Submit documentation to Consultant and Commissioning Agency for review.

## 17.2 Coordination with the Commissioning Agency:

- .1 Refer to commissioning requirements specified in the Mechanical Work General Instructions Section.
- .2 The Controls contractor shall assist and coordinate with the commissioning agency by the following:
  - .1 Setting up a suitable security access level username and password that will allow the Commissioning Agency to operate the mechanical system via the BAS.
  - .2 Create any trend logs as required. Points shall be systematically grouped to depict the operation and performance of the system being monitored (e.g.: Supply Air Temperature Analog Input, Supply Air Temperature Setpoint Analog Value, Mixing Damper Actuator Analog Output, Heating Valve Control Output, Supply Fan Command Digital Output, Supply Fan Status Analog Input would be grouped into one trend log),
  - .3 Set up and port all trend logs to the trend log archive server,
  - .4 Set up all trend logs Providing any software, or interface devices required for the Agency to connect to the EMCS with their laptop computer,
  - .5 Provide any training required to allow the Agency's technician to operate the mechanical system controlled by the BAS. This shall include:
    - .1 Logging into and out of the system,
    - .2 Overriding and clearing overrides of occupancy schedules,
    - .3 Overriding and clearing overrides of damper actuator positions,
    - .4 Overriding and clearing overrides of valve actuator positions,
    - .5 Overriding and clearing overrides of digital (or binary) outputs,
- .3 **Make any required repairs to the physical installation and wiring as per deficiencies identified by the commissioning agency.**
- .4 **Make corrections to control panel software and sequences of operation as per the recommendations of the Commissioning agency as a result of functional testing and update the as-built sequences of operation as required.**

## 2.1 Project Closeout Work

- .1 Refer to the Mechanical Work General Instructions Section.
- .2 The control contractor will go through the installation of the control system with the consultant as part of a substantial completion inspection to review both the physical installation, devices and hardware in addition to the software and control system graphics. This must be done prior to the system demonstration
- .3 **Record "As-Built" BAS shop drawings** are to include:
  - .1 Final control system shop drawings identify all BAS devices, panels and hardware.
  - .2 Updated sequences of operation for the all mechanical system.

- .3 Floor plan identifying the location of the BAS network; Ethernet, Fiber and MS/TP, along with any remote panel locations, relays, transformers and other BAS devices not located in mechanical rooms.

### 17.3 Demonstrations and Training

- .1 **There shall be 2 system Demonstrations conducted**
  - .1 **The BAS shall be demonstrated to the mechanical consult as demonstration #1 prior to the demonstration to the owner.**
  - .2 **Demonstration #2 shall take place to the Owner when all deficiencies identified by the mechanical consultant and commissioning agent have been completed and the graphics have been updated.**
  - .3 **The demonstration of the graphics shall be conducted on a large format 96" screen projector.**
- .2 **Training**
  - .1 **Include for training sessions of the BAS for each of 2 groups of people as follows:**
    - .1 One full day orientation sessions at the system manufacturer's office to educate personnel on BAS architecture, hardware, and software, with an overview of BAS operation and capabilities including but not limited to operational programmes, equipment functions (both individually and as part of a total integrated system), BAS commands, advisories, alarms, and appropriate operator intervention required in responding to the BAS operation.
    - .2 One full day sessions at the site using the BAS for a "hands-on" demonstration of all BAS functions and features with instruction regarding the chronological flow of information from field devices, contacts and sensors to the operator's work station, an overview of the communications network describing the interplay between initiating devices, field hardware panels, systems communications, and their importance within the operating BAS, and alarm indications and appropriate responses.
- .3 **Additional Training: Include for 2 follow-up site training and troubleshooting visits, 1 six months after Substantial Performance and the other at the end of the warranty period, both when arranged by the Owner and for a full day to provide additional system training as required.**

### 17.4 The Operation and Maintenance Manual

- .1 Refer to the Mechanical Work General Instructions Section.
- .2 The BAS maintenance manual shall contain:
  - .1 The as-built BAS shop drawings in both hard copy and electronic (2 copies) searchable PDF file format on a memory stick.
  - .2 A hardware specification manual which gives a functional description of all hardware components.
  - .3 An operator's manual which outlines concise instructions for operation of the system and an explanation and recovery route for all system alarms.
  - .4 An engineering manual which outlines and defines system set-up, definition and application.
  - .5 A data manual which indicates the applications data programmed into the system.
  - .6 System software documentation.
  - .7 A statement of the BAS warranty with confirmed dates and identification of any extended system warranties.
  - .8 **The as-built drawings will be organized to follow a sequential order and will include the following:**
    - .1 Cover Page
      - .1 A small floor plan of the building(s) in the upper left, including North arrow and a legend on the lower left
      - .2 A Table of Contents in the middle

- .3 Architect, Mechanical Consultant, General Contractor, Mechanical Contractor, Balancing & Commissioning Contractor contact information in the middle right
- .4 Controls Title Block in the lower right (on every page)
- .2 Sequence of operation
  - .1 Section into the various Modes of Operation and for each piece of equipment and mechanical.
  - .2 A direct copy of the Rocky Point sequence of operation is not acceptable. Additional information must be provided on the actual sequence of operation and any amendments by the commissioning agent included.
  - .3 Describe so a layman (without programming knowledge) can understand the sequence of operation.
  - .4 Explain the basis for entering modes of operation.
- .3 Building Network Riser Diagram (on floor plan)
  - .1 Floor plan (use architectural room numbers) and North Arrow
  - .2 Map out the data runs (Main and Sub Highways) over top of the floor plan
  - .3 Indicate the panel locations and DDC addresses and MAC addresses
  - .4 End of line resister locations, repeaters and switch locations
  - .5 Wide Area Network locations, IP addresses
  - .6 Modem and Host computer locations
  - .7 The communication protocols
  - .8 Connections to Security, Fire Alarm, Access and Lighting
  - .9 Power run from UPS
  - .10 All remote devices; transformers, CT, pressure sensors, etc..
- .4 Building Power Riser Diagram (on floor plan)
  - .1 Floor plan indicating where each panel is located and where each is getting power from and identify electrical panel # and circuit.
- .5 System Equipment - location & zone of control (on floor plan)
  - .1 Floor plan (use architectural room numbers) and North Arrow
  - .2 Show the mechanical room locations and indicate the equipment there
  - .3 Show Unitary ventilation locations
  - .4 Show location of the Outside Air Temperature sensor
  - .5 Show all equipment over ride controls
  - .6 Show locations of exhaust fans and identify the areas they serve
  - .7 Show trap primer solenoid valve locations.
- .6 System Schematic Drawings and associated Zone drawings which shall include the following;
  - .1 Every device has both Point Descriptor and Panel, Point information
  - .2 Device symbols (as per Legend)
  - .3 Piping and valve details (flow direction, normal positions, tag #s)
  - .4 Damper details (flow directions, normal positions, tag #s)
  - .5 Sensor details
  - .6 Zone drawings – in addition to the same details as the system drawings add the floor plan of zone, rooms to use architectural numbers, shade the zone on the building layout in upper right
- .7 Wiring details
  - .1 Panel layout with extension boards identify the device at each terminal of all panels.
  - .2 Device wiring
  - .3 Relay wiring
  - .4 Pilot relay details, terminal strip details
  - .5 Non DDC electrical interlocks
  - .6 Panel dip switch and jumper settings
- .8 Points List
  - .1 Panel number
  - .2 Sequentially list Input and Output Points with descriptor
  - .3 Panel model and revision

- .4 All Variable Names complete with functional description of what the Variable Name is for.
- .5 Identify spare points on each panel. (10% spare capacity)
- .9 Valve Schedule includes:
  - .1 Valve Tag Number, application, configuration, control type
  - .2 Valve Model Number, actuator model #, actuator linkage model #
  - .3 Valve Flow Coefficient Rating, Range, maximum flow.
  - .4 Pressure Differential Across Valve and close off pressure.
- .10 Damper Schedule includes:
  - .1 Damper Tag Number, application, configuration, control type
  - .2 Damper Model Number
  - .3 Damper Actuator model, torque rating, jackshaft configuration.
  - .4 Pressure Differential Across the Damper at full flow.
  - .5 Damper Close-off Rating
- .11 The Device data sheets will be attached at the back as an addendum and will be 8 ½ inches by 11 inches. They will have a "Portrait" orientation, and have a similar but separate numbering scheme.
  - .1 Provide a separate table of contents for the Device Data section at the start of that section.
  - .2 Clearly indicate which Models and sizes are used on the project.
  - .3 Do NOT include devices that are not part of the project.

**END OF SECTION**

## 1 GENERAL

### 1.1 Sequences of Operation

- .1 The following sequences of operation are to be read in conjunction with the building automation points list. Some inputs and outputs such as current sensors, air and water temperature sensors for information and diagnostics are not identified in the sequence of operation but included in the points list.
- .2 Additional virtual points and variables may be required in addition to the items identified in the points list and sequences of operation to achieve the desired equipment operation and performance.
- .3 These sequences of operation provide the design intent with respect to the desired operating conditions of the equipment and mechanical systems and do not represent the programming to achieve the sequence.
- .4 In general all BACnet points are to be mapped to the DDC system and the Owner/Consultant will select the BACnet points to display on the system graphic. In general BACnet points are to be used for information purposes only and not part of a control sequence. All control points are to be hard wired and they are not to be replaced by BACnet control without the approval of the owner and consultant.

### 1.2 Trend logs

- .1 In general, all DDC system points shall be trended and each trend log point shall be able to provide a minimum of 200 samples.
- .2 Trend log requirements will also be reviewed with the Owner/Consultant for specific trending requirements.
- .3 Temporary and specific trend logs may be required during the commissioning process and requested by the commissioning agent. This control contractor is to modify the trending at the request of the commissioning agent.
- .4 Trend logs shall be set up to meet the following requirements:
  - .1 Local Storage:
    - .1 Trend log sample frequency shall be setup to have the trend log information display meaningful data that can be used to Trend logs must reside in the controller of the points being trended.
    - .2 All local trend logs shall be archived to the trend archival system.
  - .2 Archival Storage:
    - .1 The trend log archival system shall be sized to store all trend logs for a minimum of five (5) years with all trended values having a maximum sample frequency of 5 minutes.
  - .3 Sample Frequency:
    - .1 Sample frequencies shall be configured to gather meaningful data required to analyze system performance, confirm loop tuning, and aid system troubleshooting.
    - .2 Control points and loops that have a slow dynamic response shall have lower sample frequencies (E.g.: outdoor air temperature, radiant slab heating, etc.).
    - .3 Control points and loops that have a faster dynamic response shall have higher sample frequencies (E.g.: mixed air temperature, water differential pressure, etc.).
    - .4 Trend logs used to verify loop tuning shall be set at the fastest possible sample frequency for the duration of the loop tuning interval.
      - .1 Loop tuning trend logs shall have a high enough sample frequency to accurately describe the loop response to rapid changes in set point or input variables.

- .2 The trend logs shall be archived and the trend sample frequency set to an interval used for day-to-day operation.
- .4 Trended Points:
  - .1 All physical input and out points.
  - .2 All setpoint values (this is to include loop setpoints, high and low limit setpoints, and all room setpoints).
- .5 Trend Log Grouping:
  - .1 Trend logs shall be grouped to display the performance of the various control loops required to control the system.
  - .2 Trend groups shall be accessible directly from the graphics.
    - .1 Trend logs shall contain all input variable, all controlled variables, and all setpoint for the system being trended.

### 1.3 Graphics Points/Display

- .1 In general, all DDC system points and global variables for each piece of mechanical equipment shall appear on the DDC system graphics.
- .2 The mechanical consultant and Owner may request additional points on each graphic screen to facilitate ease of monitoring of the systems.
- .3 In some cases the owner and consultant may request specific BACnet points to also be displayed on the graphics.
- .4 It is in the best interest of the control contractor to provide sample screen graphics for review prior to installation.
- .5 The graphic screens shall include the following minimum information:
  - .1 Main Screen: Identifies the Site and has major transfer links to key graphical pages.
  - .2 Thermographic Floor Plan Overview: Indicates the status of the site using colour backgrounds. Zones with a red background are over heating, zones with a blue background are too cold, zones with a green background are zones that are within comfort conditions, and zones with a white background indicates that the equipment serving the zone is not operating.
  - .3 Floor Plans: Indicate the zones of each floor and piece of equipment and include operating data such as zone temperature, active zone setpoint, lighting status.
  - .4 Floor Plan Equipment Summaries: List equipment serving each zone and includes the operating data associated with each zone.
  - .5 Floor Plan zones will link directly to the equipment, mechanical room and detailed equipment graphics.
  - .6 Floor Plans shall show the locations of exhaust fans, entrance heaters, unit heater, reheat coils, VAV boxes and other equipment as required with links to detailed equipment graphic pages.
  - .7 Global Variables Page: List all global variables and operating mode switches. This enables the operating to quickly review and modify global variables that impact the entire building.
  - .8 Central Plant Schematic; Displays an "as-installed" schematic of the central plant and includes data and links required to monitor, troubleshoot, and modify the operating parameters that control the plant.
  - .9 Central Air Handling Unit Schematic: Displays an "as-installed" schematic of the air handling unit and includes data and links required to monitor, troubleshoot, and modify the operating parameters that control the plant. Provide a separate graphic screen for each air-handling system.

### 1.4 Wan Connection to the DDC system

- .1 The Owner will be providing ONLY ONE (1) IP address for connection to the DDC system and this should be coordinated at the early stages of the project implementation.

### 1.5 Security Alarm Interface

- .1 Graphics

- .1 Provide a complete system graphic for the security alarm interface to show each of the security partitions and current security status. Provide links to operating schedules.
- .2 Sequence of Operation
  - .1 Provide connection to (4) security partitions plus one trouble point in the security panel. The DDC system shall monitor armed and disarmed status of each zone for coordination with mechanical programming and weekly schedules for operation of mechanical equipment and night set back.

**1.6 Occupancy Scheduling**

- .1 Building occupancy shall be defined by the operation of calendar/time clock schedules. The occupied status of the time clock schedules shall be overridden by the status of the security system, but only after morning warm-up. If the building is still armed after morning warm-up and after 9:00am the system will revert back to night setback state.
  - .1 Security system armed - building UNOCCUPIED.
  - .2 Security system unarmed - building OCCUPIED.
- .2 In general the occupied schedule shall be 8:00am to 5:00pm M-F and does not include any requirements for optimal start and morning warm-up. This schedule is to be confirmed with the Owner.
- .3 Additional Calendar schedules shall be provided for the following:
  - .1 Each major air-handling system shall be provided with a separate yearly calendar schedule for after hours operation.
  - .2 A yearly holiday calendar shall be provided to allow the Owner to designate days where the building is not occupied.
  - .3 Separate Boiler/Chiller and Heat pump lockout Calendar schedules to be provided to allow the seasonal shut down of specific equipment and prevent false starts such as heating plants starting early in the morning and chillers starting in the later afternoon.

**1.7 Temperature Setpoint Scheduling**

- .1 Spaces containing room temperature sensors with adjustable setpoints shall allow the occupants to adjust their setpoints in 0.1°C increments up to a maximum of ± 1.5°C above or below the occupied setpoint.
  - .1 All space temperature sensors shall have their occupied heating and cooling setpoints reset to standard values when the building is placed into unoccupied mode.
- .2 Building setpoints shall be defined as UNOCCUPIED, OCCUPIED, and VACANT.
- .3 An ACTIVE setpoint is the setpoint that is read from a space sensor that has an adjustable setpoint during occupied mode.
- .4 A VACANT setpoint is the setpoint when the building is occupied but the motion sensor has detected that there is no one in the zone. This is only valid for spaces that are provided with a motion sensor.
- .5 Building temperature setpoints shall be scheduled as follows:

	UNOCCUPIED	OCCUPIED	VACANT
Public/Reception	15°C – Htg 35°C – Clg	21.5°C – Htg 23.5°C – Clg	Active Htg SP less 2°C Active Clg SP plus 2°C
Office/General	15°C – Htg 35°C – Clg	19.0°C – Htg 24.0°C – Clg	Active Htg SP less 2°C Active Clg SP plus 2°C
Detention/Processing	15°C – Htg 35°C – Clg	19.0°C – Htg 24.0°C – Clg	Active Htg SP less 2°C Active Clg SP plus 2°C

**1.8 Time clock Scheduling**

- .1 Building systems shall be controlled by an optimal start time clock that uses the optimal start feature for heating and cooling.
  - .1 Early optimal start times shall be limited to a maximum of four (4) hours prior to scheduled occupancy time.
  - .2 The operating schedule shall be confirmed with the client:

- .1 Time clock scheduling shall be overridden and the required mechanical systems operation shall be cycled to maintain the maxim and minimum unoccupied/night set back building temperatures during unoccupied mode.
- .3 Time clock scheduling shall be overridden for a predetermined time interval when the local override button located in the space is activated.
  - .1 The override time interval shall be 240 minutes (adjustable).
- .4 The optimal start program shall operate according to the programmed schedule. If at the end of the optimal start period the security system indicates that the building armed, the building shall revert back to unoccupied/night set-back mode operation.
- .5 Provide a complete system graphic for the scheduling interface to show each of the time clock and current schedule status. Provide links to operating schedules.

### 1.9 Split Air Conditioning Systems

- .1 The split system AC unit shall be enabled on the weekly schedule unless it is provided for a computer/IT Server room in which case it will run continuously 24/7.
- .2 The A/C contractor will include to run interface wiring and refrigerant piping between the indoor and the outdoor units. The controls contractor shall supply all other field wiring and terminations as required to connect both systems to the DDC system.
- .3 The control contractor shall coordinate with the AC contractor to perform site start-up procedures.
- .4 The split air conditioning system shall be supplied with a remote controller (not a thermostat) to be mounted by the control contractor next to the DDC room temperature sensor, and wired back to the indoor unit.
- .5 The AC unit shall not be controlled by the DDC system. The DDC system shall only provide status of the outdoor compressor, indoor fan coil and room temperature.

### 1.10 Roof Top Unit

- .1 The roof top unit shall be enabled by the weekly schedule, separate calendar schedule for this unit, local override switch or motion sensor.
- .2 The roof top unit supply fan to be enabled with economizer dampers in the closed position and run continuously in occupied mode.
- .3 The economizer dampers, heating enable and cooling enable shall be used in sequence to maintain room temperature set point.
- .4 The DDC system shall monitor the discharge air temperature but the temperature of the discharge is not being controlled.
- .5 Once the unit has run for 5 minutes the economizer dampers shall open to 5% minimum position and the minimum outside air damper position shall be reset to main a room CO2 set point of 1000ppm.
- .6 When the room temperature is below set point, heating shall be enabled and will run a minimum of 20 minutes.
- .7 When the room temperature is above set point the economizer dampers shall modulate open to provide free cooling.
- .8 If room temperature set point can no longer be maintained and the outside air temperature is above 18 degC, cooling shall be enabled and will run a minimum of 20 minutes.

**END OF SECTION**

UNIT	DESCRIPTION	Comments - Delete this column when complete	LOCATION	DIGITAL IN	DIGITAL OUT	DEVICE TYPE	ANALOG IN	ANALOG OUT	DEVICE TYPE	COMMENTS:
<b>ROOF TOP DUAL FUEL HEAT PUP</b>										
SF	UNIT FAN START/STOP				X	R				
	UNIT FAN STATUS						X		CT	
	COMPRESSOR STATUS	Optional but provide feedback if compressor is running					X		CT	
	HEATING/COOLING ENABLE STAGE 1				X	R				
	HEATING/COOLING ENABLE STAGE 2				X	R				
	REVERSING VALVE	reversing the heat pump from cooling to heating mode			X	R				
	GAS FIRED HEATING STAGE 1				X	R				
	GAS FIRED HEATING STAGE 2				X	R				
	ECONOMIZER DAMPERS	must be specified that damper to be DDC controlled						X	DMA	
	FILTER STATUS	Required by some clients		X		FIL				
	DISCHARGE AIR TEMPERATURE SENSOR						X		DTS	
	MIXED AIR TEMPERATURE SENSOR	Some roof top unit do not have enough space					X		DTS	
	CO2 SENSOR IN RETURN AIR DUCT	Can also be located in the space					X		CO2	
	OCCUPANCY SENSOR			X		OC				
	ROOM AIR TEMPERATURE						X		RTS	
<b>FAN COIL UNIT ( SPLIT SYSTEM HEAT PUMP)</b>										
FC	UNIT FAN START/STOP	This may not be available with all split systems		X		CR				
	UNIT FAN STATUS						X		CT	
	DX-COOLING ENABLE	This may not be available with all split systems		X		CR				
	DX-HEATING ENABLE	This may not be available with all split systems		X		CR				
	OUTDOOR CONDENSING UNIT STATUS						X		CT	
	ROOM AIR TEMPERATURE							X	RTS	
<b>HEATING CONVECTOR</b>										
	SPACE TEMPERATURE						X		RTS	REFER TO DRAWINGS FOR LOCATIONS, WITH COVER
	HEATING VALVE CONTROL							X	VMA	
	HEATING WATER RETURN TEMPERATURE	Strap on temperature sensor is optional					X		WTS	STRAP-ON WATER TEMPERTURE SENSOR
<b>EXHAUST FANS</b>										
EF	EXHAUST FAN ENABLE	This is for a large exhaust fan on DDC schedule			X	R				
	EXHAUST FAN STATUS						X		CT	
EF	EXHAUST FAN ENABLE	Exhaust fan control by room temp sensor			X	R				
	EXHAUST FAN STATUS						X		CT	
	ROOM TEMPERATURE SENSOR						X		RTS	
EF	EXHAUST FAN ENABLE	Exhaust fan control by manual switch						X		Fan on/off by local switch or timer
	EXHAUST FAN STATUS							X	CT	
EF	EXHAUST FAN ENABLE	Exhaust fan control by reverse acting thermostat						X		Fan on/off by reverse acting thermostat
	EXHAUST FAN STATUS							X	CT	
<b>GLYCOL FEED STATION</b>										
	LOW LEVEL ALARM	Optional glycol fill tank alarm		X		DC				TIE INTO PUMP CONTROLLER ALARM OUTPUT
<b>SECURITY SYSTEM</b>										
	SECURITY PANEL INTERLOCK	Specify the number of security partitions			X	R				SECURITY SYSTEM ZONE STATUS (8 ZONES)
<b>EMERGENCY STOP</b>										
	EMERGENCY STOP BUTTON	Provide at each entrance/existing to boiler room								HARD WIRED TO SHUT DOWN BOILERS AND DHW
	EMERGENCY STOP BUTTON STATUS			X					R	
	REFRIGERATION LEAK DETECTION	Provide if there is refrigeration equipment in boiler room					X		S	HIGH/LOW SENSOR IN 2 LOCATON SUITABLE FOR REFRIGERANT
	EMERGENCY EXHAUST SYSTEM	Provide if there is refrigeration equipment in boiler room					X		CT	HARD WIRED FOR EXHAUST ACTIVATION WITH MANUAL OVERRIDE
<b>MISC. POINTS</b>										
	FIRE ALARM STATUS			X					CR	INTERFACE THROUGH FIRE ALARM AUXILIARY RELAY
	FIRE ALARM TROUBLE STATUS			X					CR	INTERFACE THROUGH FIRE ALARM AUXILIARY RELAY

**LEGEND**

CO2= CARBON DIOXIDE SENSOR  
 CR= CONTROL RELAY  
 CT= CURRENT SENSOR  
 CV= CONTROL VALVE  
 DC= DRY CONTACT  
 DMA = DAMPER MOTOR

OAT = OUTDOOR TEMPERATURE SEN WFS = WATER FLOW SWITCH  
 OS= OCCUPANCY SENSOR WTS = WATER TEMPERATURE SENSOR  
 RTS = ROOM TEMPERATURE SENSOR HUM=HUMIDITY SENSOR  
 RFS = RAINFALL SENSOR  
 VMA = VALVE MOTOR ACTUATOR  
 PH=PHTO CELL (DAYLIGHTING)