



SPECIFICATIONS

SOLICITATION #: 23-58067

BUILDING: PEN
717 White Lake Road Avenue
Penticton, BC

PROJECT: CHORD Antenna Production Facility Heating,
Ventilation & Air Conditioning System
Construction

PROJECT #:

Date: July 2023



SPECIFICATION

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Construction Tender Form

Project Identification: **CHORD Antenna Production Facility Heating, Ventilation & Air Conditioning System Construction**

Tender No.: **23-58067**

1.2 Business Name and Address of Tenderer

Name _____

Address _____

Contact Person(Print Name) _____

Telephone (_____) _____ **Fax:** (_____) _____

1.3 Offer

I/We the Tenderer, hereby offer to His Majesty the King in Right of Canada (hereinafter referred to as "His Majesty") represented by the National Research Council Canada to perform and complete the work for the above named project in accordance with the Plans and Specifications and other Tender Documents, at the place and in the manner set out therein for the Total Tender Amount (to be expressed in numbers only) of: \$_____. _____ **in lawful money of Canada (excluding GST/HST)**

The above amount is inclusive of all applicable (*) Federal, Provincial and Municipal taxes except that in the event of a change in any tax imposed under the Excise Act, the Excise Tax Act, the Old Age Security Act, the Customs Act, the Customs Tariff or any provincial sales tax legislation imposing a retail sales tax on the purchase of tangible personal property incorporated into Real Property, that occurs

- .1 after the date this tender was mailed or delivered, or
- .2 if this tender is revised, after the date of the last revision

the amount of this offer shall be decreased or decreased in the manner provided for in GC22 of the General Conditions of the Contract Documents.

National Research Council Canada	Conseil national de recherches Canada
Finance and Procurement Services Branch	Direction des services financiers et d'approvisionnement

1.3.1 Offer (continued)

(*) For the purpose of this tender, the Goods and Services Tax (GST) is not to be considered as an applicable tax.

In the province of Quebec, the Quebec Sales Tax is not to be included in the tender amount because the Federal Government is exempt from this tax. Tenderers shall make arrangements directly with the provincial Revenue Department to recover any tax they may pay on good and services acquired in the performance of this contract. However, tenderers should include in their tender amount Quebec Sales Tax for which an Input Tax Refund is not available.

1.4 Acceptance and Entry into Contract

I/We undertake, within fourteen (14) days of notification of acceptance of my/our offer, to sign a contract for the performance of the work provided I/we are notified, by the Department, of the acceptance of my/our offer within 30 days of the tender closing date.

1.5 Construction Time

I/We Agree to complete the work within the time stipulated in the specification from the date of notification of acceptance of my/our offer.

1.6 Bid Security

I/We herewith enclose tender security in accordance with Article 5 of the General Instruction to Tenderers.

I/We understand that if a security deposit is furnished as tender security and if I/we refuse to enter into a contract when called upon to do so, my/our security deposit shall be forfeited but the Minister may, if it is in the public interest, waive the right of His Majesty to forfeit the security deposit.

I/We understand that if the security furnished is not in the approved form as described in Article 5 of the General Instructions to Tenderers, my/our tender is subject to disqualification.

National Research Council Conseil national de recherches
Canada Canada

Finance and Procurement Direction des services financiers
Services Branch et d'approvisionnement

1.7 Contract Security

Within fourteen (14) days after receipt of written notification of the acceptance of my/our offer, I/we will furnish contract security in accordance with the Contract Conditions "F" of the Contract Documents.

I/We understand that the contract security referred to herein, if provided in the form of a bill of exchange, will be deposited into the Consolidated Revenue Fund of Canada.

1.8 Appendices

This Tender Form includes Appendix No. _____N/A_____.

1.9 Addenda

The Total Tender Amount provides for the Work described in the following Addenda:

NUMBER	DATE	NUMBER	DATE

(Tenderers shall enter numbers and dates of addenda)

National Research Council Canada	Conseil national de recherches Canada
-------------------------------------	--

Finance and Procurement Services Branch	Direction des services financiers et d'approvisionnement
--	---

1.10 Execution of Tender

The Tenderer shall refer to Article 2 of the General Instructions to Tenderers.

**SIGNED, ATTESTED TO AND DELIVERED on the _____ day of
_____ on behalf of**

(Type or print the business name of the Tenderer)

AUTHORIZED SIGNATORY (IES)

(Signature of Signatory)

(Print name & Title of Signatory)

(Signature of Signatory)

(Print name & Title of Signatory)

SEAL

BUYANDSELL NOTICE

CHORD Antenna Production Facility Heating, Ventilation & Air Conditioning System Construction

The National Research Council Canada, 717 White Lake Road, Penticton, BC has a requirement for a project that includes:

Work under this contract covers the installation of new HVAC system in the “CHORD Antenna Production Facility – Spanmaster Building” at the National Research Council’s Dominion Radio Astrophysical Observatory (DRAO) at 717 White Lake Road, Kaleden, BC, Canada.

Tender Destination

- a) Tenders are to be submitted **by email only**:
National Research Council Canada

NRC.BidReceiving-ReceptiondesSoumissions.CNRC@nrc-cnrc.gc.ca

Endorsed “Tender for (insert title of work as it appears in the drawings and specifications)” and must bear the name and address of the tenderer.

- b) Unless otherwise specified, the only documents required to be submitted with the tender are the Tender form and the Bid Security.

1. GENERAL:

Questions regarding any aspect of the project are to be addressed to and answered only by the Departmental Representative (or his designate) or the Contracting Authority.

Any information received other than from the Departmental Representative (or his designate) or the Contracting Authority will be disregarded when awarding the contract and during construction.

Firms intending to submit tenders on this project should obtain tender documents through the canadabuys.canada.ca TMA services provider. Addenda, when issued, will be available from the canadabuys.canada.ca TMA service provider. Firms that elect to base their bids on tender documents obtained from other sources do so at their own risk and will be solely responsible to inform the tender calling authority of their intention to bid. Tender packages are not available for distribution on the actual day of tender closing.

2. MANDATORY SITE VISIT:

It is mandatory that the bidder attends one of the site visits at the designated date and time. At least one representative from proponents that intend to bid must attend.

The site visits will be held on July 26th and July 27th, 2023 at **10:00am**. Meet Kory Phillips at PEN Building, 717 White Lake Road, Penticton, BC. Bidders who, for any reason, cannot attend at the specified date and time will not be given an alternative appointment to view the site and their tenders, therefore, will be considered as non-responsive. **NO EXCEPTIONS WILL BE MADE.**

As proof of attendance, at the site visit, the Contracting Authority will have an Attendance Form which MUST be signed by the bidder's representative. It is the responsibility of all bidders to ensure they have signed the Mandatory Site Visit Attendance form prior to leaving the site. Proposals submitted by bidders who have not attended the site visit or failed to sign the Attendance Form will be deemed non-responsive.

3. TENDER CLOSING DATE:

Tender closing date is August 16th, 2023 at 14:00.

4. TENDER RESULTS

Following the Tender closing, the tender results will be sent by facsimile to all Contractors who submitted a tender

5. SECURITY REQUIREMENT FOR CANADIAN CONTRACTORS

5.1 MANDATORY SECURITY REQUIREMENT:

- .1 All personnel that will be involved with the project must be security screened to **RELIABILITY** status level as defined in the security policy of Canada.

6.0 WSBC (WORK SAFE BC)

- .1 All Bidders must provide a valid WSBC certificate with their Tender or prior to contract award.

7.0 OFFICE OF THE PROCUREMENT OMBUDSMAN

- .1 **Dispute Resolution Services**
The parties understand that the Procurement Ombudsman appointed pursuant to Subsection 22.1(1) of the *Department of Public Works and Government Services Act* will, on request or consent of the parties to participate in an alternative dispute resolution process to resolve any dispute between the parties respecting the interpretation or application of a term and condition of this contract and their consent to bear the cost of such process, provide to the parties a proposal for an alternative dispute resolution process to resolve their dispute. The Office of the Procurement Ombudsman may be contacted by telephone at 1-866-734-5169 or by e-mail at boa.opo@boa-opo.gc.ca.
- .2 **Contract Administration**
The parties understand that the Procurement Ombudsman appointed pursuant to Subsection 22.1(1) of the *Department of Public Works and Government Services Act* will review a complaint filed by [*the supplier or the contractor or the name of the entity awarded this contract*] respecting administration of this contract if the requirements of Subsection 22.2(1) of the *Department of Public Works and Government Services Act* and Sections 15 and 16 of the *Procurement Ombudsman Regulations* have been met, and the interpretation and application of the terms and conditions and the scope of the work of this contract are not in dispute. The Office of the Procurement Ombudsman may be contacted by telephone at 1-866-734-5169 or by e-mail at boa.opo@boa-opo.gc.ca.
- .3 **The Office of the Procurement Ombudsman (OPO) was established by the Government of Canada to provide an independent avenue for suppliers to raise complaints regarding the award of contracts under \$25,000 for goods and under \$100,000 for services. You have the option of raising issues or concerns regarding the solicitation, or the award resulting from it, with the OPO by contacting them by telephone at 1-866-734-5169 or by**

e-mail at boa.opo@boa-opo.gc.ca. You can also obtain more information on the OPO services available to you at their website at www.opo-boa.gc.ca.

The Departmental Representative or his designate for this project is: **Brian Hoff**
Brian.Hoff@nrc-cnrc.gc.ca
Telephone: **(250) 497-2343**

Contracting Authority for this project is: **Collin Long**
Collin.Long@nrc-cnrc.gc.ca

INSTRUCTIONS TO BIDDERS

Article 1 – Receipt of Tender

- 1a) Tender must be received **by email only** not later than the specified tender closing time. Electronic bids received after the indicated closing time - NRC servers received time - will be irrevocably rejected. Bidders are urged to send their proposal sufficient time in advance of the closing time to prevent any technical issues. NRC will not be held responsible for bids sent before closing time but received by the NRC servers after the closing time. Tenders received after this time are invalid and shall not be considered, regardless of any reason for their late arrival.
- 1b) A letter of printed telecommunication from a bidder quoting a price shall not be considered as a valid tender unless a formal tender has been received on the prescribed Tender Form.
- 1c) Bidders may amend their tenders by **email only** provided that such amendments are received not later than the specified tender closing time.
- 1d) Any amendments to the tender which are transmitted by **email only** must be signed and must clearly identify the tenderer.

All such amendments are to be addressed to:
National Research Council of Canada
Collin Long, Senior Contracting Officer

NRC.BidReceiving-ReceptiondesSoumissions.CNRC@nrc-cnrc.gc.ca

Article 2 – Tender Form & Qualifications

- 1) All tenders must be submitted on the Construction Tender Form and the tender must be signed in compliance with the following requirements:
 - a) Limited Company: The full names of the Company and the name(s) and status of the authorized signing officer(s) must be printed in the space provided for that purpose. The signature(s) of the authorized officer(s) and the corporate seal must be affixed.
 - b) Partnership: The firm name and the name(s) of the person(s) signing must be printed in the space provided. One or more of the partners must sign in the presence of a witness who must also sign. An adhesive colored seal must be affixed beside each signature.
 - c) Sole Proprietorship: The business name and the name of the sole proprietor must be printed in the space provided. The sole proprietor must sign in the presence of a witness who must also sign. An adhesive coloured seal must be affixed beside each signature.
- 2) Any alterations in the printed part of the Construction Tender Form or failure to provide the information requested therein, may render the tender invalid.
- 3) All space in the Construction Tender Form must be completed and any handwritten or typewritten corrections to the parts so completed must be initialed immediately to the side of the corrections by the person or persons executing the tender on behalf of the tenderer.
- 4) Tenders must be based on the plans, specifications and tender documents provided.

- 5) A proposal submitted by a bidder who's Board of Directors or proprietor (s) are in majority the same as a former vendor who has declared bankruptcy while performing work for NRC over the last 7-years from the date of issuance of this RFP may be rejected and not eligible for award at NRC's sole discretion. In such case, NRC will advise the ineligible proponent(s).
- 6) A proposal submitted by a bidder who has had a previous contracts cancelled by NRC due to lack of performance within 3 years from the issuance date of this RFP may be rejected and not eligible for award at NRC's sole discretion. In such case, NRC will advise the ineligible proponent (s).
- 7) If there is discrepancy between the English version and the French version of this document and any of the attachments and amendments, the English version will takes precedence.
- 8) The Council does not bind itself to accept the lowest or any tender.

Article 3 - Contract

- 1) The Contractor will be required to sign a contract similar to the Standard Contract Form for Fixed Price Construction Contracts, a blank specimen of which is enclosed in the package for reference purposes.

Article 4 – Tender Destination

- 1a) Tenders are to be submitted **by email only**:
National Research Council Canada

NRC.BidReceiving-ReceptiondesSoumissions.CNRC@nrc-cnrc.gc.ca

Endorsed "Tender for (insert title of work as it appears in the drawings and specifications)" and must bear the name and address of the tenderer.

- 1b) Unless otherwise specified, the only documents required to be submitted with the tender are the Tender form and the Bid Security.

Article 5 - Security

- 1a) Bid Security is required and must be submitted in one of the following forms:
 - i) bonds of the Government of Canada, or bonds unconditionally guaranteed as to principal and interest by the Government of Canada; **OR**
 - ii) a bid bond.
- 1b) Regardless of the Bid Security submitted, it should never be more than \$250,000 maximum, calculated at 10% of the first \$250,000 of the tendered price, plus 5% of any amount in excess of \$250,000.
- 1c) Bid Security shall accompany each tender or, if forwarded separately from the tender, shall be provided not later than the specified tender closing time. Bid bond or E-bond Security must be in the ORIGINAL form. PDF via email is acceptable. **FAILURE TO PROVIDE THE REQUIRED BID SECURITY SHALL INVALIDATE THE TENDER.**
- 1d) The successful tenderer is required to provide security within 14 days of receiving notice of tender acceptance. The tenderer must furnish EITHER:

- i) a Security Deposit as described in 1(b) above together with a Labour and Material Payment Bond in the amount of at least 50% of the amount payable under the contract, OR
 - ii) a Performance Bond and a Labour and Material Payment Bond – each in the amount of 50% of the amount payable under the contract.
- 1e) Bonds must be in an approved form and from the companies whose

bonds are acceptable to the Government of Canada. Samples of the approved form of Bid Bond, Performance Bond and Labour and Material Payment Bond and a list of acceptable Bonding Companies may be obtained from the Contracting Officer, National Research Council, Building M-58, Montreal Road, Ottawa, Ontario, K1A 0R6.

Article 7 – Sales Tax

- 1) The amount of the tender shall include all taxes as levied under the Excise Act, the Excise Tax Act, the Old Age Security Act, the Customs Act or the Customs Tariff, in force or applicable at the time.
- 1) In Quebec, the Provincial Sales Tax should not be included in the Tender Price as the Federal Government is exempt. Tenderers should contact the Provincial Revenue Minister to recover all taxes paid for goods and services rendered under this contract.

Tenderers must include in their Tender Price the amount of Provincial Sales Tax for which the exemption does not apply.

Article 8 – Examination of Site

- 1) All parties tendering shall examine the sites of the proposed work before sending in their tender and make themselves thoroughly acquainted with the same and obtain for themselves any and all information that may be necessary for the proper carrying out of the Contract. No after claim will be allowed or entertained for any work or material that may be requisite and necessary for the proper execution and completion of this Contract with the exception of that provided for under GC 35 in the General Conditions of the General Specification.

Article 9 – Discrepancies, Omissions, Etc.

- 1a) Bidders finding discrepancies in, or omissions from, drawings, specifications or other documents, or having any doubt as to the meaning or intent of any part thereof, should at once notify the Engineer who will send written instructions or explanation to all bidders.
- 1b) Neither the Engineer nor the Council will be responsible for oral instructions.
- 1c) Addenda or corrections issued during the time of the bidding shall be covered in the proposal. However, the contract supersedes all communications, negotiations and agreements, either written or oral, relating to the work and made prior to the date of the contract.

Article 10 – No additional Payments for Increased Costs

- 1) The only other adjustments in the contract price allowed are those specified in the General Conditions of the General Specification. The contract price will not be amended for change in freight rates, exchange rates, wage rates or cost of materials, plant or services.

Article 11 – Awards

- 1a) The Council reserves the power and right to reject tenders received from parties who cannot show a reasonable acquaintance with and preparation for the proper performance of the class of work herein specified and shown on plans. Evidence of such competence must be furnished by the tenderers if required to do so.
- 1b) A tenderer may be required to furnish to the Contracting Office, National Research Council of Canada, Building M-58, 1200 Montreal Road, Ottawa, Ontario, K1A 0R6, Canada, unsigned copies of the insurance requirements as covered by the Insurance Conditions of the General Specification.
- 1c) The Council will accept the Lowest Compliant Bid for Contract Award.

Article 12 – Harmonized Sales Tax

- 1) The Harmonized Sales Tax (HST) which is now in effect shall be considered an applicable tax for the purpose of this tender. However, the bidder shall NOT include any amount in the bid price for said HST. The successful contractor will indicate on each application for payment as a separate amount the appropriate HST the Owner is legally obliged to pay. This amount will be paid to the Contractor in addition to the amount certified for payment under the Contract in addition to the amount certified for payment under the Contract and will therefore not affect the Contract Price. The Contractor agrees to remit any HST collected or due to Revenue Canada.

Acceptable Bonding Companies

Published September 2010

The following is a list of insurance companies whose bonds may be accepted as security by the government.

1. Canadian Companies

- ACE INA Insurance
- Allstate Insurance Company of Canada
- Ascentus Insurance Ltd. (Surety only)
- Aviva Insurance Company of Canada
- AXA Insurance (Canada)
- AXA Pacific Insurance Company
- Canadian Northern Shield Insurance Company
- Certas Direct Insurance Company (Surety only)
- Chartis Insurance Company of Canada (formerly AIG Commercial Insurance Company of Canada)
- Chubb Insurance Company of Canada
- Commonwealth Insurance Company
- Co-operators General Insurance Company
- CUMIS General Insurance Company
- The Dominion of Canada General Insurance Company
- Echelon General Insurance Company (Surety only)
- Economical Mutual Insurance Company
- Elite Insurance Company
- Everest Insurance Company of Canada
- Federated Insurance Company of Canada
- Federation Insurance Company of Canada
- Gore Mutual Insurance Company
- Grain Insurance and Guarantee Company
- The Guarantee Company of North America
- Industrial Alliance Pacific General Insurance Corporation
- Intact Insurance Company
- Jevco Insurance Company (Surety only)
- Lombard General Insurance Company of Canada
- Lombard Insurance Company
- Markel Insurance Company of Canada
- The Missisquoi Insurance Company
- The Nordic Insurance Company of Canada
- The North Waterloo Farmers Mutual Insurance Company (Fidelity only)
- Novex Insurance Company (Fidelity only)
- The Personal Insurance Company
- Pilot Insurance Company
- Quebec Assurance Company
- Royal & Sun Alliance Insurance Company of Canada
- Saskatchewan Mutual Insurance Company
- Scottish & York Insurance Co. Limited
- The Sovereign General Insurance Company
- TD General Insurance Company
- Temple Insurance Company
- Traders General Insurance Company

- Travelers Guarantee Company of Canada
- Trisura Guarantee Insurance Company
- The Wawanesa Mutual Insurance Company
- Waterloo Insurance Company
- Western Assurance Company
- Western Surety Company

2. Provincial Companies

Surety bonds issued by the following companies may be accepted provided that the contract of suretyship was executed in a province in which the company is licensed to do business as indicated in brackets.

- AXA Boreal Insurance Company (P.E.I., N.B., Que., Ont., Man., B.C.)
- AXA Boreal Insurance Company (P.E.I., N.B., Que., Ont., Man., B.C.)
- ALPHA, Compagnie d'Assurances Inc. (Que.)
- Canada West Insurance Company (Ont., Man., Sask, Alta., B.C., N.W.T.) (Surety only)
- The Canadian Union Assurance Company (Que.)
- La Capitale General Insurance Inc. (Nfld. & Lab., N.S., P.E.I., Que.(Surety only), Man., Sask., Alta., B.C., Nun., N.W.T., Yuk.)
- Coachman Insurance Company (Ont.)
- Continental Casualty Company (Nfld. & Lab., N.S., P.E.I., N.B., Que., Ont., Man., Sask., Alta., B.C., Nun., N.W.T., Yuk.)
- GCAN Insurance Company (Nfld. & Lab., N.S., P.E.I., N.B., Que., Ont., Man., Sask., Alta., B.C., Nun., N.W.T., Yuk.)
- The Insurance Company of Prince Edward Island (N.S., P.E.I., N.B.)
- Kingsway General Insurance Company (N.S., N.B., Que., Ont., Man., Sask., Alta., and B.C.)
- Liberty Mutual Insurance Company (Nfld. & Lab., N.S., P.E.I., N.B., Que., Ont., Man., Sask., Alta., B.C., Nun., N.W.T., Yuk.)
- Manitoba Public Insurance Corporation (Man.)
- Norgroupe Assurance Générales Inc.
- Orleans General Insurance Company (N.B., Que., Ont.)
- Saskatchewan Government Insurance Office (Sask.)
- SGI CANADA Insurance Services Ltd. (Ont., Man., Sask., Alta.)
- L'Unique General Insurance Inc. (Nfld. & Lab., N.S., P.E.I., N.B., Que.(Surety only), Ont.(Surety only), Man., Sask., Alta., B.C.(Surety only), Nun., N.W.T., Yuk.)

3. Foreign Companies

- Aspen Insurance UK Limited
- Compagnie Française d'Assurance pour le Commerce Extérieur (Fidelity only)
- Eagle Star Insurance Company Limited
- Ecclesiastical Insurance Office Public Limited Company (Fidelity only)
- Lloyd's Underwriters
- Mitsui Sumitomo Insurance Company, Limited
- NIPPONKOA Insurance Company, Limited
- Sompo Japan Insurance Inc.
- Tokio Marine & Nichido Fire Insurance Co., Ltd.
- XL Insurance Company Limited (Surety only)
- Zurich Insurance Company Ltd

Articles of Agreement

These Articles of Agreement made in duplicate this day of .

Between

Her Majesty the Queen, in right of Canada (referred to in the contract documents as “ Her Majesty”) represented by the National Research Council Canada (referred to in the contract documents as the “Council”)

and

(referred to in the contract documents as the “Contractor”)

Witness that in consideration for the mutual promises and obligations contained in the contract, Her Majesty and the Contractor covenant and agree as follows:

A1 Contract Documents

(23/01/2002)

1.1 Subject to A1.4 and A1.5, the documents forming the contract between Her Majesty and the Contractor, referred to herein as the contract documents, are

1.1.1 these Articles of Agreement,

1.1.2 the document attached hereto, marked “A” and entitled “Plans and Specifications”, referred to herein as the Plans and Specifications,

1.1.3 the document attached hereto, marked “B” and entitled “Terms of Payment”, referred to herein as the Terms of Payment,

1.1.4 the document attached hereto, marked “C” and entitled “General Conditions”, referred to herein as the General Conditions,

1.1.5 the document attached hereto, marked “D” and entitled “Labour Conditions”, referred to herein as the Labour Conditions,

1.1.6 the document attached hereto, marked “E” and entitled “Insurance Conditions”, referred to herein as the Insurance Conditions,

1.1.7 the document attached hereto, marked “F” and entitled “Contract Security Conditions”, referred to herein as the Contract Security Conditions, and

1.1.8 any amendment or variation of the contract documents that is made in accordance with the General Conditions.

1.1.9 the document entitled Fair Wage Schedules for Federal Construction Contracts referred to herein as Fair Wage Schedules

1.1.10

Articles of Agreement

The Council hereby designates _____ of _____ of the Government of Canada as the Engineer for the purposes of the contract, and for all purposes of or incidental to the contract, the Engineer's address shall be deemed to be:

1.2 In the contract

1.3.1 "Fixed Price Arrangement" means that part of the contract that prescribes a lump sum as payment for performance of the work to which it relates; and

1.3.2 "Unit Price Arrangement" means that part of the contract that prescribes the product of a price multiplied by a number of units of measurement of a class as payment for performance of the work to which it relates.

1.3 Any of the provisions of the contract that are expressly stipulated to be applicable only to a Unit Price Arrangement are not applicable to any part of the work to which a Fixed Price Arrangement is applicable.

1.4 Any of the provisions of the contract that are expressly stipulated to be applicable only to a Fixed Price Arrangement are not applicable to any part of the work to which a Unit Price Arrangement is applicable.

A2 Date of Completion of Work and Description of Work

(23/01/2002)

2.1 The contractor shall, between the date of these Articles of Agreement and the _____, _____, in the careful and workmanlike manner, diligently perform and complete the following work:

which work is more particularly described in the Plans and Specifications.

Articles of Agreement

A3 Contract Amount

(23/01/2002)

3.1 Subject to any increase, decrease, deduction, reduction or set-off that may be made under the Contract, Her Majesty shall pay the Contractor at the times and in the manner that is set out or referred to in the Terms of Payment

3.1.1 the sum of (GST/HST extra), in consideration for the performance of the work or the part thereof that is subject to Fixed Price Arrangement, and

3.1.2 a sum that is equal to the aggregate of the products of the number of units of Measurement of each class of labour, plant and material that is set out in a Final Certificate of Measurement referred to in GC44.8 multiplied in each case by the appropriate unit price that is set out in the Unit Price Table in consideration for the performance of the work or the part thereof that is subject to a Unit Price Arrangement.

3.2 For the information and guidance of the Contractor and the persons administering the contract on behalf of Her Majesty, but not so as to constitute a warranty, representation or undertaking of any nature by either party, it is estimated that the total amount payable by Her Majesty to the Contractor for the part of the work to which a Unit Price Arrangement is applicable will be approximately \$N/A

3.3 A3.1.1 is applicable only to a Fixed Price Arrangement.

3.4 A3.1.2 and A3.2 applicable only to a Unit Price Arrangement.

A4 Contractor's Address

(23/01/2002)

4.1 For all purposes of or incidental to the contract, the Contractor's address shall be deemed to be:

Articles of Agreement

A5 Unit Price Table

(23/01/2002)

5.1 Her Majesty and the Contractor agree that the following table is the Unit Price Table for the purposes of the contract.

Column 1 Item	Column 2 Class of Labour Plant Or Material	Column 3 Unit of Measurement	Column 4 Estimated Total Quantity	Column 5 Price per Unit	Column 6 Estimated Total Price
		N/A			

5.2 The Unit Price Table that is set out in A5.1 designates the part of the work to which a Unit Price Arrangement is applicable.

5.3 The part of the work that is not designated in the Unit Price Table referred to in A5.2 is the part of the work to which a Fixed Price Arrangement is applicable.

Articles of Agreement

Signed on behalf of Her Majesty by

as Senior Contracting Officer

and _____

as _____

of the **National Research Council Canada**

on the _____

day of _____

Signed, sealed and delivered by

as _____ and
Position

by _____

as _____
Position

of

on the _____

day of _____

Seal

Sections - AME Consulting Group Ltd “Mechanical Specifications”

Section No.	Section Title
21 05 01	Common Works Results for Mechanical
21 05 10	Fire Extinguishers
23 05 01	Acceptable Manufacturers
23 05 15	Common Installation Requirements for HVAC Pipework
23 05 29	Hangers and Supports for Mechanical Piping and Equipment
23 05 48	Vibration and Seismic Control for Mechanical
23 05 53	Identification for Mechanical Piping and Equipment
23 05 93	Testing, Adjusting, and Balancing for HVAC
23 07 13	Duct Insulation
23 11 23	Facility Gas Piping
23 31 00	HVAC Ducts and Casings
23 33 00	Duct Accessories
23 34 00	HVAC Fans
23 37 00	Diffusers, Registers, and Grilles
23 74 00	Packaged Outdoor HVAC Equipment
25 05 00	Common Work Results for Integrated Automation
25 08 00	Commissioning of Integrated Automation
25 90 00	Integrated Automation Control Sequences
33 51 00	Site Work Natural Gas Distribution

Sections & Forms – NRC-Specific

Section No.	Section Title
01 10 00	General Instructions
00 15 45	General and Fire Safety Requirements
01 74 19	Waste Management and Disposal
01 91 13	General Commissioning (Cx) Requirements
01 91 31	Commissioning (Cx) Plan
01 91 33	Commissioning Forms
01 91 43	Commissioning Training
N/A	<i>Form: AHU (BUILT-UP) CX CHECKLIST</i>
N/A	<i>Form: NRC BAS Field Equipment Checklist</i>
N/A	<i>Form: NRC BAS Graphics Standard Checklist</i>
N/A	<i>Form: NRC BAS Sequence Standard Checklist</i>
N/A	<i>Form: Commissioning (Cx) Project Control Sheet</i>
N/A	<i>Form: Fan Cx Checklist</i>



NRC DRAO – DISH PRODUCTION FACILITY

PROJECT NO.: 447b-022-22

MECHANICAL SPECIFICATION

Re-Issued for Tender
JUNE 5, 2023

200-638 Smith Street
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Permit to Practice No: 1000236



2023-07-06

PROFESSIONAL'S SEAL & SIGNATURE

1. GENERAL

1.1 Section Scope

- .1 This Section specifies general conditions for Divisions 21, 22, 23 and 25 and is to be read, interpreted, and coordinated with all other sections.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Drawings and General Provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specification Sections apply to work specified in this section.
- .3 Section 25 05 00 – Common Works Results for Integrated Automation.
- .4 Section 001000 - General Instructions for CHORD Antenna Production Facility HVAC Construction
- .5 Section 001545 - General and Fire Safety Requirements for CHORD Antenna Production Facility HVAC Construction
- .6 Section 017419 - Waste Management and Disposal for CHORD Antenna Production Facility HVAC Construction
- .7 Section 019113 - General Commissioning (Cx) Requirements for CHORD Antenna Production Facility HVAC Construction
- .8 Section 019131 - Commissioning (Cx) Plan
- .9 Section 019133 - Commissioning Forms
- .10 Section 019141 - Commissioning Training

1.3 References

- .1 The latest revisions of the following standards shall apply unless noted otherwise.
- .2 National Codes:
 - .1 National Building Code of Canada [2020] (NBC).
- .3 American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE):
 - .1 ASHRAE 90.1- [16], Energy Standard for Buildings except Low-Rise Residential Buildings.
 - .2 ASHRAE 62.1-[01], Ventilation for Acceptable Indoor Air Quality.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .5 Electrical Equipment Manufacturers' Association Council (EEMAC):

1.4 Definitions

- .1 "concealed" – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
- .2 "exposed" – means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.

- .3 "finished" - means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.
- .4 "provision" or "provide" (and tenses of "provide") – means supply and install complete.
- .5 "install" (and tenses of "install") – means secure in position, connect complete, test, adjust, verify and certify.
- .6 "supply" – means to procure, arrange for delivery to site, inspect, accept delivery and administer supply of products; distribute to areas; and include manufacturer's supply of any special materials, standard on site testing, initial start-up, programming, basic commissioning, warranties and manufacturers' assistance to Contractor.
- .7 "delete" or "remove" (and tenses of "delete" or "remove") – means to disconnect, make safe, and remove obsolete materials; patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by Departmental Representative and reviewed with Consultant.
- .8 "BAS" – means building automation system; "BMS" – means building management system; "FMS" – means facility management system; and "DDC" means direct digital controls; references to "BAS", "BMS", "FMS", and "DDC" generally mean same.
- .9 "governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and/or "Municipal authority" – means government departments, agencies, standards, rules and regulations that apply to and govern work and to which work must adhere.
- .10 "OSHA" and "OHSA" – stands for Occupational Safety and Health Administration and Occupational Health and Safety Act, and wherever either one is used, they are to be read to mean local governing occupational health and safety regulations that apply to and govern work and to which work must adhere, regardless if Project falls within either authority's jurisdiction.
- .11 "Mechanical Divisions" – refers to Divisions 20, 21, 22, 23, 25 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.
- .12 "Electrical Divisions" – refers to Divisions 26, 27, 28 and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Electrical Contractor, unless otherwise noted.
- .13 "Consultant" – means person, firm, corporation identified as such in Agreement, or Documents, and is licensed to practice in Place of the Work, and has been appointed by Departmental Representative to act for Departmental Representative in a professional capacity in relation to the Work.
- .14 Wherever words "indicated", "shown", "noted", "listed", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to is "indicated", "shown", "listed", or "noted" on Contract Documents.
- .15 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to is "reviewed by", "to the satisfaction of", "submitted to", etc., Consultant.

1.5 General Scope

- .1 The scope of Section 21 Fire Suppression, Section 22 Plumbing, Section 23 HVAC, and Section 25 Control is for building services within the project structure and 1m from the building.
- .2 Provide complete, fully tested, and operational systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.

- .3 Contract documents and drawings of this Division are diagrammatic and approximately, to scale unless detailed otherwise. They establish scope, material, and installation quality but are not detailed installation instructions.
- .4 Follow manufacturers' recommended installation instructions, details, and procedures for equipment, supplemented by requirements of the Contract Documents.
- .5 Install equipment generally in locations and routes indicated. Run piping and ductwork close to building structure, parallel to building lines, maximize headroom and maintain minimum interference with other services and free space. Remove and replace improperly installed equipment to satisfaction of the Consultant at no extra cost.
- .6 For work within existing facilities, confirm locations and elevations of existing piping and equipment prior to commencement of new work.
- .7 Install equipment to provide service access, maintain service clearances and for ease of maintenance.
- .8 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Departmental Representative. Uncrate equipment, move in place and install complete; start up and test.
- .9 Install control valves, control dampers, thermal wells, and other devices on piping and ductwork, furnished by Division 25.

1.6 Coordination of Work

- .1 Cooperate and coordinate with other trades on the project.
- .2 Make reference to electrical, mechanical, structural, and architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Jointly work out all conflicts on site before fabricating or installing any materials or equipment.
- .3 Where dimensional details are required, work with the applicable architectural and structural drawings.
- .4 Full size and detailed drawings shall take precedence over scale measurements from drawings.
- .5 Any areas indicated as space for future materials or equipment shall be left clear.

1.7 Permits and Fees

- .1 All work shall comply with provincial, municipal, bylaws and authorities having jurisdiction.
- .2 Obtain all permits and pay all fees applicable to the scope of work.
- .3 Contractor shall arrange for inspections of the work by the authorities having jurisdiction and shall provide certificates indicating Final Approval.

1.8 Examination of Site

- .1 Before submitting tender, visit and examine the site and note all characteristics and features affecting the work. No allowances will be made for any difficulties encountered or any expenses incurred because of any conditions of the site or item existing thereon, which is visible or known to exist at the time of tender.

1.9 Tender Price Breakdown

- .1 Submit a tender price breakdown within thirty (30) days of tender closing and before first progress claim, in a format agreed to with the Consultant.
- .2 As a minimum, include the following in the tender price breakdown:

- .1 Site Services: Materials, labour
- .2 Mechanical: Equipment, materials, labour
- .3 Sheet Metal: Equipment, materials, labour
- .4 Controls: Equipment, materials, labour

1.10 Submittals

- .1 Submittals shall be in accordance with Division 01 - Submittal Procedures, Division 01 – Closeout Procedures, Division 01 – Closeout Submittals and the following:
 - .1 Installed materials and equipment shall meet specified requirements regardless of whether or not shop drawings are reviewed by the Consultant.
 - .2 No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent.
 - .3 Shop drawings shall be reviewed by the General Contractor and Mechanical Sub-Contractor indicating that the shop drawings have been reviewed, coordinated with the work and that the shop drawings are submitted without qualifications. Shop drawings shall bear the 'reviewed' stamp dated and initialed by the General Contractor and Mechanical Sub-Contractor prior to submitting the shop drawings to the consultant. Shop drawings, which do not bear the contractors and sub-trades 'reviewed' stamp, initials and date will be rejected and sent back as 'not reviewed'.
 - .4 Submit samples, in addition to drawings, of all items, which in the Consultant's judgment, can be better examined for capacity, quality, finish or detail by sample rather than by drawings. Samples shall be submitted before equipment or material is ordered.
 - .5 If shop drawings are rejected technically after 3 submissions, the Contractor at no additional expense to the Departmental Representative shall revert to the specified product and manufacturer for this project.
- .2 Contractor shall provide and submit to the Consultant Assurance of Professional Design and Commitment for Field Review by Supporting Registered Professional Schedule S-B and Assurance of Professional Field Review and Compliance by Supporting Registered Professional Schedule S-C for seismic engineering.
- .3 Requirements for Contractor Retained Engineers
 - .1 Professional engineers retained to perform consulting services with regard to Project work, i.e. seismic engineer, fire protection engineer or structural engineer, are to be members in good standing with local Association of Professional Engineers, and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of governing authorities in Place of the Work.
 - .2 Retained engineer's professional liability insurance is to protect Contractor's consultants and their respective servants, agents, and employees against any loss or damage resulting from professional services rendered by aforementioned consultants and their respective servants, agents, and employees in regards to the Work of this Contract.
 - .3 Unless otherwise specified in Division 00 or 01, liability insurance requirements are as follows:
 - .1 Insurance policy is not to be cancelled or changed in any way without insurer giving Departmental Representative minimum thirty days written notice;
 - .2 Liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the Place of the Work.

- .4 Retained consultants are to ascertain that sub-consultants employed by them carry insurance in the form and limits specified above.
- .5 Evidence of the required liability insurance in such form as may be required is to be issued to Departmental Representative, Departmental Representative's Consultant, and Municipal Authorities as required prior to commencement of aforementioned consultant's services.
- .4 Submit shop drawings for all products identified in the relevant specification sections of Divisions 21, 22, 23 and 25. Provide drawings as electronic files (file format: .dwg, .dxf, pdf, or comparable). When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Submittals shall include a complete bill of materials of equipment to be used indicating quantity, manufacturer, model number, and other relevant technical data.
- .5 Submit the following shop drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia.
 - .1 Fastening details for Seismic restraints.
 - .2 Mounting details for spring isolation of equipment.
- .6 Shop drawings and product data shall be accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Capacity and performance characteristics indicated on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification for compliance to applicable codes.
- .7 Shop drawings to indicate:
 - .1 Material Specification including CSA or ULC reference numbers.
 - .2 Clearly mark submittal material using arrows, underlining or circling to show differences from specified ratings, capabilities and options being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pumps, seals, material, or painting.
 - .3 Dimensioned construction drawings with plans and sections showing size, arrangement and necessary clearances, with mounting point loads.
 - .4 Weights of all major equipment for review by the appropriate Consultant.
 - .5 Mounting arrangements and installation details to suit the applications on this project.
 - .6 Motor efficiencies on motors 1H.P. and larger.
 - .7 List of the manufacturers and figure numbers for all valves, traps and strainers.
 - .8 Control explanation and internal wiring diagrams for packaged equipment.
 - .9 Control system drawings including a written description of control sequences relating to the schematic diagrams. Refer to additional requirements in controls sections.
 - .10 Operating and maintenance requirements.

- .11 Submit as a shop drawing, an electrical equipment list for any equipment supplied by the mechanical contractor or his subtrades. The list is to be submitted in a timely fashion so that the electrical contractor can utilize the list as a final check prior to ordering motor control centres, starters, or disconnects. The list is to indicate the following:
 - .1 The horsepower size and number of motors.
 - .2 The minimum circuit amps (MCA) for packaged equipment such as roof top units.
 - .3 The voltage and phase of the motors.
 - .4 Whether or not a starter or a disconnect is included as part of the package.
- .8 Material Safety Data Sheets (MSDS):
 - .1 Submit Material Safety Data Sheets (MSDS) in accordance with Division 01 - Submittal Procedures for the following products. Indicate VOC emissions, prior to installation or use:
 - .1 Adhesives.
 - .2 Caulking compounds.
 - .3 Sealants.
 - .4 Insulating materials.
 - .5 Fireproofing or fire stopping materials.
- .9 Closeout Submittals:
 - .1 Provide mechanical operation and maintenance data in compliance with Division 01 - Closeout Submittals and the following:
 - .1 The Contractor shall furnish and pay for three (3) complete sets of operating and maintenance manuals for the complete mechanical installation plus two (2) copies of the digital version of the manuals on USB type flash drive.
 - .2 Supply indexed copies of equipment manufacturers' operating and maintenance (O&M) instruction data manuals. Consolidate each copy of data in an identified hard cover three "D" ring binder. Each binder to include:
 - .1 Front cover: project name; wording – "Mechanical Systems Operating and Maintenance Manual"; and date;
 - .2 Introduction sheet listing Consultant, Contractor, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses;
 - .3 Equipment manufacturer's authorized contact person name, telephone number and company website;
 - .4 Table of Contents sheet, and corresponding index tab sheets;
 - .5 Copy of each "REVIEWED" or clean, updated "REVIEWED AS NOTED" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, company website address, and email address for local source of parts and service; when shop drawings are returned marked "Reviewed As Noted" with revisions marked on shop drawing copies, they are to be revised by equipment supplier to incorporate comments marked on "Reviewed" shop drawings and a clean updated copy is to be included in operating and maintenance manuals;

- .3 Operation and maintenance manual approved by, and final copies deposited with the Consultant a minimum of 7-days before final inspection.
- .4 Operation data to include but not limited to:
 - .1 Pressure test reports, and certificates issued by governing authorities
 - .2 Control schematics for systems including environmental controls.
 - .3 Wiring and connection diagrams.
 - .4 A description of the systems and associated controls.
 - .5 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .6 Operational instructions for systems and associated components.
 - .7 A description of actions to be taken in the event of equipment failure.
 - .8 Valves schedule and flow diagrams.
 - .9 Colour coding chart.
- .5 Maintenance data to include:
 - .1 Servicing, maintenance, operation, and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .3 Recommended maintenance practices and precautions.
 - .4 Complete parts lists with numbers.
- .6 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets indicating point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results and final commissioning report.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting, and balancing.
- .7 Digital Version of Manuals
 - .1 The digital version of the manuals and the hard copy version shall be prepared by the same company.
 - .2 Utilize latest version of Adobe Acrobat, Portable Document Format (pdf).
 - .3 The digital manual shall be enhanced with the following features: Bookmarks, Internet Links, Internal Documents Links and Optical Character Recognition (OCR).
 - .4 All shop drawings shall be scanned to a minimum 8.5" x 11" size. If the original page is 11" x 17", the digital copy shall also be 11" x 17".
 - .5 Provide a minimum 300 DPI for all scanned pages.
 - .6 All scanned material may be searched for text with minimum 60% Optical Character Recognition (OCR).
 - .7 Rotation of scanned page images/texts shall be displayed within +/- 20 degrees.

- .8 Digital manual shall be organized in the same manner as the hard copy manual. Bookmark all major tabs and sub-sections and each set of shop drawings. Link the Table of Contents to the referenced section. Insert Internet Links to the Mechanical Equipment Manufacturers/Suppliers/Contractors official websites
- .8 Approvals:
 - .1 Submit 1 copy of draft Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless directed by Consultant.
 - .2 Make changes as required and re-submit as directed by Consultant.
- .9 Warranties
 - .1 Include copy of all equipment warranty and extended warranty certificates into the Operation and Maintenance Manual.
- .10 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need as it becomes apparent during demonstrations and instructions.
 - .2 Chemical treatment reports.
 - .3 Back-flow preventer test certificates.
 - .4 Results of Departmental Representative's Orientation (demonstrations).
 - .5 List of spare parts turned over to Departmental Representative's forces.
- .2 Site records:
 - .1 Contractor shall maintain 1 set of white prints at contractors cost to mark changes as work progresses and as changes occur.
 - .2 Use different colour waterproof ink for each service. Do not use pencil or black ink.
 - .3 Transfer information weekly to show work as actually installed.
 - .4 Make available for reference purposes and review.
- .3 Record drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for Mechanical, finalize production of record drawings.
 - .2 Use site record set to electronically produce CAD/Revit files and pdfs of drawings thus forming reproducible "Record Drawings" set.
 - .3 Identify each drawing in lower right-hand corner in letters at least 12 mm high as follows: - "RECORD DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
 - .4 Submit Record drawings, to consultant for approval and make corrections as directed.
 - .5 Provide digital copies of final record drawings reviewed by Consultant onto USB type flash drive, or method as directed by Departmental Representative. Provide 2 complete sets of "Record Drawings" on separate USBs. Submit "Record Drawings" sets of white prints and USBs to Consultant
 - .6 Perform testing, adjusting, and balancing for HVAC using record drawings.

- .7 Submit completed reproducible record drawings with Operating and Maintenance Manuals.
- .8 Cost to transfer record information onto reproducible media & Auto-CAD or Revit are this contractor's responsibility. Consultant will release drawings to contractor after signing a copyright form.
- .9 Should the Contractor choose to utilize this consultant for transferring site records (Set with marked changes) information to record drawings, allow \$400 / sheet for all drawings in the construction set. This will cover costs for drafting time & printing costs.
- .10 Submitted drawings are to be of same quality as original Contract Drawings. CAD/Revit drawing files are to be compatible with AutoCAD/Revit software release version confirmed with consultant.

1.11 Construction Detail Samples

- .1 Samples of repetitive items encountered during the construction of this project are required to establish quality control.
- .2 Samples shall be provided within 30 days of contract award or 14 days prior to installation on site of specific samples.
- .3 Construction details are samples specifically required for this project and are required as follows:
 - .1 Ductwork Fittings - high pressure (including joints and sealer).
 - .2 Ductwork Fittings - low pressure (including joints and sealer).
 - .3 Fire damper installation (mounted in mock stud wall c/w breakaway duct section, 40" x 40" overall).
 - .4 Pipe sleeve installation - fire rated wall/floor.
 - .5 Pipe sleeve installation - non-fire rated wall.
 - .6 Pipe anchor and sleeve detail.
 - .7 Internal duct insulation c/w butt joints, open ended duct, high velocity and low velocity details.
 - .8 Pipe hangers.
 - .9 Sprinkler heads.
 - .10 Typical seismic restraint details for equipment, ductwork and piping.
- .4 Acceptance of the standard of the sample is strictly at the discretion of the Consultant.
- .5 Once the quality of the sample has been accepted it shall establish the quality expected throughout the remainder of the project.

1.12 Spare Parts Submittals

- .1 Furnish spare parts in accordance with Division 01 - Closeout Submittals and as follows:
 - .1 One set of packings for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One head gasket set for each heat exchanger.
 - .4 One set of V-belts for each piece of machinery.
 - .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

- .2 Additional spare parts shall also be included as outlined in their appropriate sections.
- .3 Provide one set of special tools if required to service equipment as recommended by manufacturers.

1.13 Quality of Work

- .1 All work shall be by qualified tradesmen with valid Provincial Trade Qualification Certificates. Spot checks will be made by the Consultant.
- .2 Work, which does not conform to standards accepted by the Consultant and the trade, may be rejected by the Consultant. The Contractor shall redo rejected work to the accepted standard at no cost to the Departmental Representative.

1.14 Metric Conversion

- .1 All units in this division are expressed in SI units.
- .2 Submit all shop drawings and maintenance manuals in SI units.
- .3 On all submittals (shop drawings etc.), use the same SI units as stated in the specification.
- .4 Equivalent Nominal Diameters of Pipes - Metric and Imperial:
 - .1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment, and piping.
 - .2 When CSA approved SI Metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

Equivalent Nominal Diameter Of Pipes					
mm	inches (NPS)	mm	inches (NPS)	mm	inches (NPS)
3	1/8	40	1-1/2	200	8
6	1/4	50	2	250	10
10	3/8	65	2-1/2	300	12
15	1/2	75	3	375	15
20	3/4	100	4	450	18
25	1	125	5	500	20
30	1-1/4	150	6	600	24

- .5 Metric Duct Sizes:
 - .1 The Metric duct sizes are expressed as 25 mm = 1 inch.

1.15 Drawings and Specifications

- .1 Drawings and specifications are complementary to each other, and what is called for by one shall be binding as if called for by both.
- .2 Should any discrepancy appear between drawings and specifications, which leaves the Contractor in doubt as to the true intent and meaning of the plans, and specifications, obtain written clarification from the Consultant during the tender period. Without a written clarification, the better quality and/or greater quantity of work or materials shall be estimated, performed and furnished within the tendered price.
- .3 Examine all contract documents, including all drawings and specifications, and work of other trades to ensure that work is satisfactorily carried out without changes to building.

1.16 Cutting, Patching and Coring

- .1 Provide holes and sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves.
- .2 Drill for expansion bolts, hanger rods, brackets, and supports.
- .3 Perform x-rays and obtain written approval from the Structural Consultant before cutting or burning structural members. Use of Ground Penetration Radar (GPR) method to locate concealed electrical conduit, structural re-bar, post-tension cables, etc. is also acceptable.
- .4 Provide openings and holes required in precast members for mechanical work. Cast holes 100 mm or larger in diameter. Field cut smaller than 100 mm.
- .5 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective section.
- .6 Removal of any existing pipe, conduit, or ductwork within a slab core hole or slab opening through floors and roofs must be removed completely, including any associated sleeving, in a safe manner. Provisions are to be made during the removal process to protect any occupants and/or fabric of the space below. The Consultant is to be advised of all existing mechanical service penetration locations, such that site visits and field reviews can be fully co-ordinated and undertaken before and after the opening is closed in and filled.
- .7 Filling of any existing slab core or opening is to be with an engineered design of concrete fill complete with doweling for adhesion and/or fire stopping system as appropriate.

1.17 Excavation and Backfill

- .1 Refer to the requirements of Division 31.
- .2 Provide all excavating to facilitate installation of the mechanical work, including shoring, pumping, 150 mm compacted sand bedding under and first 300 mm of compacted sand over piping and ducting.
- .3 Refer to drawing details as applicable.

1.18 Installation of Equipment

- .1 Pipe all equipment drains to building drains except systems containing glycol.
- .2 Unions and flanges shall be provided in piping or ductwork to permit easy removal of equipment.
- .3 Maintain permanent access to equipment for maintenance.

1.19 Connections to Existing Services

- .1 Maintain liaison with the Departmental Representative and provide a mutually acceptable schedule to interrupt, reroute or connect to existing building services with the minimum of interruption of those services.
- .2 Major services shall not be interrupted before all preparatory work is completed and all required materials are on site. Provide a minimum of 48 hours' notice for all service shutdowns. Allow for major service interruptions outside of normal operating hours of the facility.
- .3 Interruptions and shutdowns of existing services shall be by the building/plant maintenance staff. Advise building/plant maintenance staff of the duration of service interruption or shut down.
- .4 The local Fire Department shall be advised of any shut down or disruption of the fire suppression systems.

1.20 Selective Demolition

- .1 Reference Standards
 - .1 Unless otherwise specified, carry out demolition work in accordance to CSA S350-M1980 Code of Practice for Safety in Demolition of Structures.
- .2 Remove from site all equipment, ducting or piping which is no longer required because of work under this Contract.
- .3 Existing Conditions
 - .1 Visit and examine the site and note all characteristics and irregularities affecting the work of this Section.
- .4 Protection
 - .1 Prevent movement or settlement of adjacent work. Provide and place bracing or shoring and be responsible for safety of such work. Be liable for any such movement or settlement and any damage or injury caused.
 - .2 Cease operations and notify the Prime Consultant immediately for special protective and disposal instructions when any asbestos materials are uncovered during the work in this Section.
 - .3 Prevent debris from blocking surface drainage inlets and all types of drainage piping systems which remain in operation.
- .5 Salvageable Materials
 - .1 Except as otherwise stated, salvageable materials from area of demolition shall become the property of the Departmental Representative at his discretion. All material not taken over by the Departmental Representative or removed from the building under this contract shall be removed from this site and disposed of as required by any applicable disposal regulations.
 - .2 Turnover to and deliver to the Departmental Representative's storage area all items which have been determined to have salvage value and has been removed due to the Work.

1.21 Equipment and Materials

- .1 Materials and equipment installed shall be new, CSA approved and of quality specified.
- .2 Each major component of equipment shall bear manufacturer's name, address, catalog and serial number in a conspicuous place.
- .3 Where two or more products of the same type are required, products shall be of the same manufacturer.
- .4 Notify the Consultant in writing ten (10) days prior to the tender close, any materials or equipment specified which is not currently available or will not be available for use as called for herein. Failing this, the contract will assume that the most expensive alternate has been included in the tender price.
- .5 All equipment supplied to the project will meet efficiencies as defined in ASHRAE Standard 90.1 and NECB (current versions).

1.22 Cleaning

- .1 During construction, keep site reasonably clear of rubbish and waste material resulting from work on a daily basis to the satisfaction of Departmental Representative and Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove rubbish and debris, and be responsible for repair of any damage caused as a result of work.
- .2 Clean equipment and devices installed as part of this project.

1.23 Delivery, Storage and Handling

- .1 Deliver, store and handle materials in accordance with Division 01 - Common Product Requirements, the manufacturer's written instructions and the following:
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials and equipment in accordance with the manufacturer's recommendations in a clean, dry, well-ventilated area.
 - .2 Store and protect equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Protect equipment and materials in storage on site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping, equipment and duct systems.
- .5 Protect equipment and open-end duct with polyethylene covers and maintain equipment on crates until installation.
- .6 Operate, drain and flush out unsealed bearings and refill with fresh oil before final acceptance.
- .7 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.
- .8 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.
- .9 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.24 Fire Stopping and Smoke Seals

- .1 Provide fire stopping and smoke seals in accordance with Division 07 – Fire Stopping and Section 22 07 11. If the requirements for fire stopping of mechanical services penetrations of Section 22 07 11 differ from the requirements of Division 07, the most stringent requirements shall apply.

1.25 Access Doors

- .1 General
 - .1 Provide access doors for maintenance or adjustment of all parts of the mechanical system. This shall apply but not be limited to valves, dampers, cleanouts and controls.
 - .2 Where equipment is concealed by a T-bar ceiling, the location of equipment shall be indicated by coloured markings. Refer to Section 23 05 53 Identification for Mechanical Piping and Equipment.
 - .3 Where equipment is concealed by a continuous structural or architectural surface, supply access doors of design to suit and match the surface in which they will be installed.
 - .4 Provide stainless steel doors in walls of washrooms, kitchen, janitor rooms and laundry rooms.
 - .5 Provide Drywall type access doors in all public drywall spaces requiring access to equipment.
 - .6 All fasteners on access panels shall be tamper proof, contractor shall provide three (3) sets of keys.

- .7 Locate all access doors outside of secure areas where possible. Where not possible, review the locations of panels with the Departmental Representative's Consultant prior to installation. All access panels within secure areas are to be of penal quality, lockable, vandal-proof and ligature resistant.
- .8 Provide 300 mm x 300 mm minimum size for inspection and hand access.
- .9 600 mm x 600 mm minimum size, larger if indicated on drawings, where entry is required and access is difficult.
- .10 Size to suit masonry modules when located in a masonry wall.
- .11 When located in a finished floor with tile, stonework, terrazzo, etc., a recessed bearing type access door is required. The door surface shall have a recess to take the particular surface material and pattern if this is available at the time the units are ordered.
- .12 Security Access Doors:
 - .1 Access doors for security areas shall be 1.70 mm [14 gauge] thick double skinned internally reinforced at 150 mm [6"] on centre, 4.76 mm [3/16"] thick, insulated in pressed sink wiped cold rolled steel metal frame (similar to door frame) complete with necessary preparation to receive security lock escutcheon and hinges.
- .2 Submittals:
 - .1 Submit shop drawings for all access doors anticipated on this project.

1.26 Single Point Electrical Connection

- .1 If the equipment is indicated on the schedules or within the motor list (both included in the mechanical drawings) as a single point connection, the equipment shall be provided with all integral HOA type starters, internal wiring to all motors, starters, lighting, service outlets etc. such that a single electrical connection can be utilized to power all components within the unit. The unit shall also incorporate the required step-down transformers and wiring to connect all of these internal components including controls wiring. Coordinate with the controls subcontractor for the supply, installation, and wiring of control components.

1.27 Electrical Motors

- .1 Supply mechanical equipment complete with electrical motors.
- .2 Quality Assurance
 - .1 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: NEMA, EEMAC, CSA, CEC Part 1, IEEE and ANSI. All motors to be UL listed and CSA labelled.
 - .2 All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch.
 - .3 All motors intended for use with a [variable speed drive] [variable frequency drive] (VFD) shall be inverter duty rated.
 - .4 Motors connected to VFD(s) shall be wound using inverter spike resistant magnet wire capable of 1600V.
 - .5 The noise level of each motor shall comply with NEMA standards, less than 80 dBA at 1 meter.
 - .6 Minimum certified motor efficiency shall be as outlined in current version of ASHRAE 90.1 and NECB.
- .3 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B. Motors driving high torque or high inertia loads may be EEMAC Design C or D.

- .4 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection.
- .5 Motors less than 3/4-hp shall be 120 V, 60 Hz, 1 phase. Motors 3/4-hp and larger shall be 3 phase at the indicated voltage.
- .6 All motors shall be 1800 rpm unless otherwise noted.
- .7 Provide motors complete with equipment except where indicated.
- .8 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.
- .9 Provide motors designed with Class B insulation, Class F insulation for totally enclosed motors.
- .10 Motors exposed to outdoor temperature to be lubricated with lubricants suitable for operation at 6 deg. C. below the lowest temperature recorded by ASHRAE or the Climatic Information (Supplement to the National Building Code), for the location in which they are installed.
- .11 All motors 10 hp and larger that are controlled by a VFD are to use a dielectric grease bearings and a grounding kit with a system of brass or stainless steel brushings.
- .12 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.
- .13 Submittals
 - .1 Submit data of test method used and motor efficiencies with shop drawings.

1.28 Motor Starters and Accessories

- .1 Motor starters must be capable of starting associated motors under the imposed loads. Confirm starter voltage matches motor prior to ordering.
- .2 Unless otherwise specified, starters for 1-phase motors are to be 115 volt; thermal overload protected manual starting switches with a neon pilot light, a surface or recessed enclosure to suit the application, and, where automatic operation is required, a separate H-O-A switch in an enclosure to match starter enclosure.
- .3 Unless otherwise specified, starters for 3-phase motors less than 50 HP are to be combination "quick-make" and "quick-break" fused disconnects and full voltage non-reversing across-the-line starters, each complete with and overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.
- .4 Unless otherwise specified, starters for 3-phase motors 50 HP to 150 HP are to be reduced voltage, non-reversing, auto-transformer type starters complete with one overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.
- .5 Unless otherwise specified, starters for 3-phase motors 150 HP and larger are to be reduced voltage, non-reversing, closed transition "wye-delta" starters complete with one overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.
- .6 Starters for 2-speed double winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.
- .7 Starters for 2-speed single winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.

- .8 Starters for reversible motors for cooling towers are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to allow fan(s) to coast down to a stop before being operated in reverse rotation.
- .9 Unless otherwise specified, motor starter enclosures are to be in accordance with following NEMA ratings:
 - .1 Enclosures located in sprinklered areas – Type 2;
 - .2 Enclosures exposed to the elements – Type 3R, constructed of stainless steel;
 - .3 Enclosures inside the building in wet areas – Type 3R, constructed of stainless steel;
 - .4 Enclosures in explosion rated area – Type 7 with exact requirements to suit the area and application;
 - .5 Enclosures except as noted above – Type 1;
 - .6 Enclosures located in finished areas – as above but recess type with brushed stainless steel faceplate.
- .10 Motor control centres are to be multi-unit, 2.28 m (9') high, NEMA Class 1, type "B", factory assembled, dead front, floor mounted, freestanding motor control centre with tin plated copper bus and an NEMA Type 1 or Type 2 enclosure as for loose starters specified above. Each motor control centre is to be complete with starters as specified above, load and control wiring terminal boards, and required facilities for line and load side power wiring connections.
- .11 Disconnect switches for motor control centres are to be heavy-duty, CSA certified, front operated switches as per motor starter schedule, each complete with a handle suitable for padlocking in "off" position and arranged so that door cannot be opened with handle in "on" position and an NEMA enclosure as specified for loose starters. Fusible units are to be complete with fuse clips to suit fuse types specified below.
- .12 Fuses are to be, 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.

1.29 Miscellaneous Metals

- .1 Provide all necessary miscellaneous to hang or support materials, equipment and provide access for work under this contract.
- .2 All miscellaneous metals shall be prime painted.
- .3 Miscellaneous metals shall include but not limited to:
 - .1 Hangers for equipment, piping and ductwork.
 - .2 Support for equipment.
 - .3 Access platforms and catwalks.

1.30 Scaffolding, Hoisting and Rigging

- .1 Unless otherwise specified or directed, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval from Departmental Representative.
- .2 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.
- .3 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from Departmental Representative.

1.31 Pipe Sleeves

- .1 Pipe sleeves shall be provided for piping passing through walls and floors. Minimum schedule 40 steel pipes or factory fabricated, flanged, high-density polyethylene sleeves with reinforced nail bosses. Sleeves shall extend 25 mm on either side of the wall.
- .2 Schedule 40 steel pipes shall be used as floor pipe sleeves in wet areas with a 50 mm up-stand.
- .3 Review and coordinate sleeve diameters with fire stop installation details as applicable.
- .4 Pipe sleeves are not required where pipes pass through cored concrete walls or floors.

1.32 Water Proofing Materials

- .1 Modular, mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so when bolts are tightened the links expand to seal the opening watertight. Select seal assemblies to suit pipe size and sleeve size or wall opening size.
- .2 Acceptable products are:
 - .1 Thunderline Corp. (Power Plant Supply Co.) "LINK SEAL" Model S-316;
 - .2 The Metraflex Co. "MetraSeal" type ES

1.33 Escutcheons and Plates

- .1 Provide escutcheons and plates on all piping and ductwork passing through finished walls, floors and ceilings.
- .2 Escutcheons shall be one piece, stainless or chrome plated steel.

1.34 Temporary Heat

- .1 Do not use the permanent system for temporary heating purposes without written permission from the Consultant.
- .2 If approved, permanent mechanical systems in building may be used for temporary heating during construction subject the following conditions:
 - .1 Each entire system is complete, pressure tested, cleaned, and flushed out.
 - .2 Specified water treatment system has been commissioned, and treatment is being continuously monitored.
 - .3 Thoroughly clean and overhaul permanent equipment used during the construction period, replace worn or damaged worn or damaged parts before final inspection.
 - .4 Use of permanent systems for temporary heat shall not modify terms of warranty.
 - .5 Operate heating systems under conditions, which ensure no temporary or permanent damage. Operate with proper safety devices and controls installed and fully operational. Operate systems only with treated water as specified.
 - .6 Air systems shall not be used for temporary heating.
 - .7 When permanent systems are used for temporary heat, provide alarm indicating system failure. Connect alarm to independent alarm company system.
 - .8 Where pumps are used for temporary heating, replace mechanical seals, regardless of condition, with new mechanical seals.
 - .9 Energy costs are to be paid by Contractor.

- .10 During this period of construction, such systems/equipment to not become property of Departmental Representative or be Departmental Representative's responsibility for maintenance or service. Systems/equipment are to remain property of respective manufacturers/suppliers or Contractor, who are responsible for full maintenance and servicing of systems/equipment in order to maintain validity of warranties after turn over to Departmental Representative.
- .11 Prior to application for a Certificate of Substantial Performance of the Work and turn over to Departmental Representative, such systems/equipment to be cleaned, restored to "new" condition, paint finishes "touched-up", filters cleaned or replaced, etc.

1.35 Progress Claim Breakdown

- .1 Prior to submittal of first progress payment draw, submit a detailed breakdown of work cost to assist Consultant in reviewing and approving progress payment claims.
- .2 Payment breakdown is subject to Departmental Representative's approval and Consultant's review. Progress payments will not be processed until an approved breakdown is in place. Breakdown is to 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, system testing and verification, and project closeout submittals.
- .3 Indicate equipment, material and labour costs for site services (if applicable) and indicate work of each trade in same manner as indicated on progress draw.
- .4 Progress claims will not be certified nor payment made beyond 95% on the overall Mechanical contract and beyond 70% on the Control systems contract, until commissioning and verification of the systems are complete. (The 70% limit on Controls is included in the overall fig.). This procedure is to allow for any necessary deficiency holdbacks on items, which do not become apparent until the systems are commissioned.

1.36 Notice for Required Field Reviews

- .1 Whenever there is a requirement for Consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 5 working days' notice in writing to Consultant.
- .2 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.
- .3 Do not conceal work until Consultant advises that it may be concealed.
- .4 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

1.37 Changes in the Work

- .1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity or type of work from that required by Contract Documents, prepare and submit to Consultant for review, a quotation being proposed cost for executing change or revision.
- .2 Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.
- .3 Make requests for changes or revisions to work to Consultant in writing and, if Consultant agrees, will issue Notice of Change.

- .4 Do not execute any change or revision until written authorization for the change or revision has been obtained from Consultant.

1.38 Temporary or Trial Usage

- .1 Temporary or trial usage by the Departmental Representative or Consultant of mechanical equipment supplied under contract shall not represent acceptance.
- .2 Repair or replace permanent equipment used temporarily.
- .3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.
- .4 Avoid thermal shock to heating system by coordination with the Departmental Representative during planning, construction and operation of temporary heating system.

1.39 Guarantee / Warranty

- .1 Furnish a written guarantee stating that all work executed in this contract will be free from defective workmanship and materials for a period of one (1) year from the date of Substantial Performance. The Contractor shall, at his own expense, repair and replace any work, which fails or becomes defective during the term of the guarantee/warranty, providing such work is not due to improper usage. The period of guarantee specified shall not in any way supplant any other guarantees of a longer period but shall be binding on work not otherwise covered.
- .2 Use of permanent systems for temporary heat shall not modify terms of the manufacturers' warranty or the guarantee.
- .3 If the equipment is used during construction, the warranty or guarantee period shall not be shortened or altered.

1.40 Substantial and Total Performance

- .1 Prior to requesting an inspection for Substantial Performance, provide a complete list of items, which are deficient.
- .2 A certificate of Substantial Performance will not be granted unless the following items are completed and available to the Departmental Representative's Consultant:
 - .1 Final Plumbing Inspection Certificate from the Authority having Jurisdiction.
 - .2 Final Gas Inspection Certificate from the Authority having Jurisdiction.
 - .3 Fire Sprinkler Materials and Test Certificate.
 - .4 Fire alarm test certificate (via DIV.26).
 - .5 Schedule S-C for seismic engineering.
 - .6 Final Backflow Prevention test reports for all backflow devices.
 - .7 Commissioning checklists are completed and submitted as per Division 01.
 - .8 Fire stopping and Fire Damper test letter.
 - .9 Major equipment – suppliers start-up test sheets and letters certifying start up (Boilers, chillers, packaged equipment).
 - .10 Draft Operating/Maintenance Manuals have been submitted for review.
 - .11 All mechanical systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation.
 - .12 Air and water systems have been balanced with draft report submitted to the Consultant.

- .13 Mechanical identification is complete.
- .14 Warranty forms have been mailed to the manufacturer. Provide copy of the original warranty for equipment, which has a warranty period longer than one year.
- .15 Operating and Maintenance demonstrations have been provided to the Departmental Representative.
- .16 Written inspection report by manufacturer's representative has been submitted for noise and vibration control devices and flexible connections.
- .17 Record drawings have been submitted.
- .18 Fan plenums have been cleaned, and temporary filters have been replaced with permanent filters.
- .19 All previously identified deficiencies have been corrected and accepted.
- .3 Prior to a Total Performance Inspection, provide declaration in writing that deficiencies noted at time of substantial performance inspection have been corrected and the following items completed prior to the total performance inspection:
 - .1 Submit final air and water balance reports.
 - .2 Submit final operating and maintenance manuals.
 - .3 Complete final calibration.
- .4 The Consultant shall provide one (1) visitation for the purpose of total performance inspection. Subsequent visitations if required shall be at the expense of the Contractor.
- .5 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until substantial performance is declared.

1.41 Alternate Materials and Equipment

- .1 The price submitted for this contract shall be based on the use of materials and equipment as specified or as contained within the Acceptable Manufacturers List.
- .2 Requests for alternate equivalent materials or equipment must be submitted to the Consultant no later than seven (7) working days prior to the Mechanical trades' closing tender date. Submit all applicable technical data, including performance curves and physical details for review. Approval of requests shall only be given by addendum.
- .3 Approved equivalents and/or alternatives to specified products shall be equal to the specified product in every respect, operate as intended, and meet the space, capacity, and noise requirements outlined.
- .4 The Contractor shall be fully responsible for any additional labour and materials required by any trades or other Contractors to accommodate the use of other than specified materials or equipment. The Contractor shall bear any and all costs for design/system modifications to accommodate the "alternate" equipment. Extras will not be approved to cover such work.

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 Refer to Section 23 05 01 Acceptable Manufacturers.

2.2 Existing Services

- .1 Disconnect and cap all mechanical services in accordance with requirements of the authority having jurisdiction. Natural gas supply lines shall be removed by the local gas company or by a qualified tradesman in accordance with gas company instructions.

- .2 Building Mechanical Services: Maintain activity of all building services during demolition/removal of existing services required of this contract.
- .3 Maintain all trap seals and cap open-end pipe to ensure no sewer gas enters the building during renovations or demolition work. Maintain all existing sewer piping in a wet condition daily.

2.3 Demolition

- .1 Completely demolish the items scheduled and remove all materials from the premises unless otherwise requested by the Departmental Representative.
- .2 Carry out demolition in a manner to cause as little inconvenience to the occupied building area as building area as possible. Co-ordinate this activity with the Departmental Representative and/or the Consultant.
- .3 Carry out demolition in an orderly and careful manner.
- .4 All coring, patching and removal of existing equipment, pipes, and ductwork, which may affect the operation of occupied areas of the building, shall be carried out outside of regular office hours or as scheduled with the Departmental Representative.

2.4 Core Drilling

- .1 Clearly identify all proposed piping penetrations through existing slabs, walls etc. and advise the General Contractor. Obtain x-rays or GPR scanning of the locations to ensure penetration will avoid any existing post tension cables or reinforced steel. Advise the Structural Consultant of any conflicts as a result of the x-rays or GPR scans and obtain the Structural Consultant approval before any coring take place.

2.5 Access Doors

- .1 Drywall Surface: Extruded aluminum frame with gypsum board inlay and structural corner elements. Hinge to be concealed 2-point hinge, non-corroding with screwdriver operated cam latch.
- .2 Masonry Surface: Universal design, steel door (16ga) and steel frame (18ga), door flush to frame, rounded safety corners, continuous concealed hinge, screwdriver operated cam latch, prime coat grey painted finish.
- .3 Tile Surface: Universal design, stainless steel door (16ga) and stainless steel frame (18ga), door flush to frame, rounded safety corners, continuous concealed hinge, screwdriver operated cam latch, #4 satin stainless steel finish.
- .4 Plaster Walls and Ceiling: steel door (14ga) and steel frame (14ga), door flush to frame edge, expansion casing bead and 75 mm wide galvanized lath surround recessed 18 mm to receive plaster, continuous concealed hinge, screwdriver operated cam latch, prime coat grey painted finish.
- .5 Acoustic Plaster: Steel door (16ga) and steel frame (14ga), door recessed 12 mm lined with self-furring lath, 75 mm wide galvanized lath surround recessed 18 mm to receive plaster flush to frame edge, concealed pivoting rod type hinge, screwdriver operated cam latch, prime coat grey painted finish.
- .6 Acoustical Tile Ceilings: Steel door (16ga) and steel frame (14ga), door recessed 25 mm to receive acoustic tile, concealed pivoting rod type hinge, screwdriver operated cam latch, prime coat grey painted finish.
- .7 Fire Rated Walls:
 - .1 Non-combustible construction: Uninsulated steel door (16ga) and steel frame (16ga), door flush to frame edge, 25mm mounting frame with masonry anchor straps, concealed self-closing hinge, flush key latch, prime coat grey painted finish, ULC rated 2 hour 'B' label.

- .2 Combustible construction: Insulated steel door (20ga) for maximum 250°C rise after 30 minutes and steel frame (16ga), door flush to frame edge, 25mm mounting frame with masonry anchor straps, concealed self-closing hinge, flush key latch, prime coat grey painted finish, ULC rated 1-1/2 hour 'B' label.
- .8 Fire Rated Ceilings: 50mm Insulated steel door (16ga) and steel frame (16ga), door flush to frame edge, 25mm mounting frame with masonry anchor straps, concealed upswing self-closing hinge, L handle latch, white baked enamel finish, size 600mm x 600mm (24" x 24") ULC rated 2 hour 'B' label.
- .9 Ductwork: Ultra low leakage type, flat oval design, galvanized steel frame (22ga), double skin galvanized steel door (22 ga) with 25mm insulation fully enclosed in panel, bulb type seal integrally fastened to door, lever cam locks. Provide stainless steel in lieu of galvanized steel in stainless steel ductwork.

2.6 Electrical Motors

- .1 All Motors, 1 H.P. motors and larger, shall be energy efficient design and have a minimum and nominal full load efficiency, which will meet or exceed the values listed in accordance CAN/CSA C390-1. The minimum efficiency shall be guaranteed.
- .2 Belt Drives: Provide belt drives to the following requirements:
 - .1 Provide steel, cast iron or aluminum sheaves for motors less than 3/4 H.P.
 - .2 Provide steel or cast iron sheaves keyed to shafts, for motors 3/4 H.P. and larger.
 - .3 For motors less than 10 H.P. provide standard adjustable pitch drive sheaves having +/-10% range. Use mid-position of range for specified RPM.
 - .4 For motors 10 H.P. and larger, provide fixed pitch drive sheaves with split tapered bushing and keyway. Provide final drive sheaves of size to suit final balancing.
 - .5 Match drive and driven sheaves.
 - .6 V-belts shall conform to the American Belt Manufacturers standards. Multiple belts shall be matched sets.
 - .7 Not less than a 2-belt configuration is required for each drive for motors 3/4 H.P. and larger.
 - .8 Poly Chain GT belt drives shall be used on all motors 10HP and larger.
 - .9 Minimum drive rating shall be 150% of nameplate rating of motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
 - .10 Motor slide rail adjustment baseplate with double draw bolt, shall allow for centre line adjustment.
 - .11 Tension belts to manufacturers recommendations before start up and after 100 hours of operation using calibrated belt tensioning gauge.
 - .12 Provide one spare set of belts for each piece of equipment with each belt separately identified for the equipment item to be served.
- .3 Shaft Couplings: Shaft couplings shall be of the pin or jaw neoprene insert type, gear type, or flexing steel insert type and shall allow coupling inserts to be easily removed without disassembly of the equipment.
- .4 Guards:
 - .1 Provide removable protective guards on all exposed V-belt drives and shaft couplings in accordance with Worker's Compensation Board requirements.
 - .2 Guards for drives shall have:
 - .1 1 mm [18ga.] expanded metal screen welded to 25 mm [1"] steel angle frame.

- .2 1.5 mm [16ga.] thick galvanized sheet metal tops and bottoms.
- .3 Removable side[s] for servicing.
- .4 38 mm [1-1/2"] dia. holes on both shaft centres for insertion of tachometer.
- .5 Sectionalize if necessary so one man can handle removal.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Fabricate and install belt guards for V-belt drives to permit movement of motors for adjusting belt tension and for belt slap.
- .5 Provide removable "U" shaped guards for flexible couplings with 2.5 mm [12ga.] thick galvanized frame and 1.2 mm [18ga.] thick expanded mesh face.
- .6 Provide guards on all unprotected fan inlets and outlets. Guards to be provided by fan manufacturer.
- .7 Prime coat guards and finish paint to match equipment.
- .8 Secure guards to equipment allowing for ease of removal.

3. EXECUTION

3.1 Painting Repairs and Restoration

- .1 Do painting in accordance with Division 09 - Interior Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.
- .4 Clean exposed bare metal surfaces supplied under Divisions 21, 22, 23 and 25. Apply at least one coat of corrosion resistant primer paint to all supports and equipment fabricated from ferrous metal.
- .5 Paint all pipe hangers and exposed sleeves, in exposed areas, with a rust inhibiting primer.

3.2 System Cleaning

- .1 Clean interior and exterior of all systems including strainers. Commercially vacuum interior of ductwork and air handling units.

3.3 Field Quality Control

- .1 Manufacturer's Field Services:
 - .1 Obtain written reports from manufacturers' verifying compliance of the work, in handling, installing, applying, protecting, cleaning and start-up of a product.
 - .2 Submit Manufacturer's Field Reports as described in PART 1 - Submittals.
 - .3 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.4 Demonstration

- .1 Consultant and/or Departmental Representatives representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct the operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.

- .3 Where specified elsewhere in Division 21, 22, 23 or 25 manufacturers to provide demonstrations and instructions.
- .4 Use operation and maintenance manual, record drawings, and audio visual aids as part of instruction materials.
- .5 Instruction duration requirements shall be as specified in the appropriate sections.
- .6 Contractor will record these demonstrations on digital video for future reference.

3.5 Access Doors

- .1 Installation:
 - .1 Provide all access doors required to access work installed by Divisions 21, 22, 23 and 25. Be responsible for coordinating locations, cutting opening and installing panels. Any secondary supports, blocking etc. will be by the ceiling or wall contractor.
 - .2 Access doors in mechanical equipment to be provided by this Division.
 - .3 Access panel requirements and locations shall be fully coordinated with all involved contractors prior to the installation of any mechanical systems or equipment.
- .2 Location:
 - .1 Ensure that equipment is within view and accessible for operating, inspecting, adjusting, servicing without using special tools.
- .3 Provide 3 sets of each type of access door key to the Departmental Representative at substantial completion. Obtain a signed receipt indicating date, quantity of keys and person receiving keys. Submit receipt to the Departmental Representative's Consultant.

3.6 Electrical Motors

- .1 Manufacturer's instructions:
 - .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- .2 Installation:
 - .1 Unless otherwise noted starters and protection devices will be included under Division 26 - Electrical.
 - .2 Co-ordinate with Division 26 Contractor to ensure proper connection, correct thermal overload protection and correct motor controls.
 - .3 Where starters are included in this Division as an integral part of packaged equipment, they shall contain thermal overload protection in all ungrounded lines.
 - .4 Equipment, which has more than one voltage rating, shall be fed from a single power source through a disconnect switch.
 - .5 Fasten securely in place.
 - .6 Make removable for servicing, easily returned into, and positively in position.
- .3 Setting and Alignment:
 - .1 Employ a journeyman millwright to align all V-belt drives and/or shaft coupling drives. The millwright shall check that centrifugal fan wheels are properly centred on fan shafts.
 - .2 Align shaft couplings, using a dial indicator, to within +/-0.051 mm [0.002"] after grouting is complete and the piping system is operational.

- .3 Align V-belt drives using a straight edge.
- .4 Submit a certificate from the millwright employed, certifying that all shaft couplings and V-belt drives have been aligned and centrifugal fan wheels centred prior to initial start-up and checked again after final system balance adjustment.

3.7 Protection

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

1. GENERAL

1.1 Section Scope

- .1 Supply and installation of portable fire extinguishers, extinguisher cabinets, and accessories.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and shall be read, interpreted, and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical
- .3 Section 23 05 01 – Acceptable Manufacturers
- .4 Section 001545 - General and Fire Safety Requirements for CHORD Antenna Production Facility HVAC Construction

1.3 References

- .1 The latest revisions of the following standards shall apply unless noted otherwise.
- .2 Applicable Building and Fire Code - Refer to Section 21 05 01
- .3 American National Standards Institute (ANSI)
 - .1 ANSI/NFPA 10, Portable Fire Extinguishers.
- .4 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S503, Carbon Dioxide Fire Extinguishers
 - .2 CAN/ULC-S504, Dry Chemical Fire Extinguishers
 - .3 CAN/ULC-S507, Water Fire Extinguishers
 - .4 CAN/ULC S508, Rating and Fire Testing of Fire Extinguishers and Class "D" Extinguishing Media

1.4 Submittals

- .1 Comply with Division 1 – Submittal Procedures and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and in addition the following:
- .2 Product Data: Provide fire extinguisher operational features, colour, and finish, anchorage details.
- .3 Shop Drawings: Indicate cabinet physical dimensions, rough-in measurements for recessed cabinets, wall bracket mounting measurements, locations, and type. Indicate locations of all fire extinguishers on the Fire Suppression shop drawings.
- .4 Instructions: submit manufacturer's installation instructions.
- .5 Closeout submittals: submit test schedule and any refill, recharge and/or re-certification requirements for incorporation into manual specified in Section 21 05 01 – Common Work Results for Mechanical

1.5 General Requirements

- .1 Provide fire extinguishers in accordance with applicable Codes, the Authority having jurisdiction and at locations shown on drawings. Where drawing locations are not specifically shown, account for the number of fire extinguishers required by code, and indicate nominal locations on fire suppression shop drawings for review by the Architect.

- .2 Do not install fire extinguishers when ambient temperatures may cause freezing of extinguisher ingredients.
- .3 Provide hand portable fire extinguishers rated in accordance with CAN/ULC S508 and bearing ULC label

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 Refer to Section 23 05 01 – Acceptable Manufacturers

2.2 Portable Fire Extinguishers

- .1 Multi-Purpose Dry Chemical – Pressure Type Extinguisher:
 - .1 Description: Multipurpose stored pressure rechargeable fire extinguisher, squeeze grip positive on/off operation, heavy duty steel cylinder with gloss enamel finish, pull pin safety lock, forged valve, hose and nozzle, with universal wall mounting bracket.
 - .2 Capacity: 2.25 kg (5 lbs) OR 4.5 kg (10 lbs)
 - .3 ULC Rating: 3-A, 40-BC OR 4-A, 80-BC
 - .4 Classification: Class A, B, and C fires
- .2 Clean Agent Extinguisher
 - .1 Description: Stainless steel shell and non-magnetic valve, hose and nozzle. Easy grip handle with ring pin and retention chain. Extinguisher shell factory hydrostatically tested to 4130 kPa (600 psi), with universal wall mounting bracket.
 - .2 Zero ozone depletion potential
 - .3 Factory charged with FE-36 that is a colorless, odorless, electrically non-conductive, residue free, low toxicity agent.
 - .4 Capacity: 6 kg (13-1/4 lbs)
 - .5 ULC Rating: 2A, 10BC
 - .6 Classification: Class A, B, and C fires
- .3 Carbon Dioxide Extinguisher
 - .1 Description: Insulated handle, hose, and horn discharge assembly, self-closing lever or squeeze-grip operation, aluminum cylinder, with universal wall mounting bracket.
 - .2 Capacity: 4.5 kg (10 lbs) or 9 kg (20 lbs)
 - .3 ULC Rating: 10-BC
 - .4 Classification: Class B, and C fires
- .4 Pressurized Water Extinguisher
 - .1 Description: Stored pressurized water type, stainless steel cylinder, and base, chrome plated brass valve, rechargeable, squeeze-grip operated.
 - .2 Capacity: 9.4 L (2.5 gal)
 - .3 ULC Rating: 2-A
 - .4 Classification: Class A
- .5 Dry Powder Extinguisher:

- .1 Description: Dry powder stored pressure fire extinguisher, heavy duty plated brass valve, stainless steel handle and lever, extended applicator wand, FM Approved, heavy-duty steel cylinder and wall mounting bracket.
- .2 UL and FM Approved for Class D fires
- .3 Classification: Class D

2.3 Extinguisher Brackets

- .1 Type recommended by extinguisher manufacturer.

3. EXECUTION

3.1 Examination

- .1 Verify rough openings for cabinet are correctly sized and located.
- .2 Coordinate with the Architectural wall elevations and plans for specific locations.
- .3 Confirm suitability of final locations with the Authority having Jurisdiction prior to installation. Report any additional locations or conflicts immediately to the departmental representative's Consultant.

3.2 Installation

- .1 Provide five (5) additional fire extinguishers and cabinets, beyond the code minimum for Authority Having Jurisdiction requirements. These shall be mounted, where required, based on the post occupancy walk-through with the inspector at no additional cost to the Departmental Representative. Turn over unused fire extinguishers and cabinets to the Departmental Representative.
- .2 Provide surface mounted cabinets for fire extinguishers located in service areas only.
- .3 Coordinate locations of fire extinguisher cabinets with the framing trades in order to facilitate recessed and semi-recessed installations.
- .4 Mount fire extinguishers and cabinets such that the top of the extinguisher is at 1524 mm (5 feet) maximum above the floor.
- .5 Install fire extinguisher cabinet doors, glazing panels and fire extinguishers in the cabinets prior to the project substantial completion review by the departmental representative's Consultant.

3.3 Identification

- .1 Identify fire extinguishers in accordance with the recommendations of NFPA 10.
- .2 Attach a tag or label to all fire extinguishers, indicating the month and year of installation, with space for recording subsequent service dates.

END OF SECTION

1. GENERAL

1.1 Section Scope

- .1 This section provides a list of acceptable Manufacturers for this project.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical.

1.3 Submittals

- .1 Requests for alternate equivalent materials or equipment must be submitted to the Departmental Representative's Consultant no later than seven (7) working days prior to the Mechanical trades' closing tender date. Submit all applicable technical data, including performance curves and physical details for review. Approval of requests shall only be given by addendum.

1.4 General Requirements

- .1 The price submitted for this contract shall be based on the use of materials and equipment as specified or as contained within the Acceptable Manufacturers List.
- .2 Approved equivalents and/or alternatives to specified products shall be equal to the specified product in every respect, operate as intended, and meet the space, capacity, and noise requirements outlined.
- .3 The Contractor shall be fully responsible for any additional labour and materials required by any trades or other Contractors to accommodate the use of other than specified materials or equipment. The Contractor shall bear any and all costs for design/system modifications to accommodate the "alternate" equipment. Extras will not be approved to cover such work.

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 The following listed Manufacturers are acceptable for their ability to meet the general design intent, quality and performance characteristics of the specified product. The list does not endorse the acceptability of all products available from the listed Manufacturers/Suppliers.
- .2 It remains the responsibility of the Contractor to ensure the products supplied are equal to the specified products in every respect, operate as intended, and meet the performance specifications and physical dimensions of the specified product.
- .3 The contractor shall be fully responsible for any additional work or materials, to accommodate the use of equipment from the acceptable Manufacturers and Suppliers list.
- .4 Any manufacturers not included on the list of acceptable manufacturers must submit a formal request to be included on this list.
- .5 List of acceptable Manufacturers:

Type of Equipment	Approved Manufacturers
Plumbing & HVAC	
Access Doors - Drywall	Baucoplus
Access Doors - Wall	Maxam, Acudor, Milcor, Can.Aqua, Mifab, Bilco, Baucoplus, Elmdor
Actuators	Belimo,
Air Handling Units - Packaged	Carrier, Daikin, Dunham Bush, Engineered Air, Lennox, Trane, VTS America, York (Johnson Controls)
Air Terminals - Grilles, Registers, Diffusers	Anemostat, E.H. Price, Krueger, Nailor Industries, Tuttle & Bailey, Swegon, Titus, Trox, Primex, Zehnder
Balancing Agents (BC)	KD Engineering, MDT Systems, Western Mechanical Systems, Blue Collar Group, Flotech Mechanical, Raincity Technical Services, NovaGreen
Cleaning Agencies - Ductwork	Power Suction Services, Enviro-Vac Systems Inc., Clean Air Services Canada, AirCare
Commissioning Agents	AME Group, KD Engineering, Blue Collar Group, MDT Systems, Western Mechanical Services, Kane Consulting, Wyndham Commissioning (Vancouver Island), WSP, Zenith, Raincity Technical Services
Controls Contractors -	Reliable Controls approved vendors only
Dampers - Backdraft	Alumavent, E.H. Price, Penn, Pottorff, Ruskin, Tamco
Dampers - Balancing	Maxam, Ruskin
Dampers - Control	EH Price, Nailor Industries, Pottorff, Ruskin, Tamco
Dampers - Fire	Alumavent, EH Price, Maxam, Nailor Industries, Pottorff, Ruskin
Ductwork - Access Doors	Nailor Industries, Ortech, Ventlok
Ductwork - Concealed Regulator	Maxam, Pottorff, Ruskin, Young
Ductwork - Duct Connectors - Thermal Break	Ventifabrics "Ventlon"
Ductwork - Duct Connectors - Vibration	Duro Dyne "Durolon", Dynair "Hypalon", Ventifabrics "Ventlon"

Type of Equipment	Approved Manufacturers
Plumbing & HVAC	
Ductwork - Duct Sealer	Foster 32-14, Hardcast Versa Grip, Hardcast Foil Grip 1402, United Duct Sealer, Trans Continental Multi-Purpose
Fans – HVLS	Big Ass Fan, Envira-North, Canarm,
Filters - Air - Mechanical	AAF, Cambridge, Camfil, Flanders, Pacific, Viledon
Flexible Connectors - Ducting	Thermaflex, G.I. Industries Type IHP
Flexible Connectors - Piping	Flexonics, Tube Turn, Atlantic, Hyspan, Hydroflex, Metraflex, United Flexible, Mason, Techniquip, United Flexible, Triflex, Victaulic, Anvilstar, Unisource
Gas Monitoring Systems (CO, CO2, NO2, etc.)	ACME, Critical Environment Technologies, Honeywell, MSA, QEL, Opera/Belimo, Canadian Gas Service
Gauges - Air	Dwyer, Magnehelic
Gauges - Differential Pressure	Dwyer
Gauges - OWG Pressure	Trerice, Marsh, Ashcroft, Weiss, Moeller, Miljoco, Weksler, c
Insulation - Acoustic - Duct	Manson, Knauf, CertainTeed, Johns Manville, Owens Corning, Evonik
Insulation - Fabric Adhesive, Coatings	Robson, Bakor, Childers, Epolux, Foster
Insulation - PVC jacket	Knauf, Speedline, Proto, Zeston, Shur-Fit, Belform
Insulation - Thermal - Duct	CertainTeed, Manson, Knauf, Johns Manville, Owens Corning
Insulation - Vapour Barrier Jacket Adhesive	Bakor, Epolux, Nacan, Foster, Childers
Insulation – Vapour Barrier-Jacket	Knauf ASJ, Kingspan ASJ, Manson ASJ, Johns Manville AP-T Plus, Owens Corning ASJ, Roxul ASJ, VentureWrap 1555U.
Pipe and Valve Identification	Seton, Brady, Incom
Pipe Restraints	Trelleborg
Piping - Insulation Shields	Klo-Shure
Piping Hangers and Saddles	Anvil, Myatt, Taylor Walraven
Test Plugs – Pressure / Temperature	Flow Design Superseal, Miljoco P/T Plugs, Sisco P/T Plugs

Type of Equipment	Approved Manufacturers	
Plumbing & HVAC		
Valves – Ball	Apollo, Crane/Jenkins, KVC, Gruvlok, Kitz, NCI Canada, Nexus Valve, Red&White, Victaulic, Watts	
Valves – Gate	Bonney Forge, Crane, Hattersley, Kitz, NCI Canada, Nibco, Red-White/Toyo	
Valves – Globe	Bonney Forge, Crane, Hattersley, Kitz, NCI Canada, Nibco, Red-White/Toyo	
Valves – Pressure Reducing	Watts, Armstrong, Bell & Gossett, Taco, Crosby, Sarco, Clayton, Singer, Zurn, Wilkins, BCA, Cash Acme, Braukman, Bermad/Victaulic	
Valves – Seismic	Koso, Pacific Seismic Products	
Variable Frequency / Speed Drives	ABB, Allen-Bradley, Baldor, Danfoss, Eaton, Hitachi, Siemens, Teco-Westinghouse, Toshiba, WEG, Yaskawa	
Vibration – Neoprene Pad	Mason, Korfund, Vibro-Acoustics	
Vibration – Neoprene Washer Bushing	Mason, Korfund, Vibro-Acoustics	
Vibration – Rubber Floor Mounts	Mason, Korfund, Vibro-Acoustics	
Vibration – Seismic Snubbers	Mason, Korfund, Vibro-Acoustics	
Vibration – Spring Floor Mounts	Mason, Korfund, Vibro-Acoustics	
Vibration – Spring Hangers	Mason, Korfund, Vibro-Acoustics	
Type of Equipment	Approved Manufacturers	Notes
Fire Suppression Systems		
Fire Extinguishers and Cabinets	National Fire Equipment, Wilson & Cousins, Guardian, Ansul	

3. EXECUTION

3.1 Post Tender Submission Requirement

- .1 Submit within 14 days of contract award a copy of the list underlining the name of the Manufacturer whose price was carried in the tender. If no Manufacturer's names are submitted, it will be assumed that the price carried in the tender was that of the specified Manufacturer or where the specified product is generic, the first acceptable Manufacturer listed for each item and equipment.

END OF SECTION

1. GENERAL

1.1 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical.
- .3 Section 23 05 48 - Vibration and Seismic Control for Mechanical.
- .4 Section 23 11 23 – Facility Natural Gas Piping.

1.2 References

- .1 The latest revisions of the following standards shall apply unless noted otherwise.
 - .1 Applicable Building Code - Refer to Section 21 05 01
 - .2 Applicable Fire Code - Refer to Section 21 05 01
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-[99], Ready-Mixed Organic Zinc-Rich Coating.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA B139-[15], Installation Code for Oil Burning Equipment.
 - .2 CAN/CSA B149.1-[15], Natural Gas and Propane Installation Code
 - .3 CAN/CSA B149.2-[15], Propane Storage and Handling Code
- .4 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-11-[2015, Edition 3.2], Green Seal Standard for Paints, Coatings, Stains, and Sealers.
- .5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-[A2016], Architectural Coatings.
 - .2 SCAQMD Rule 1168-[A2017], Adhesive and Sealant Applications.

1.3 Submittals

- .1 Comply with Division 01 – Submittal Procedures and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and in addition the following:
- .2 Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 Delivery, Storage and Handling

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

2. PRODUCTS

2.1 Material

- .1 Paint: zinc-rich to CAN/CGSB-1.181.
 - .1 Paints in accordance with manufacturer's recommendations for surface conditions.
 - .2 Primer: maximum VOC limit [250] g/L to Standard GS-11.
 - .3 Paints: maximum VOC limit [150] g/L to Standard GS-11.
- .2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .1 Sealants: maximum VOC limit to SCAQMD Rule 1168.
- .3 Sealants: maximum VOC limit to SCAQMD Rule 1168.
- .4 Adhesives: maximum VOC limit to SCAQMD Rule 1168.

3. EXECUTION

3.1 Application

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 Connections to Equipment

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Provide line sized isolation valves at each piece of equipment.
- .3 Install unions or flanges downstream of isolation valves and at equipment or apparatus connection for ease of maintenance and assembly. Do not use direct welded or threaded connections to valves, equipment, or other apparatus.
 - .1 Unions are not required in installations using grooved mechanical couplings (The couplings shall serve as unions).
- .4 Install removable sections of pipe or 300 mm (12") spool pieces on the suction side of end suction pumps and where required for ease of maintenance.
- .5 Arrange piping connections to allow ease of access and for removal of equipment.
- .6 Align and independently support piping connections adjacent to equipment to prevent piping stresses being transferred.
- .7 Do not reduce equipment connection sizes by bushing.
- .8 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.
- .9 The flexible type grooved joint couplings may be used in lieu of a flexible connector at equipment connections for vibration attenuation and stress relief. Couplings shall be placed in close proximity to the source of the vibration, as per manufacturer's recommendations.

3.3 Clearances

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and CSA B139. Maintain a minimum of 25 mm (1") space between adjacent flanges or pipe insulation, whichever has the larger diameter.

- .2 Provide space for disassembly, removal of equipment and components as CSA B139 or as indicated whichever is greater without interrupting operation of other system, equipment, components.
- .3 Provide adequate clearance for installation of insulation.

3.4 Dielectric Couplings

- .1 General: Compatible with system, to suit pressure rating of system.
- .2 Locations: Where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: Isolating flanges.
- .5 Dielectric waterway fittings may be used in lieu of unions or flanged connections. Waterways shall be grooved and/or threaded end(s), with inert thermoplastic lining.

3.5 Pipework Installation

- .1 Install pipework to CSA B139.
- .2 Installation by certified journey person.
- .3 Screwed fittings jointed with Teflon tape or pipe dope as recommended by manufacturer.
- .4 Grooved joint couplings and fittings shall be installed in accordance with the manufacturer's written installation instructions.
 - .1 Grooved ends shall be clean and free from indentations, projections, or roll marks.
 - .2 Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer.
 - .3 The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed and report their findings to the Consultant. A distributor's representative is not considered qualified to conduct the training or jobsite visit(s). Contractor shall remove and replace any joints deemed improperly installed.
- .5 During construction, protect all openings in piping and equipment, by capping or plugging to prevent entry of foreign material.
- .6 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .7 Assemble piping using fittings manufactured to ANSI standards.
- .8 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .9 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .10 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .11 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .12 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .13 Group piping wherever possible and as indicated.

- .14 Ream pipe ends. Clean scale and dirt, inside and outside before and after assembly. Remove welding slag or other foreign material from piping.
- .15 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .16 Provide for thermal expansion as indicated.
 - .1 Engage the grooved piping products manufacturer to provide piping system design services to accommodate thermal movement, seismic movement, and for the settlement of the piping system. The service includes required grooved piping components detailed in CAD on an overlay of the mechanical contract drawing(s), including anchor load calculations and placement of anchors. A calculation report showing thermal movement and accommodation shall also be provided. A design stamped by a qualified professional engineer from the jurisdiction in which the grooved piping products manufacturer is located or where the project is being constructed is required. Include cost in the tender price.
- .17 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless otherwise indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use ball valves at branch take-offs for isolating purposes except where otherwise specified.
 - .7 Install butterfly valves on chilled water and related condenser water systems only.
 - .8 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .9 Install plug cocks or ball valves for glycol service.
 - .10 Use chain operators on valves NPS 2-1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .18 At each seismic joint or seismic separation, provide flexible connections along with support of these systems on each side of the seismic joint or separation. Refer to this Section and Section 23 05 16 Vibration and Seismic Control for Mechanical.

3.6 Sleeves

- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
- .2 Material: Schedule 40 black steel pipe.
- .3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation for insulated pipe.
- .5 Installation:
 - .1 Concrete, masonry walls, and concrete floors on grade: Terminate flush with finished surface.
 - .2 Other floors: Terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:

- .1 Foundation walls and below grade floors: Fire retardant, waterproof non-hardening mastic.
- .2 Elsewhere: Provide space for fire stopping. Maintain fire rating integrity.
- .3 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.
- .4 Ensure no contact between copper pipe or tube and sleeve.

3.7 Escutcheons

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
- .2 Construction: One piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.
- .3 Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.

3.8 Flushing Out of Piping Systems

- .1 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 00 - Cleaning supplemented as specified in Section 23 25 00 HVAC Water Treatment.
- .2 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.9 Pressure Testing of Equipment and Pipework

- .1 Advise Consultant or project manager 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: Test as specified in relevant sections of Divisions 21, 22 & 23.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of construction manager or project manager.
- .6 Pay costs for repairs or replacement, retesting, and making good. Consultant to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by authorities.

3.10 Existing Systems

- .1 Connect into existing piping systems at times approved by Departmental Representative.
- .2 Request written approval by Departmental Representative 10 days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.

3.11 Cleaning

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 Section Scope

- .1 Materials and installation for hangers and supports for mechanical and plumbing piping, ducting and equipment.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical
- .3 Section 23 05 16 – Expansion Fittings and Loops for Mechanical Piping
- .4 Section 23 05 48 – Vibration and Seismic Control for Mechanical.

1.3 References

- .1 The latest revisions of the following standards shall apply unless noted otherwise.
- .2 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1 – Power Piping.
- .3 ASTM International
 - .1 ASTM A125 – Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307 – Standard Specification for Carbon Steel Bolts, Studs and Threaded Rod, 60,000 PSI Tensile Strength.
 - .3 ASTM A563 – Standard Specification for Carbon and Alloy Steel Nuts.
 - .4 ASTM F2536 – Standard Guide for Installing Plastic DWV Piping From Slab On Grade.
- .4 [Factory Mutual (FM)]
- .5 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP-58 – Pipe Hangers and Supports - Materials, Design and Manufacture.
- .6 Underwriter's Laboratories of Canada (ULC)
- .7 Canadian Standards Association
 - .1 CSA B149.1 – Natural Gas and Propane Code
- .8 Cast Iron Soil Pipe Institute
 - .1 CISPI Designation 301-18 - Standard Specification For Hubless Cast Iron Soil Pipe And Fittings For Sanitary And Storm Drain, Waste, And Vent Piping Applications.
 - .2 CISPI Designation 310-20 - Specification For Coupling For Use In Connection With Hubless Cast Iron Soil Pipe And Fittings For Sanitary And Storm Drain, Waste, And Vent Piping Applications.
- .9 National Fire Protection Association:
 - .1 NFPA 13 – Standard for the Installation of Sprinkler Systems
 - .2 NFPA 14 – Standard for the Installation of Standpipe and Hose Systems

1.4 Submittals

- .1 Comply with Division 01 – Submittal Procedures and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and additionally the following:
 - .1 Submit shop drawings for:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.
 - .2 Certificates:
 - .1 Submit certificates from the manufacturer certifying that materials comply with specified performance characteristics and physical properties of the listed Related Standards.
 - .3 Manufacturers' Instructions:
 - .1 Provide manufacturer's installation instructions.

1.5 General Requirements

- .1 Natural gas/propane piping: to CSA B149.1 Natural Gas and Propane Code
- .2 Fuel oil piping: to CSA B139 Installation Code for Fuel Burning Appliances.
- .3 Construct pipe hangers and supports to manufacturer's recommendations utilizing manufacturer's regular production components, parts, and assemblies.
- .4 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP-58.
- .5 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
- .6 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- .7 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.
- .8 Provide hangers and supports to secure equipment in place, prevent vibration, protect against damage from earthquake, maintain grade, provide for expansion and contraction, and accommodate insulation.
- .9 Support from (top of) structural members. Where structural bearings do not exist or inserts are not in suitable locations, suspend hangers from steel channels or angles. Provide supplementary structural members, as necessary.
- .10 Arrange and pay for the services of a professional engineer registered in the applicable jurisdiction to provide all required engineering services necessary for the complete design, sizing and detailing of all anchors and anchor supports to structure required for the project.

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 Refer to Section 23 05 01 – Acceptable Manufacturers

2.2 General

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP-58.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.
- .3 Toggle hangers and/or strap hangers shall not be used.
- .4 Power actuated fasteners and “drop-in” anchors shall not be used for tension load applications such as pipe and duct hangers.
- .5 Hangers and supports and installation method for fire suppression systems shall be capable of supporting five times the weight of the water filled pipe plus 114 kg (250 pounds) at each point of piping support. Components of hanger assemblies that directly attach to the pipe or to the building structure shall be listed.

2.3 Pipe Hangers

- .1 Finishes:
 - .1 Interior pipe hangers and supports: galvanized unless noted otherwise. (Refer to 1.5.5 in General Requirements above.)
 - .2 Ensure steel hangers in contact with copper piping are copper plated, epoxy coated or have a non-metallic sleeve coupling between the dissimilar metals.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut, and carbon steel retaining clip.
 - .2 Cold piping NPS 2½ or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed, FM approved to MSS-SP58.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed, FM approved.
 - .2 Cold piping NPS 2 ½ or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed, FM approved.
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm (¼”) minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed, FM approved. Size inserts to suit threaded hanger rod diameter. Refer to “minimum rod diameter” table below.
- .5 Shop and field-fabricated assemblies:
 - .1 Trapeze hanger assemblies and steel brackets: to ASME B31.1 and MSS SP58.
 - .2 Sway braces for seismic restraint systems: to Section 23 05 48 - Vibration and Seismic Control for Mechanical.

- .6 Hanger rods: threaded rod material to MSS SP-58:
- .1 For fire suppression systems the hanger rod size shall be the same as that approved for use with the hanger assembly and the size of the rods shall be not less than:

Maximum Pipe Size NPS	Minimum Rod Diameter mm (in)
up to and including 4"	9 (3/8)
6" and 8"	12 (1/2)
10" and 12"	16 (5/8)

- .2 For plumbing systems as defined by plumbing codes, metal hanger rods supporting nominally horizontal piping systems located inside a building, the rod diameter shall not be less than:
- .1 For 2" pipe or less: 6mm (1/4")
- .2 For 2-1/2:" to 4" pipe: 8mm (3/8")
- .3 Over 4" pipe: 13mm (1/2")
- .3 Ensure that hanger rods are subject to tensile loading only.
- .4 Provide linkages where lateral or axial movement of pipework is anticipated.
- .5 The following table shall be used for HVAC piping systems:

Maximum Pipe Size NPS	Minimum Rod Diameter mm (in)	Maximum Rod Length mm (in)
up to 2	9 (3/8)	n/a
2-1/2 to 3	12 (1/2)	635 (25)
4 to 5	16 (5/8)	785 (31)
6	20 (3/4)	940 (37)
8 to 12	22 (7/8)	1090 (43)
14	25 (1)	1270 (50)
16	30 (1-1/4)	1575 (62)

- .6 Provide reinforcing hanger angle for rod lengths in excess of maximum length as scheduled by the Seismic Engineer. Refer to Section 23 05 48 – Vibration and Seismic Control for Mechanical.
- .7 Pipe attachments: material to MSS SP-58:
- .1 Attachments for steel piping: carbon steel galvanized.
- .2 Attachments for copper piping: copper plated black steel.
- .3 Use insulation shields for cold pipework.
- .4 Oversize pipe hangers and supports to accommodate insulation thickness and maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
- .8 Adjustable clevis: material UL listed and FM approved, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
- .9 Yoke style pipe roll: carbon steel yoke, rod, and nuts with cast iron roll.
- .10 U-bolts: carbon steel with 2 nuts at each end to ASTM A563.

- .1 Finishes for steel pipework: galvanized.
- .2 Finishes for copper, glass, brass, or aluminum pipework: galvanized with formed portion plastic coated or epoxy coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod.
- .12 No-Hub Cast Iron Soil Pipe Fitting Restraints:
 - .1 CISPI Designation 301-18 and 310-20, large-diameter no-hub cast iron fittings, over 100 mm (4") in size, shall be provided with supplemental support to minimize the risk of joint separation under high-thrust conditions. Auxiliary restraint products used shall be manufactured assemblies with thrust pressure rating adequate for the specific installation. Field-devised methods and materials shall not be used to accomplish this application solution.

2.4 Riser Clamps

- .1 Steel or cast-iron pipe: galvanized carbon steel to MSS SP58, type 42, UL listed, FM approved.
- .2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

2.5 Insulation Protection Shields

- .1 Insulated cold piping:
 - .1 64 kg/m³ (4 lb./ft³) density insulation plus insulation protection shield, galvanized sheet carbon steel. Length designed for maximum 3 m (10 foot) span.
 - .2 Non-metallic support coupling, sized to suit standard and millimeter pipe O.D. UL listed, meeting 25/50 flame and smoke spread ratings. Supplied with hanger and/or strut mount as a complete support assembly.
- .2 Insulated hot piping:
 - .1 Curved plate 300 mm (12 inch) long, with edges turned up, welded-in centre plate for pipe sizes NPS 300 mm (12 inch) and over.
 - .2 For piping to 60°C (140°F) Non-metallic support coupling, sized to suit standard and millimeter pipe O.D. UL listed, meeting 25/50 flame and smoke spread ratings. Supplied with hanger and/or strut mount as a complete support assembly.

2.6 Equipment Supports

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Division 5. Submit calculations with shop drawings.

2.7 Equipment Anchor Bolts and Templates

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

2.8 Other Equipment Supports

- .1 Fabricate equipment supports from structural grade steel meeting requirements of Division 5.
- .2 Submit structural calculations with shop drawings.

3. EXECUTION

3.1 Manufacturer's Instructions

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 Installation

- .1 Install in accordance with manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.
- .3 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to industry standards.
 - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: install below joint.
- .4 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
 - .1 Vertical movement of pipework is 13 mm ($\frac{1}{2}$ " or more,
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 Variation in supporting effect does not exceed 25 % of total load.
- .8 No-hub pipe and fitting coupling joints over 100 mm (4") in size shall receive auxiliary support by means of appropriate bracing materials, per U.S. soil pipe and fitting manufacturers' installation instructions, CISPI Designation 301-18 and 310-20, and CISPI Cast Iron Soil Pipe and Fittings Handbook. Auxiliary restraint products used shall be manufactured assemblies with thrust pressure rating adequate for the specific installation and shall be installed onto horizontal joints over 100 mm (4") in size. Field-devised methods and materials shall not be used to accomplish this application solution.

3.3 Hanger Spacing

- .1 Maximum horizontal spacing of supports and additional support conditions for piping used for plumbing systems, as defined by plumbing codes, shall be compliant with the requirements of the applicable plumbing code for the pipe materials being installed for the piping systems.
- .2 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
- .3 Within 300 mm (12") of each elbow.

Maximum Pipe Size NPS	Maximum Spacing Steel m (ft)	Maximum Spacing Copper m (ft)	Minimum Rod Dia mm (in)
up to 1/2	1.8 (6)	1.5 (5)	9 (3/8)
3/4, 1, 1-1/4	2.4 (8)	1.8 (6)	9 (3/8)
1-1/2, 2	3.0 (10)	2.4 (8)	9 (3/8)
2-1/2, 3, 4	3.7 (12)	3.0 (10)	12 (1/2)
5, 6, 8	4.3 (14)		16 (5/8)
10, 12	4.9 (16)		

- .4 Install PEX-a pipe support vertically or horizontally for plenum and non-plenum applications or support PEX pipe at 900 mm (36") intervals with manufactured hanger fittings regardless of size. PEX installed with PEX-a pipe support shall follow the manufacturers pipe support recommendations for hanger spacing
- .5 For other plastic piping, provide supports at intervals recommended by manufacturer.

3.4 Hanger Installation

- .1 Hanger installation for fire suppression piping systems shall be compliant with the requirements of the applicable NFPA standard.
- .2 Install hanger so that rod is vertical under operating conditions.
- .3 Adjust hangers to equalize load.
- .4 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.
- .5 Do not support from metal deck.
- .6 Install hangers to provide minimum 13 mm (1/2") space between finished covering and adjacent work.
- .7 Support vertical piping at every other floor.
- .8 Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers.
- .9 Support riser piping independently of connected horizontal piping.
- .10 Install plastic inserts between steel studs and piping.
- .11 Provide insulation protection saddles on all insulated piping.

3.5 Horizontal Movement

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.
- .2 Where horizontal pipe movement is less than 13 mm (1/2"), offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 Final Adjustment

- .1 Adjust hangers and supports:
 - .1 Ensure that rod is vertical under operating conditions.
 - .2 Equalize loads.
- .2 Adjustable clevis:
 - .1 Tighten hanger load nut securely to ensure proper hanger performance.

- .2 Tighten upper nut after adjustment.
- .3 C-clamps:
 - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
 - .1 Hammer jaw firmly against underside of beam.

3.7 Inserts

- .1 Install in accordance with manufacturer's recommendations.
- .2 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practical.
- .3 Set inserts in position in advance of concrete work. Use grid system in equipment rooms.
- .4 Provide reinforcement rod in concrete for inserts carrying piping over 100 mm (4") or ducts over 1500 mm (60") wide.
- .5 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

END OF SECTION

1. GENERAL

1.1 Section Scope

- .1 The work in this section includes, but is not limited to the following:
 - .1 Vibration isolation for piping, ductwork, and equipment.
 - .2 Equipment isolation bases.
 - .3 Flexible piping connections.
 - .4 Seismic restraints for isolated equipment.
 - .5 Seismic restraints for non-isolated equipment.
 - .6 Certification of seismic restraint designs and installation supervision.
 - .7 Certification of seismic attachment of housekeeping pads.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical.
- .3 Section 23 21 16 – Hydronic Piping Specialties.
- .4 Section 23 33 00 - Duct Accessories.

1.3 References

- .1 The latest revisions of the following standards shall apply unless noted otherwise.
- .2 Applicable Building Code: Refer to Section 21 05 01 – Common Work Results for Mechanical.
- .3 National Fire Protection Association (NFPA):
 - .1 NFPA 13-[2013] – Standard for the Installation of Sprinkler Systems.
- .4 Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
 - .1 SMACNA – Seismic Restraint Manual Guidelines for Mechanical Systems.
- .5 American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE):
 - .1 ASHRAE HVAC Applications Handbook (Seismic Design Chapter 54).
- .6 Federal Emergency Management Agency (FEMA):
 - .1 FEMA – Installing Seismic Restraints for Mechanical Equipment.
- .7 Vibration Isolation and Seismic Control Manufacturers Association (VISCMA):
 - .1 VISCMA – Installing Seismic Restraints for Mechanical Equipment.

1.4 Submittals

- .1 Comply with Division 01 – Submittal Procedures and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and additionally the following:
 - .1 Consultant Assurance of Professional Design and Commitment for Field Review by Supporting Registered Professional Schedule S-B and Assurance of Professional Field Review and Compliance by Supporting Registered Professional Schedule S-C for seismic engineering.

- .2 Shop drawings: submit drawings for vibration control stamped and signed by a Professional Engineer.
- .3 Shop drawings: submit drawings for seismic control stamped and signed by a Professional Engineer registered or licensed in Province of British Columbia.
- .4 Provide separate shop drawings for each isolated system complete with performance and product data.

1.5 General Requirements

- .1 All mechanical equipment, piping, and ductwork as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent 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.
- .2 Provide seismic restraints for all required equipment, piping, and ductwork.
- .3 Responsibilities:
 - .1 The Contractor shall retain the services of a qualified professional seismic engineer (Seismic Engineer) registered in the Province of British Columbia. The Seismic Engineer shall design and review the installation of all seismic restraints as well as mechanical equipment and mechanical system supports. The restraints and supports shall be specifically designed to fasten to the structure indicated in the contract documents and installed in the field. The complete design for these systems shall comply with all applicable building code requirements.
 - .2 Seismic Engineer shall provide and submit to the Departmental Representative's Consultant Assurance of Professional Design and Commitment for Field Review by Supporting Registered Professional Schedule S-B and Assurance of Professional Field Review and Compliance by Supporting Registered Professional Schedule S-C for seismic engineering.
 - .3 Manufacturer of vibration isolation and seismic control equipment shall have the following responsibilities:
 - .1 Determine vibration isolation and seismic restraint sizes and locations.
 - .2 Provide vibration isolation and seismic restraints as scheduled or specified.
 - .3 Provide calculations and materials if required for restraint of non-isolated equipment.
 - .4 Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.
- .4 All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.
- .5 It is the intent of the seismic portion of this specification to keep all mechanical and electrical building system components in place during a seismic event.
- .6 All such systems must be installed in strict accordance with seismic codes, component manufacturer's, and building construction standards. Whenever a conflict occurs between the standards, the most stringent shall apply.
- .7 Seismic restraints shall be designed in accordance with seismic force levels as indicated in the Building Code for the specific region of the project.
- .8 All elastomeric components in isolation pads, mounts, and seismic snubbers shall be bridge bearing neoprene, meeting CSA Standard CAN3-S6 Section 11.10.

- .9 Provide an acceptable means of corrosion protection for all equipment, attachments, and accessories supplied under this section, suitable for the conditions in which this equipment, etc. will be installed.
- .10 Bolt all equipment to the structure. Do not bridge isolation elements.
- .11 Use ductile materials in all vibration isolation equipment.
- .12 Motor Drive Equipment:
 - .1 Provide vibration isolation on all motor driven fans regardless of power rating and all other motor driven equipment over 0.35 kW (0.5 HP) (as indicated on the motor nameplate), and on piping and ductwork specified herein.
 - .2 For fans less than 0.35 kW (0.5 HP), provide isolation with neoprene grommets at the support points. Select isolators for a minimum static deflection of 3mm.
 - .3 Fire pumps and jockey pumps driven by electric motors are excluded.
 - .4 Provide horizontal limit springs on all fans (except vertical discharge) having a static pressure in excess of 1.0 kPa static pressure, and on hanger supported, horizontally mounted axial fans with more than 330 N thrust due to static pressure. The springs shall limit the movement of flexible duct connections to 25% of the fabric width under steady state conditions and to 40% at start-up.
- .13 Isolators:
 - .1 Provide neoprene isolators for deflections 6mm ($\frac{1}{4}$ ") and under.
 - .2 Provide either neoprene or steel spring isolators for deflections between 6mm and 12mm ($\frac{1}{2}$ ").
 - .3 Provide steel spring isolators for deflections of 12mm ($\frac{1}{2}$ ") and over.
 - .4 Provide adjustable limit stops for spring isolation mounts on equipment with operating weights substantially different from the installed weights.
 - .5 All spring isolators shall be "open spring" unless otherwise stated. Seismically rated housed spring isolators may be used in lieu provided that they meet this project's requirements for seismic restraint.
 - .6 Isolators and bases which are factory supplied with equipment shall meet the requirements of this section. Where internal isolation is provided, the isolation requirements specified in the minimum static deflection table apply to all separate vibration sources in the unit. Where internal vibration isolation is not provided, the unit frame shall be rigid enough such that the isolators can be attached directly without additional stiffening.
 - .7 Space isolators under equipment so that the minimum distance between adjacent corner isolators is at least equal to the height of the center of gravity of the equipment. Include height of center of gravity on shop drawings. Otherwise, provide suitable horizontal restraint isolators.
 - .8 Select isolators in accordance with equipment weight distribution to allow for an average deflection meeting or exceeding the specified deflection requirements and so that no isolator has a deflection less than 80% of the static deflection specified. A minimum of 4 isolators are required for each piece of equipment, unless specified otherwise. Number and colour code each isolator to show location. Mark code number and colour on shop drawings, on each isolator and on each base to ensure proper placement. Clearly tag all springs to show undeflected height and static deflection.
 - .9 Refer to the minimum static deflection table contained in this Section.
- .14 Bases:

- .1 Provide all concrete inertia bases where specified or required by equipment manufacturers. Bases to be located between the vibrating equipment and the vibration isolation elements. Provide concrete inertia bases for centrifugal fans with static pressure in excess of 0.875 kPa (3.5" SWG) and/or motors in excess of 30 kW (40 HP) and on base mounted pumps over 15 kW (20 HP), except slab on grade installations or unless otherwise specified. Provide concrete inertia bases on all plug fans that also require thrust restraints.
 - .2 Other than equipment requiring concrete inertia bases, provide structural steel bases for all vibration isolated equipment, unless the equipment manufacturer certifies direct attachment capabilities.
 - .3 Co-ordinate with Division 03 for the provision of housekeeping pads at least 100 mm (4") high under all isolated equipment. Provide at least 175 mm (7") clearance between drilled inserts and edge of housekeeping pads and follow structural consultant's instructions for drilled inserts.
- .15 Ducting:
- .1 Install flexible duct connectors on all ductwork connected to isolated equipment.
- .16 Piping Hangers:
- .1 Provide resilient hangers on all piping, etc., rigidly connected to vibration isolated equipment. Provide the hangers for a distance of 3.0m (9.75') for a 1 NPS pipe and 13.5m (44') for a 10 NPS pipe. Isolate other pipe sizes for a proportionate distance (both interpolation and extrapolation may be required). Select the three closest hangers to the vibration source for the lesser of 25mm (1") static deflection or the static deflection of the isolated equipment. Select the remaining isolators for the lesser of 25mm (1") static deflection or one-half the static deflection of the isolated equipment.
 - .2 Where resilient hangers cannot be provided for piping rigidly connected to vibration isolated equipment (such as a rigid fire-stop falling within the required isolation distance), provide flexible connectors. One end of each flexible connector shall be installed directly to a flange of the isolated equipment (between the equipment and isolation valves) unless otherwise indicated on the drawings.
- .17 Electrical Connections:
- .1 Coordinate with the Division 26 to ensure all electrical connections to vibration isolated equipment is made with flexible conduit or other flexible means and does not restrict the maximum anticipated movement.

1.6 Regulatory Requirements

- .1 Tested values must show that the seismic restraint hardware used in conjunction with the vibration isolation product is capable of withstanding the increased forces, as calculated for the specific project, using the formulae provided in the applicable building code.
- .2 Supply isolators and seismic restraints meeting the structural requirements of the building code, including Section 4.1.8.18 with respect to seismic snubbers, or provide equivalent requirements where integral seismic restraint is provided in isolators / bolting.
- .3 Include building code Section 6.2.1.6(2). Vibration isolator housings are considered a safety guard with respect to isolated equipment and any contained compressed springs. Include "Fail Safe" seismic restraint in all vibration isolation designed to hold mechanical equipment and springs in place.

2. PRODUCTS

2.1 General

- .1 Isolation, anchors, bolts, bases, restraints, etc., are to be designed to withstand without failure or yielding, the dynamic G load as specified in Code for the seismic zone in which building is located. Design loads are ultimate limit state loads (1.5 times working load) acting through the centre of gravity of the anchored or restrained equipment. "Fail Safe" designs are acceptable.
- .2 For both isolated and non-isolated floor mounted equipment, i.e. tanks, heat exchangers, boilers, etc., design and provide anchors and bolts to withstand, without failure or yielding, a dynamic ultimate limit state load as defined in Code, of the greater of 0.3 g or as required by Code, applied horizontally through the centre of gravity.
- .3 Where impact forces may be significant, use ductile materials.
- .4 Seismic restraining devices factory supplied with equipment are to meet requirements of this Section.

2.2 Acceptable Manufacturers

- .1 Refer to Section 23 05 01 – Acceptable Manufacturers.

2.3 Open Spring Mounts

- .1 Base mount free-standing assemblies, each complete with a stable colour coded steel spring welded in place, drilled mild steel mounting plate bonded to a ribbed rubber or neoprene acoustical pad, and an external 16 mm (5/8") diameter level adjustment bolt.

2.4 Closed Spring Mounts

- .1 Base mount free-standing enclosed assemblies, each complete with stable colour coded spring(s), 2 piece cast housing, non-binding rubber horizontal stabilizers, a ribbed rubber or neoprene acoustical pad bonded to base of the closed housing, and an external level adjustment bolt.

2.5 Totally Retained Spring Mounts

- .1 Base mount free-standing enclosed and retained assemblies to limit both vertical and lateral movement of mounted equipment, each complete with stable colour coded spring(s), drilled welded steel housing and top plate, ribbed rubber or neoprene acoustical pad bonded to bottom of housing, vertical limit adjusting hardware, and a level adjustment bolt.

2.6 Type 1 - Neoprene Pad Isolators

- .1 Neoprene or neoprene / steel / neoprene pad isolators.
- .2 Minimum static deflection 2.5 mm (0.1") or greater.
- .3 Use hold down bolts selected for seismic loads. Isolate bolts from base of unit using neoprene washer/bushing.
- .4 Size bolt and washer/bushing for minimum lateral clearance.

2.7 Type 2 - Rubber Floor Mounts

- .1 Bridge bearing neoprene mountings.
- .2 Minimum static deflection of 5mm (0.2") or greater and all directional seismic capability.

- .3 The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge bearing specifications.

2.8 Type 3 - Spring Floor Mounts

- .1 Spring isolators shall be free standing, laterally stable and supplied complete with a lower molded neoprene acoustical cup or $\frac{1}{4}$ " (6mm) neoprene acoustical friction pad between the baseplate and the support.
- .2 All mountings shall have a leveling bolt that allows for rigid attachment to the equipment.
- .3 Spring diameters shall be no less than 0.8 of compressed height at rated load and have an additional travel to solid equal to 50% of rated deflection.
- .4 Nominal static deflection shall be 25 mm. No spring shall be loaded to less than 70% of its rated capacity nor exceed manufactures capacity.
- .5 Open springs may be used in conjunction with Type 5 or 5PD seismic snubbers or housed in a seismically rated housing. Where spring is housed to meet seismic requirements, the housing shall be of ductile iron or steel construction and allow for all directional seismic snubbing. The snubber shall be vertically adjustable and designed for a maximum of 6.4 mm travel in all directions. Potential impact areas to be protected by a minimum of a 3.2 mm neoprene bushing. Submittals to include spring diameter, rated deflection, spring constant, and free and operating height.

2.9 Type 4 - Restrained Air Springs

- .1 Restrained air springs shall have upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene element within a rigid housing that includes vertical limit stops to prevent air spring extension when weight is removed.
- .2 Air spring configuration shall be multiple bellows.
- .3 Natural frequency at 690 kPa shall be 1.5 Hz.
- .4 Air inlet to the air spring assembly shall be from the side. Designed to operate at maximum air pressure of 690kPa [100psig]. All air spring systems shall be interconnected and supplied with either the building control air or a supplementary air supply. The air spring system shall be supplied complete with three leveling valves to maintain leveling within plus or minus 3mm ($\frac{1}{8}$ "). Provide air compressor where necessary (if no suitable building supply is available).
- .5 Air springs shall be used in conjunction with either Type 5 or 5PD seismic snubbers or be fitted within an OSHPD approved integral housing (see type 3A).
- .6 Suitable for outdoor installation.

2.10 Type 5 - Seismic Snubbers

- .1 Omni-directional seismic snubbers consisting of interlocking steel members restrained by a one piece molded neoprene bushing of bridge bearing neoprene.
- .2 Bushing shall be replaceable and a minimum of 6mm ($\frac{1}{4}$ ") thick.
- .3 Rated loadings shall not exceed 6895 kPa (1000 psi).
- .4 A minimum air gap of 3mm ($\frac{1}{8}$ ") shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Ensure neoprene bushing can easily be rotated by hand after installation ensure no short circuits exist before systems are activated.

2.11 Type 7N – Neoprene Hangers

- .1 Double deflection neoprene hangers shall consist of a rigid steel frame containing a neoprene element with an upper embedded steel washer and an integral bottom flange, which will protrude, and friction fit into the lower circular opening of the hanger frame. The lower hole in the hanger box shall be of a large enough diameter to permit the threaded hanger rod to swing through a minimum 30° arc from side to side before contacting the neoprene flange. Nominal static deflection under load shall be 5mm. No hanger shall be loaded to less than 50% of this deflection nor exceed the manufacturers maximum recommended loading.

2.12 Type 7S – Spring Isolation Hangers

- .1 Spring isolation hangers shall consist of a rigid steel frame containing a steel spring (see Type 3) and shall be seated in a steel washer reinforced neoprene cup. This cup shall have a neoprene bushing projecting through the steel box. Spring diameters and hanger box lower hole diameters shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the protruding neoprene bushing. Spring selection and submittal data similar to that for Type 3.

2.13 Type 7SN - Spring Hangers with Neoprene Elements

- .1 Hangers shall consist of rigid steel frames containing minimum 32mm (1 1/4") thick neoprene elements at the top and a steel spring seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box.
- .2 Provide a combination rubber and steel rebound washer as the seismic up stop for suspended piping, ductwork, and equipment. Rubber thickness shall be a minimum of 6mm (1/4").
- .3 To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring.
- .4 Spring diameters and hanger box lower hole diameters shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the protruding neoprene bushing.
- .5 Colour coded springs, rust resistant, painted box type hangers.

2.14 Type 8 - Neoprene Washer/Bushing

- .1 A one piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact.
- .2 Use washer/bushing only on light-weight equipment.

2.15 Type 9 – Horizontal Thrust Restraints

- .1 Spring isolated air handling equipment shall be fitted with horizontal thrust restraints design to keep movement due to thrust to $\pm 1/4"$ at equipment start and stop.
- .2 Restraints shall consist of a pair of Type 3 springs, complete with neoprene molded cups having the same deflection as those specified for the equipment. The restraints shall be attached at the centreline of the thrust and symmetrical on each side of the unit.

2.16 Type 10 – Acoustical Split Wall Seals

- .1 Split wall seals shall consist of two bolted pipe halves with a minimum 18 mm thick neoprene sponge bonded to the liner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping.

- .2 Concrete may be packed around the seal to make it integral with the floor, wall, or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum 25 mm past both sides of the wall.
- .3 Where temperatures exceed 113°C 10# density fiberglass may be used in lieu of the sponge.

2.17 Type 11 - Pipe Riser Anchor

- .1 All directional acoustical pipe anchors shall consist of two sizes of steel tubing separated by a minimum 12 mm thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi (0.35 kg/mm²) and be designed to balance for equal resistance in any direction.
- .2 Provide hot application isolators as required.

2.18 Type 12 – Pipe Riser Guides

- .1 Guides are to be used in conjunction with Type 3 spring isolators and shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 12 mm thick 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow for vertical motion due to pipe expansion or contraction. Guides shall be capable of ±40 mm motion or to meet project requirements.

2.19 Type 13 - Flexible Piping Connections

- .1 Flexible piping connectors are to be supplied with seismic restraint materials.
- .2 Where flexible connections are not specified with piping in other Sections they are to be as specified herein.
- .3 Expansion joints shall be peroxide cured EPDM throughout with Kevlar® tire cord reinforcement. Substitutions must have certifiable equal or superior characteristics. The raised face rubber flanges must encase solid steel rings to prevent pull out. Flexible cable wire is not acceptable.
- .4 Sizes 3/4" through 2" (19mm through 50mm) may have one sphere, bolted threaded flange assemblies, and cable retention.
- .5 Sizes 1 1/2" through 14" (40mm through 350mm) shall have a ductile iron external ring between the two spheres. Sizes 16" through 24" (400mm to 600mm) may be single sphere.
- .6 Minimum ratings through 14" (350mm) shall be 250psi at 170°F and 215psi at 250°F. (1.72MPa at 77°C and 1.48MPa at 121°C), 16"(400mm) through 24"(600mm) 180psi at 170°F and 150psi at 250°F. (1.24MPa at 77°C and 1.03 MPa at 121°C). Higher published rated connectors may be used where required.
- .7 Safety factors shall be a minimum of 3/1. All expansion joints must be factory tested to 150% of maximum pressure for 12 minutes before shipment.
- .8 The piping gap shall be equal to the length of the expansion joint under pressure. Control rods passing through 1/2"(13mm) thick Neoprene washer bushings large enough to take the thrust at 1000psi (0.7 kg/mm²) of surface area may be used on unanchored piping where the manufacturer determines the condition exceeds the expansion joint rating without them.
- .9 Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration acceleration and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer.
- .10 All expansion joints shall be installed on the equipment side of the shut off valves.

2.20 Type 14 - Flexible Duct Connectors

- .1 Flexible duct connectors of Durodyne with Durolon fabric or approved equal.
- .2 Provide 75 mm (3") flexible duct connectors and a 40 mm (1½") metal to metal gap. Centrifugal fans with 900 mm (36") diameter and larger fan wheels, use 150 mm (6") long flexible connection.
- .3 Do not install connectors on perchloric acid fume exhaust systems.
- .4 Provide stabilizing springs limiting movement at flexible connections to 25% of fabric width under steady state conditions and 40% at start up.

2.21 Bases – Type B1 - Concrete Inertia

- .1 Concrete inertia bases shall be formed in a structural steel perimeter base, reinforced as required to prevent flexure, misalignment of drive and driven unit or stress transfer into equipment. The base shall be complete with motor slide rails, pump base elbow supports, reinforcing, equipment bolting provisions and isolators.
- .2 Minimum thickness of the inertia base shall be according to the following tabulation:

Motor Size		Minimum Thickness	
HP	KW	mm	inches
5 to 15	4 to 11	150	6
20 to 50	15 to 37	200	8
60 to 75	45 to 55	250	10
100 to 250	75 to 190	300	12

- .3 Height saving brackets shall be employed in all mounting locations to provide a base clearance of 25mm (1").

2.22 Bases – Type B2 - Steel

- .1 Provide integral structural steel bases.
- .2 Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped where space is a problem.
- .3 Pump bases for split case pump shall include supports for suction and discharge elbows.
- .4 All perimeter members shall be steel beams with a minimum depth equal to $\frac{1}{10}$ of the longest dimension of the base. Base depth need not exceed 14" (350mm) provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.
- .5 Height saving brackets shall be employed in all mounting locations to provide a base clearance of 25mm (1").

2.23 Closed Cell Foam Gaskets

- .1 20 mm (¾") thick continuous perimeter closed cell foam gasket to isolate base of package type equipment, air handler units, exhaust fans, etc. from concrete floors and roof curbs.
- .2 Do not use on NFPA96 installations.

2.24 Anchor Bolts

- .1 Equal to Mason Industries type SAB seismic anchor bolts.

2.25 Seismic Cable Restraints

- .1 Galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint.
- .2 Cables must be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement.
- .3 Cables must not be allowed to bend across sharp edges.
- .4 Cable assemblies shall suit installation type:
 - .1 Ceiling and at the clevis bolt.
 - .2 Between the hanger rod nut and the clevis.
 - .3 Clamped to a beam.

3. EXECUTION

3.1 General

- .1 All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.
- .2 Brace in-line equipment independently of ducts and pipes.
- .3 Do not mix solid and cable bracing.
- .4 All runs to have a minimum of two transverse and one longitudinal brace. A run is defined as any change in direction except offsets.

3.2 Seismic Restraint Installation

- .1 The following Mechanical Components Restraint Guide is to be used as a general guide only to establish appropriate restraint methods, hardware, and attachments, however, due to differences in construction, size, weight, and configuration of different manufacturer's equipment and variety of ways and means that equipment and components can be installed, specific restraint methods are to be confirmed in the field. Seismic restraint materials and methods are to be reviewed and approved by Seismic Consultant.

3.3 Mechanical Component Restraint Guide

Item	Type Of Restraint	Minimum No. of Restraints	Notes
In-line Pumps	SCR	2	Pipe mounted type pump
Pumps Non-Isolated	BTHP	4	Base mount type pump
Pumps Isolated	SNBR	4	Base mount type pump
Expansion Tanks	SCR	4	
D.H.W. Tanks	SCR	4	Attach to removable steel strap yoke
Glycol Tanks	SCR	4	Attach to removable steel strap yoke
Boilers			
- With Base	BTHP	4	
- Without Base	CSSB	4	
Chillers			
- Isolated	SNBR	4	

Item	Type Of Restraint	Minimum No. of Restraints	Notes
- Non-Isolated	BTHP	4	
AHU's and A/C Units Free Standing			
- With Base	BTHP	4	
- Without base	CSSB	4	
Packaged Rooftop Air Units (all types)			
Fans – Suspended			
- Isolated	SCR	4	
- Non-Isolated	SCR	4	
Grilles, Registers, Diffusers	SCR	4	Where not bolted to duct (i.e. in tee-bar ceilings)
Piping	SCR TSR	As required	As per Specification
Ductwork	SCR TSR	As required	As per Specification

LEGEND	
SCR	Slack cable restraint (bolted to structure)
SNBR	Seismic snubber (bolted to structure)
TSR	Threaded support rod (bolted or clamped to structure)
BTSLPR	Bolt to sleeper (sleeper bolted to structure)
BTHP	Bolt to concrete housekeeping pad (pad to be keyed to structure)
CSSB	Custom steel shoe base (bolted to structure)
BTRC	Bolt to roof curb (roof curb bolted to roof structure)

3.4 Seismic Piping Restraints

- .1 Seismic restrain all piping as follows:
 - .1 Seismically restrain all piping as follows:
 - .1 Fuel oil piping, gas piping, medical gas piping, and compressed air piping that is 1 NPS or larger.
 - .2 Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1 ¼ NPS and larger.
 - .3 All other piping 2 ½ NPS and larger.
 - .2 Provide transverse piping restraints at 12m (40') maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
 - .3 Provide longitudinal restraints shall be at 24m (80') maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
 - .4 For fuel oil and all gas piping transverse restraints must be at 6m (20') maximum and longitudinal restraints at 12m (40') maximum spacing.

- .5 Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
- .6 Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.

3.5 Seismic Ductwork Restraints

- .1 Seismically restrain all ductwork as follows:
 - .1 Restrain all ductwork and duct mounted equipment.
 - .2 Transverse restraints shall occur at 9m (30') intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
 - .3 Longitudinal restraints shall occur at 18m (60') intervals with at least one restraint per duct run.
 - .4 The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
 - .5 A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
 - .6 Walls, including gypsum board non-bearing partitions, which have ducts running through them, may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.

3.6 Seismic Cable Restraints

- .1 Cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.
- .2 Cable assemblies are installed taut on non-isolated systems.
- .3 Where cable restraints are installed on support rods with spring isolators, the spring isolation hangers must be specification type.

3.7 Vibration Isolator Installation - General

- .1 Vibration isolation products as outlined in section 2 above are to be applied based on 4 basic project specific situations. The requirements for each of these is outlined below:
 - .1 Acoustical classification W - Warehouse, Industrial
- .2 This project has an acoustical classification of (W). See Vibration Isolation Application Schedule for vibration isolation application requirements.
- .3 Unless otherwise specified, vibration isolation products are to be product of one manufacturer.
- .4 Ensure 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 Use the lowest RPM scheduled for two-speed equipment in determining isolator deflection.
- .6 Before bolting isolators to the structure, start equipment and balance the systems so that the isolators can be adjusted to the correct operating position before installing (seismically rated) anchors.

- .7 Where hold down bolts for isolators or seismic restraint equipment penetrate roofing membranes, the sealing of all roofing membrane penetrations shall be in complete compliance with the installation and warranty requirements of the applicable roofing contractors association. Ensure sealing compound is compatible with isolator components such as neoprene.
- .8 Unless otherwise indicated, install isolation materials for base mounted equipment on concrete housekeeping pad bases which extend at least over the full base and isolated area of the isolated equipment. Additional requirements are as follows:
 - .1 Block and shim bases level so ductwork and piping connections can be made to a rigid system at proper operating level, before isolated adjustment is made, and ensure there is no physical contact between isolated equipment and building structure;
 - .2 Steel bases are to clear the sub-base by 25 mm (1");
 - .3 Concrete bases are to clear the sub-base by 50 mm (2").
- .9 Where a pump intake pipe or similar pipe configuration requires a pedestal support, construct inertia or steel base large enough to accommodate pedestal.
- .10 Isolate piping larger than 25 mm (1") dia. directly connected to motorized and/or vibration isolated equipment with 25 mm (1") static deflection spring hangers at spacing intervals in accordance with following:
 - .1 For pipe less than or equal to 100 mm (4") dia. – first 3 points of support;
 - .2 For pipe 125 mm (5") to 200 mm (8") dia. – first 4 points of support;
 - .3 For pipe equal to or greater than 250 mm (10") dia. – first 6 points of support;
- .11 First point of isolated piping support is to have a static deflection of twice the deflection of the isolated equipment but maximum 50 mm (2").
- .12 Isolate steam Pressure Reducing Stations (PRV's) and upstream and downstream piping for a distance of 15 m. Install PRV station pipe pedestals on 12 mm thick heat insulating pads, with heat insulating grommets on the hold down bolts and Type 1 pads below. The insulating pad shall be sufficient to maintain Type 1 pad within manufacturer's temperature limits. Submit shop drawing of detail.
- .13 Connect emergency generator mufflers directly to structure. Provide seismic restraint for mufflers. (Flex connection between generator and exhaust piping provided by Div. 26).
- .14 Flexible pipe connectors (Type 13 isolator) shall be provided and installed per the Vibration Isolation Application Schedule.
- .15 Provide hot dipped galvanized housings and neoprene coated springs, or other acceptable weather protection, for all isolation equipment located outdoors or in areas of high moisture which may cause corrosion.
- .16 Provide a minimum clearance of 50mm (2") to other structures, piping, equipment, etc., for all equipment mounted on vibration isolators.
- .17 Before bolting isolators to the structure, start equipment and balance the systems so that the isolators can be adjusted to the correct operating position before installing drilled inserts.
- .18 When spring isolators are used for equipment with operating weights substantially different from installed weights, block the equipment with temporary shims to the final heights prior to making piping connections. When full load is applied, adjust the isolators to take up the load just enough to allow shim removal.
- .19 After installation and adjustment of isolators, verify deflection under load to ensure loading is within specified range.

- .20 Where hold-down bolts for isolators or attachments penetrate roofing membranes, co-ordinate with Division 7 and with roofing contractor.
- .21 For all pump installations, ensure that pumps are installed and aligned such that no piping loads are imposed on the pump. Pumps and piping should be independently supported and aligned prior to final connection.
- .22 Where isolated piping connected to noise generating equipment is routed from the mechanical room through plumbing chases or other openings, position isolated piping to avoid contact with the structure, framing, gypsum wallboard and other elements which may radiate noise. Submit proposed details to meet this requirement. On all AAA and AA projects, Type 10 acoustical seals shall be provided on piping entering or leaving mechanical rooms.
- .23 Ensure that the installed seismic restraints do not adversely affect the proper functioning of any vibration isolation products required by this section.
- .24 All fire protection piping shall be braced in accordance with NFPA 13 and 14.
- .25 For control wiring connections to vibration isolated equipment ensure 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 conduit will remain intact if equipment moves 300 mm (12") laterally from its installed position, and flexible enough to transmit less vibration to structure than is transmitted through vibration isolation. Coordinate these requirements with mechanical trades involved. If electrical power connections are not made in a similar manner as part of the electrical work, report this fact to Consultant.

3.8 Type 2 - Rubber Floor Mounts

- .1 Mount in-line pumps on two (2) rubber floor mount isolators under each support foot, where scheduled.
- .2 For equipment mounted on a slab on grade, mount on rubber floor mount isolators unless otherwise specified.
- .3 Provide protection of the rubber element from contact with oil in the mechanical room.

3.9 Type 3 - Spring Floor Mounts

- .1 Isolate all floor or pier mounted equipment on spring floor mount isolators, unless otherwise specified.
- .2 Isolate air-cooled chillers on spring floor mount isolators and Neoprene pads under isolator base plates. Submit details of pipe supports on roof and wall/roof penetration.
- .3 Isolate air compressors on spring floor mount isolators and concrete inertia base unless scheduled otherwise.
- .4 Mount cooling towers on spring floor mount isolators and, if necessary, seismic snubbers to meet seismic requirements unless scheduled otherwise.

3.10 Type 4 - Restrained Air Springs

- .1 Isolate 19kW (25HP) pumps and larger on restrained air mounts except use rubber floor mounts for slab on grade installations.
- .2 Isolate Chillers on restrained air mounts as scheduled.

3.11 Type 5 - Seismic Snubbers

- .1 Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated.

3.12 Type 6S Continuous Rail Type Isolation for Roof Mounted Equipment

- .1 Erect roof curb vibration isolation in accordance with instructions shipped with assembly. Match vibration isolation with associated roof top unit and orient isolation as identified by manufacturer to ensure proper loading and optimum performance.
- .2 Caulk top of roof curb with 2 beads of caulking provided and centre isolation assembly onto roof curb and, unless otherwise noted, screw in place with 50 mm (2") lag screws at 900 mm (36") O.C. Position gasket on top rail or alternatively, caulk with 2 beads of caulking provided and orient and lower roof top unit onto isolation rails and, unless otherwise noted, screw unit into top rail with 25 mm (1") lag screws at 900 mm (36") O.C.
- .3 After roof top unit is secured in place, but before damageable work is installed, spray each isolated equipment assembly with water and correct any water leaks.

3.13 Type 7S & 7SN - Spring Hangers

- .1 Locate isolation hangers as near to the overhead support structure as possible.
- .2 Installation shall permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.
- .3 All discharge ductwork runs for a distance of 15m (50') from the connected equipment shall be isolated from the building structure by means of spring hangers. Spring deflection shall be a minimum of 19mm (0.75").

3.14 Type 8 - Neoprene Washer/Bushing

- .1 Isolate variable frequency drive controller using neoprene washer/bushing isolators or soft grommets such that structure borne noise transmission to occupied space is less than airborne noise transmission.

3.15 Type 13 - Flexible Piping Connectors

- .1 Supply flexible piping connectors for connections (including plumbing) to seismically restrained equipment. Hand connectors to appropriate piping trade at site for installation.

3.16 Type 14 - Flexible Duct Connectors

- .1 Install flexible duct connectors so that duct cross-section is not reduced by the deflection of the flexible connector.

3.17 Closed Cell Foam Gaskets

- .1 Select width for nominal 21kPa (3psi) loading under weight of equipment and allow for 25% compression 5mm (³/₁₆").
- .2 Increase width of curb using steel shim if necessary to accommodate gasket.
- .3 For light equipment such as exhaust fans, deflection should be a minimum of 1mm (0.05").

3.18 Minimum Static Deflection Schedule

Equipment	Equipment Supported By:	
	Slab on Grade	Elevated Slab
Fans, Blowers & Packaged H & V Units:		
Under 0.5 HP	1mm (¹ / ₁₆ ")	1mm (¹ / ₁₆ ")
0.5 HP to 7.5 HP	25mm (1")	25mm (1")
7.5 HP to 40 HP - up to 400 rpm	38mm (1½")	38mm (1½")
7.5 HP to 40 HP - over 400 rpm	25mm (1")	25mm (1")

Over 40 HP – up to 400 rpm	38mm (1½")	38mm (1½")
Over 30 KW (40 Hp) – over 400 rpm	25mm (1")	38mm (1½")

NOTES:

- .1 Table indicates required static deflection of isolators for all fans regardless of power rating and for all other motor driven equipment over 0.37kW (0.5 HP).
- .2 Advise consultant of equipment not contained in this table and obtain clarification as to the isolation performance requirements.
- .3 Steel spring isolators shall be used for all deflections 12mm (½") and over.
- .4 Neoprene isolators shall be used for deflections 6mm (¼") and under.
- .5 Use housed spring isolators for heat pump.
- .6 Concrete inertia bases required for pumps over 15kW (20HP), fans over 30kW (40HP).

3.19 Vibration Isolation Application Schedule

Equipment	AAA	AA	A	W
Mounted Packaged Air Handling Equipment				
Internally Isolated	6S & 14	6S & 14	6N & 14	-
Not Internally Isolated	6S & 14	6S & 14	6N & 14	6N & 14
Fans Hung				
>>5hp<<1200 rpm	7SN & 14	7S & 14	7S & 14	7S & 14
>>5hp>> 1200 rpm	7SN & 14	7S & 14	7N & 14	8 & 14
>>1/2hp>>1200 rpm	7S & 14	7N & 14	8 & 14	8 & 14
Fractional	8 & 14	8 & 14		

Note:

- .1 Table indicates type of isolation required, base type (B) if required and any other sections of note.
- .2 Type 3 and 4 isolators may be used with Type 5 and 5PD and snubbers. Those pieces of equipment requiring seismic 'post disaster' protection must use 5PD snubbers with Type 3 and 4 isolators.

3.20 Field Quality Control

- .1 Seismic Engineer:
 - .1 The Seismic Engineer shall perform all field services as required to fulfil the Building Code obligation for the provision of the Assurance of Professional Field Review and Compliance by Supporting Registered Professional Schedule S-C for seismic engineering.
 - .2 Submit concise field reports to the Consultant within 3 days of each site review.
 - .3 Make adjustments and corrections in accordance with written report.
- .2 Manufacturer's Field Services:
 - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
 - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:

- .1 Twice during the installation, at [25] % and [60] % completion stages.
- .2 Upon completion of installation.
- .3 Submit a concise manufacturer's report to the Consultant within 3 days of manufacturer representative's review.
- .4 Make adjustments and corrections in accordance with written report.

END OF SECTION

1. GENERAL

1.1 Section Scope

- .1 Materials and installation for the identification of all mechanical piping, ducting, equipment, and controls.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical.

1.3 References

- .1 The latest revisions of the following standards shall apply unless noted otherwise.
- .2 Canadian Standards Association (CSA International):
 - .1 CAN/CSA B128.1 – Design and Installation of Non-potable Water Systems.
 - .2 CAN/CSA B128.2 – Maintenance and Field Testing of Non-potable Water Systems
 - .3 CAN/CSA Z305.1 – Non-flammable Medical Gas Piping.
 - .4 CAN/CSA Standard-Z7396.1-17 Medical Gas Pipeline Systems – Part 1
- .3 Canadian Gas Association (CGA):
 - .1 CSA/CGA B149.1 – Natural Gas and Propane Installation Code.
- .4 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-1.60 – Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3 – Identification of Piping Systems.
- .5 National Fire Protection Association (NFPA):
 - .1 NFPA 13 – Standard for the Installation of Sprinkler Systems.
 - .2 NFPA 14 – Standard for the Installation of Standpipe and Hose Systems.

1.4 Submittals

- .1 Comply with Division 01 – Submittal Procedures and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and additionally the following:
 - .1 Submit data on all materials.

1.5 General Requirements

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- .2 Identify each system and system component according to the nomenclature used on the drawings and specifications. Identification to be consistent throughout the project.
- .3 When identifying systems and components in existing buildings, the new items shall be numbered sequentially with existing systems. Where possible include the zone or building area serviced by each system.
- .4 Submit list of system and component labels to the Consultant for review prior to engraving.

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 Refer to Section 23 05 01 – Acceptable Manufacturers.

2.2 Piping Systems Governed by Codes

- .1 Any piping that is governed by CSA/NFPA or any other applicable code as addressed in contract documents, is to comply with those applicable codes concerning identification.

2.3 Manufacturer's Equipment Nameplates

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers raised or recessed.
- .3 Information to include, as appropriate:
 - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.4 System Equipment Nameplates

- .1 Each piece of equipment shall be identified with its equipment schedule identification, e.g. supply fan SF-1, cooling coil CC-1, pump P-1.
 - .1 Coordinate equipment with drawings and with departmental representative's requirements.
- .2 Colours:
 - .1 Hazardous: red letters, white background.
 - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .3 Construction:
 - .1 3 mm ($\frac{1}{8}$ ") thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .4 Sizes:
 - .1 Conform to following table:

Size No.	Size (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

- .2 Use maximum of 25 letters/numbers per line.
- .5 Locations:
 - .1 Terminal cabinets, control panels: use size # 5.

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

2.5 Piping Systems Identification

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows to CAN/CGSB 24.3 except where specified otherwise.
- .2 Medical Gas Pipeline Systems:
 - .1 All medical gas pipelines shall have a permanent label at intervals of 6.0 m [20 ft.], immediately before and after barriers, at each valve, and behind access doors and inlet and outlet points.
 - .2 Lettering colour, background colour, lettering height and gas or gas mixture symbol shall be in accordance with CAN/CSA Z7396.1 Medical Gas Pipeline Systems – Part 1.
- .3 Pictograms:
 - .1 Where required by Workplace Hazardous Materials Information System (WHMIS) regulations.
- .4 Letter Height:
 - .1 13 mm [1/2"] high - 1-1/4 NPS pipe & smaller.
 - .2 25 mm [1"] high - 1-1/2 NPS up to 2-1/2 NPS pipe.
 - .3 50 mm [2"] high - 3 NPS and larger pipe.
- .5 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 75mm (3"): 100mm long x 50mm high (4" x 2").
 - .2 Outside diameter of pipe or insulation 75mm (3") and greater: 150mm long x 50mm high (6" x 2").
 - .3 Use double-headed arrows where flow is reversible.
- .6 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .7 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20mm (3/4") and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 Other pipes: pressure sensitive plastic-coated cloth or vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150°C (302°F) and intermittent temperature of 200°C (392°F).
- .8 Colours and Legends:
 - .1 Where not listed, obtain direction from the Consultant.
 - .2 Colours for legends, arrows to following table:

Background Colour	Legend, Arrows
Yellow	BLACK
Green	WHITE

Background Colour	Legend, Arrows
Red	WHITE
Blue	WHITE

- .3 Background colour marking and legends for piping systems:

Contents	Background Colour Marking	Legend
Natural Gas/Propane	Refer to CGA code	

2.6 Valves, Controllers Identification

- .1 Provide valve identification and secure with non-ferrous chain or "S" hooks suitable for the system temperature.
- .2 Identification tags shall be of brass, aluminum, metalphoto, lamicoide or fiberglass, stamped or engraved with 12mm (½") high identifier markings.
- .3 Tag the following valves as a minimum:
 - .1 Valves on main piping circuits.
 - .2 Valves on major branch lines.
 - .3 Valves on minor branch lines in horizontal or vertical service spaces and mechanical rooms.
 - .4 Drain valves and hose bibbs on systems containing glycol.
 - .5 Control valves.
- .4 Do not tag the following valves:
 - .1 Valves on control valve stations.
 - .2 Valves on steam trap stations.
 - .3 Plumbing fixture stops or hose bibbs.
 - .4 System drain valves.
- .5 Provide a valve tag schedule. Include in the identification of each tagged item, valve type, service, function, normal position and location of tagged item.
- .6 Provide a flow diagram for each system, reference applicable charts and schedules.

2.7 Ductwork Systems Identification

- .1 50mm (½") high stencilled letters and directional arrows 150mm long x 50mm high (6" x 2").
- .2 Colours: black, or co-ordinated with base colour to ensure strong contrast.

2.8 Ductwork Access Identification

- .1 Secure 50 mm (2") high, self-adhesive stick-on letters, on duct access panels to identify their usage, according to the following:
 - .1 Cleaning and service access, colour black, tag "C.A"
 - .2 Controls including sensors, colour black, tag "C"
 - .3 Backdraft dampers, balance dampers and control dampers, colour black, tag "D"
 - .4 Fire dampers, colour red, tag "F.D."

- .5 Smoke dampers and duct smoke detectors, colour red, tag "S.D."

2.9 Controls Components Identification

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section. Include: sensors, transmitters, BMS controlled valve and damper actuators, end-devices, distributed control panels (DCP)'s, application specific controllers (ASC)'s and field panels.
- .2 Inscriptions to include function and (where appropriate) fail safe position.
- .3 Warning notices shall be provided at all equipment controlled by the BMS and at all associated motor starters. The warning notices shall state that the equipment is under the control of the BMS and may start or stop at any time without warning. Provide warning notices at minimum at all MCC's, at local disconnect switches, at AHU plenum doors, and electrical motors.
- .4 Provide warning notices on all Distributed Control Panel doors indicating that hand held radio transmitters are not to be keyed within 3 meters of the DCP.
- .5 All BMS wire and cable shall be identification tagged. Wire/cable shall be identification tagged at every termination location. Wire/cable and tubing terminating at distributed control panels (DCP) and application specific controllers (ASC) shall be tagged with the DCP/ASC controller termination number. Wire/cable and tubing terminating at field devices shall be tagged with both the DCP/ASC number and the DCP/ASC termination number. At any splices or terminal strips between the field device and DCP/ASC, the wiring shall be tagged on both sides of the termination point the same as for a field device termination.
- .6 In accordance with CSA B44-[16] clause 2.7.9.2, provide signage indicating the allowable temperature and relative humidity range for the elevator machinery spaces, machine rooms, control spaces, and control rooms. Post in the machine room, control room, control space, or where specified by the elevator manufacturer, in the machinery space.

2.10 Ceiling Access Identification

- .1 Provide 6 mm (1/4") self adhesive coloured dots to the T-bar framing, adjacent to panel to be removed or to access doors in solid ceilings. Identify the location of equipment concealed above as follows:
 - .1 **Yellow** - Concealed equipment and cleaning access.
 - .2 **Black** - Control equipment, including control valves, dampers and sensors.
 - .3 **Red** - Fire and smoke dampers, fire protection equipment and fire system drains.
 - .4 **Green** - Heating water, chilled water, domestic cold water, domestic hot water isolation valves.

3. EXECUTION

3.1 General

- .1 Provide identification only after painting has been completed.
- .2 Perform work in accordance with CAN/CGSB-24.3 Identification of Piping Systems except as specified otherwise.
- .3 Provide ULC and/or CSA registration plates as required by respective agency.

3.2 Nameplates

- .1 Location shall be in conspicuous location to facilitate easy reading and identification from operating floor.

- .2 Provide standoffs for nameplates on hot and/or insulated surfaces.
- .3 Do not paint, insulate or cover nameplate data.

3.3 Location of Identification on Piping and Ductwork Systems

- .1 Provide on long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17m (55') intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Provide adjacent to each change in direction.
- .3 Provide at least once in each small room through which piping or ductwork passes.
- .4 Provide on both sides of visual obstruction or where run is difficult to follow.
- .5 Provide on both sides of separations such as walls, floors, partitions.
- .6 Provide where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 Provide at beginning and end points of each run and at each piece of equipment in run.
- .8 Provide at point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification shall be easily and accurately readable from usual operating areas and from access points. Position the identification approximately at right angles to the most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.4 Valves, Controllers Identification

- .1 Provide identification on valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve.
- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass located in the main mechanical room. Provide one copy in each operating and maintenance manual.
- .3 Number valves in each system consecutively.
 - .1 Identification coding is to start with a utility description followed by a maximum of three numerals:
 - .2 Domestic Water DW-1, DW-2, DW-3...
 - .3 Natural Gas G-1, G-2, G-3...
 - .4 Steam S-1, S-2, S-3...
 - .5 Heating Water HW-1, HW-2, HW-3...
 - .6 HVAC to be numbered H-1, H-2, H-3...
 - .7 Fire Protection to be numbered FP-1, FP-2, FP-3...

3.5 Identification Requirements Specific for Non-potable Water Systems

- .1 Distribution piping for non-potable water systems shall be clearly identified in accordance with the following:
 - .1 Pipe for non-potable systems shall be:
 - .1 Marked with the legend WARNING: NON-POTABLE WATER – DO NOT DRINK.

- .2 Purple in color, or marked with a continuous purple stripe.
- .2 Markings on pipe for non-potable water systems shall be:
 - .1 Permanent, distinct, and easily recognizable.
 - .2 In legible letters and numerals at least 5mm (1/4") high, except where the size of the pipe makes 5mm (1/4") high letters and numbers impracticable.
 - .3 Of a color that contrasts with the color of the pipe.
 - .4 Repeated at intervals no greater than 1.5m (4.9').
- .3 The presence of buried pipes shall be identified with a permanent warning tape installed at least 300mm (12") above the pipe, running lengthwise. In addition, a tracer wire shall be installed for non-metallic pipes.
- .4 Outlet points shall be clearly and permanently marked with the legend WARNING: NON-POTABLE WATER – DO NOT DRINK. The sign shall be not less than 100mm x 100mm (4" x 4").

END OF SECTION

1. GENERAL

1.1 Section Scope

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
- .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges and document results.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical.
- .3 Section 23 08 00 – Commissioning of Mechanical Systems.

1.3 References

- .1 The latest revisions of the following standards shall apply unless noted otherwise.
- .2 Associated Air Balance Council (AABC)
 - .1 National Standards for Total System Balance, MN-1.
- .3 National Environmental Balancing Bureau (NEBB)
 - .1 Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 HVAC Systems – Testing, Adjusting, and Balancing.
- .5 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 62.1 – Ventilation for Acceptable Indoor Air Quality.
 - .2 ASHRAE 62.2 – Ventilation for Acceptable Indoor Air Quality in Low Rise Residential Buildings.

1.4 General Requirements

- .1 TAB is used throughout this Section to describe the process, methods, and requirements of testing, adjusting and balancing for HVAC.
- .2 TAB means to test, adjust, and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.5 Approved TAB Agencies

- .1 Refer to Section 23 05 01 – Acceptable Manufacturers.

1.6 Qualifications of TAB Personnel

- .1 Employ an approved independent testing and balancing agency to test and balance the following systems.

- .2 Submit names of personnel to perform TAB to the Departmental Representative's Consultant within 90 days of award of contract. Provide documentation confirming qualifications, years of direct field testing and balancing experience and successful experience. Provide a list of a minimum of ten comparable projects successfully completed by all key members of the balancing team and the Standard under which the projects were completed.
- .3 TAB shall be performed in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved:
 - .1 AABC – National Standards for Total System Balance, MN-1
 - .2 NEBB – Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems
 - .3 SMACNA -HVAC Systems – Testing, Adjusting and Balancing
- .4 Recommendations and suggested practices contained in the TAB Standard are mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy the Contract requirements.
- .6 Where the instrument manufacturer's calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .7 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
 - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by the TAB Specialist.
 - .2 Where new procedures, and requirements, are applicable to the Contract requirements, procedures shall have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), requirements, and recommendations contained in these procedures and requirements are mandatory.

1.7 Exceptions

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

1.8 Submittals

- .1 Comply with Section 21 05 01 – Common Work Results for Mechanical, Submittals, and the following:
- .2 Preliminary TAB Report
 - .1 Submit for checking and approval of the Departmental Representative's Consultant, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
 - .1 Details of instruments used.
 - .2 Details of TAB procedures employed.
 - .3 Calculations procedures.
 - .4 List of air and liquid systems to be TAB
 - .5 Summaries.
- .3 TAB Report
 - .1 Format in accordance with referenced standards.
 - .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.

- .2 System schematics.
 - .3 Date of test, Name, and address of building and balancing technician's name.
 - .4 Range of outdoor air temperature during the balancing period.
 - .5 Main branch duct traverses. Maximum and minimum outdoor air quantities.
 - .6 Static pressure across each component in an air handling system at full flow.
 - .7 Static pressure across each fan.
 - .8 Fans: Tag, service and location, motor speed, fan specified and actual capacity. Fan motor size, starting time, amps, and voltage.
 - .9 Flow measuring devices: Flow rates.
 - .10 Terminal heating/cooling elements: Entering and leaving liquid temperatures, and flow rates.
 - .11 Provide fan performance curve for each new air handling system and pump performance curve for each new pump system.
- .3 Submit copies of TAB Report to the Departmental Representative's Consultant for verification and approval.

1.9 Co-ordination

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.10 Pre-TAB Review

- .1 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.
- .2 Ensure devices are accessible and maintainable. Advise the installing Contractor of omissions or conflicts affecting the scope of this section.
- .3 Review contract documents before project construction is started and confirm in writing to Consultant the adequacy of provisions for TAB and that other aspects of design and installation are pertinent to the success of TAB.
- .4 Review specified standards and report to Consultant in writing describing any proposed procedures which vary from the standard.

1.11 Start-up

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Divisions 21, 22, 23 and 25.

2. PRODUCTS

2.1 Instruments

- .1 Prior to TAB, submit to the Departmental Representative's Consultant a list of instruments used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standards for applicable system.

- .3 Calibration shall be within 6 months of TAB. Provide certificate of calibration to the Departmental Representative's Consultant.

3. EXECUTION

3.1 Start of TAB

- .1 Notify the Consultant 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .2 Application of weather-stripping, sealing, and caulking.
 - .3 Pressure, leakage, other tests specified elsewhere Division 23.
 - .4 Provisions for TAB installed and operational.
- .3 Start-up, verification for proper, normal, and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Coil fins combed, clean.
 - .6 Access doors, installed, closed.
 - .7 Outlets installed, volume control dampers open.

3.2 Tolerances

- .1 Application Tolerances:
 - .1 Do TAB to following tolerances of design values:
 - .1 Laboratory/Healthcare HVAC systems: plus 10%, minus 0%.
 - .2 General HVAC systems: plus or minus 5%.
 - .3 Hydronic systems: plus or minus 10%.
- .2 Accuracy Tolerances:
 - .1 Measured values accurate to within plus or minus 2% of actual values.
- .3 Site Tolerances:
 - .1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Pro-rate specified system leakage tolerances. Leakage for sections of duct systems: not to exceed total allowable leakage.
 - .2 Leakage tests on following systems not to exceed specified leakage rates.
 - .3 Small duct systems up to 250Pa (1"WC): leakage 2%.
 - .4 Large low pressure duct systems up to 500Pa (2"WC): leakage 2%.
 - .5 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.3 Testing

- .1 Test ducts and piping before installation of insulation or other forms of concealment. Do not externally insulate or conceal work until tested and approved.
- .2 Test after seals have cured.
- .3 Test when ambient temperature will not affect effectiveness of seals, and gaskets.
- .4 Conduct tests in presence of the Departmental Representative's Consultant or Departmental Representative's representative.
- .5 Bear costs including retesting and making good.
- .6 Refer to Piping Sections for specific test requirements.
- .7 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures.

3.4 Air System Procedure

- .1 Perform balancing, adjusting and testing with building doors and windows in their normal operation position.
- .2 Perform drop test on all fire dampers and reset to open position.
- .3 The following procedure shall be adopted for central systems:
 - .1 Ensure dampers or volume control devices are in fully open position.
 - .2 Balance central apparatus to $\pm 10\%$ air flow.
 - .3 Balance branches, mains to $\pm 10\%$ air flow.
 - .4 Recheck central apparatus.
 - .5 Balance all terminal air outlets to $\pm 10\%$.
 - .6 Rebalance central apparatus to $\pm 5\%$.
 - .7 Recheck all air outlets.
 - .8 Perform acoustical measurements.
 - .9 Perform building pressurization tests and measurements at minimum and maximum outdoor air damper positions of the main air unit(s).
- .4 When balancing air outlets:
 - .1 Rough balance furthest outlets and then balance sequentially back to source.
 - .2 Fine balance furthest outlet back to source.
- .5 Take static pressure readings and air supply temperature readings at 10 points on each air system.
- .6 Make air quantity measurements in ducts by "Pitot Tube" traverse of entire cross sectional area. If readings are inconsistent across duct, relocate to two duct *diameters *widths and re-do traverse.
- .7 Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control only by duct internal devices such as dampers and splitters.
- .8 Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.
- .9 Where modulating dampers are provided, take measurements, and balance at extreme conditions. (Balance variable volume systems at maximum air flow rate - full cooling, and at minimum air flow rate - full heating).

- .10 The final balanced condition of each area shall include testing and adjusting of pressure conditions. Test and record building pressurization levels in the aquatic space throughout full range of fan delivery rates, under both clean & dirty filter conditions. Document abnormal building leakage conditions noted.
- .11 Complete balancing to achieve positive building pressure with respect to lobby. A positive pressure relative to outside of 10 Pa minimum and 20 Pa maximum shall be achieved, measured with negligible outside wind velocity.

3.5 Verification

- .1 Reported results subject to verification by the Departmental Representative's Consultant.
- .2 Provide personnel and instrumentation to verify up to 30% of reported results.
- .3 Number and location of verified results as directed by the Departmental Representative's Consultant.
- .4 Pay costs to repeat TAB as required to satisfaction of the Departmental Representative's Consultant.

3.6 Settings

- .1 After TAB is completed to satisfaction of the Departmental Representative's Consultant, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

3.7 Completion of TAB

- .1 TAB is considered complete when final TAB Report received and all results are accepted by the Departmental Representative's Consultant.

END OF SECTION

1. GENERAL

1.1 Section Scope

- .1 Internal and external thermal duct insulation, accessories, sealers, and finishes.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical.

1.3 References

- .1 The latest revisions of the following standards shall apply unless noted otherwise.
- .2 Applicable Building Code – Refer to Section 21 05 01 – Common Work Results for Mechanical
- .3 Applicable energy code or standard – Refer to Section 21 05 01 – Common Work Results for Mechanical.
- .4 Thermal Insulation Association of Canada (TIAC) – National Insulation Standards.
- .5 British Columbia Insulation Contractors Association (BCICA) – Quality Standard for Mechanical Insulation Manual.
- .6 CAN/ULC S102-M88 – Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
- .7 CGSB 51-GP-52MA – Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation
- .8 ASTM C612 – Standard Specification for Mineral Fiber Block and Board Thermal Insulation
- .9 ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- .10 ASTM C553 – Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
- .11 ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining.
- .12 ASTM C1290 – Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.

1.4 Submittals

- .1 Comply with Division 01 – Submittal Procedures and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and in addition the following:
 - .1 Certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Manufacturer's installation instructions.

1.5 General Requirements

- .1 The Installation firm shall be a current member of one of the following:
 - .1 Thermal Insulation Association of Canada (TIAC).
 - .2 British Columbia Insulation Contractors Association (BCICA).
 - .3 Thermal Insulation Association of Alberta (TIAA).

- .2 Only Journeyman insulation applicators, with 3 years minimum successful experience in this size and type of project, shall perform the work.
- .3 Definitions:
 - .1 "CONCEALED" insulated mechanical services in trenches, chases, furred spaces, shafts and hung ceilings (services in tunnels are not considered to be concealed.)
 - .2 "EXPOSED" will mean not concealed.
 - .3 "K" value means Thermal Conductivity
 - .4 "UNCONDITIONED SPACE" referred to in the duct thickness tables are crawlspaces (vented or not vented), parkades, warehouse space, shipping and receiving areas and other areas noted on the drawings.
 - .5 "EXTERIOR SPACE" referred to in the duct thickness tables are all spaces outside the building insulation envelope, including attic spaces, unless noted otherwise.
 - .6 UL GREENGUARD: Provides independent third-party, Indoor Air Quality (IAQ) certification of products for emissions of respirable particles and Volatile Organic Compounds (VOC's), including formaldehyde and other specific product-related pollutants. Certification is based upon criteria used by Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA) and World Health Organization (WHO).
 - .7 ASJ: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper
 - .8 SSL: Self-Sealing Lap.
 - .9 FSK: Foil Scrim Kraft; jacketing.
 - .10 PSK: Poly Scrim Kraft; jacketing.
 - .11 PVC: PolyVinyl Chloride.
- .4 Unless otherwise specified, insulation system materials inside 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 ULC S102, Surface Burning Characteristics of Building Materials, and Assemblies.
- .5 Provide thermal insulation on all HVAC ductwork and as follows:
 - .1 Heating only duct and plenum – service temperature 20°C to 65°C (68°F to 149°F)
 - .2 Cooling only or combined cooling and heating duct and plenum - service temperature 5°C to 65°C (41°F to 149°F)
 - .3 Outside air duct and plenum - -40°C (-40°F) to ambient
 - .4 All exhaust air ductwork from outside wall or roof to damper but a minimum of 3 m (10 ft.) inside building.
 - .5 Supply and return ductwork exposed in the space being served does not require insulation unless noted otherwise.
 - .6 Where an internal duct liner is used in lieu of external insulation, the internal thickness shall match that of the "Rigid Exterior Duct Insulation" table.
 - .7 Insulation may be omitted on heating only ductwork in return air plenums provided the ductwork serves that area.
- .6 Provide acoustic internal insulation on ductwork as follows:
 - .1 All ductwork indicated on drawings with cross hatching.
 - .2 All exposed supply and return ductwork in mechanical rooms from fan discharge to duct shaft or mechanical room perimeter wall.

- .3 Where internal insulation is required, external insulation may be reduced or omitted by an equivalent thickness.

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 Refer to Section 23 05 01 – Acceptable Manufacturers

2.2 General

- .1 Products shall not contain asbestos, lead, mercury, mercury compounds or Polybrominated diphenyl ethers (PBDE).
- .2 Mineral fibre specified includes glass wool and rock wool.
- .3 The RSI value shall not be reduced from the specified values when tested in accordance with ASTM C1290.
- .4 Insulation and jacketing materials shall not exceed 25 flame spread, 50 smoke developed rating when tested in accordance with CAN/ULC S102-M88.
- .5 Elastomeric insulation shall comply with NFPA 90A, 90B and ASTM C1534
- .6 Foam insulation products shall not use CFC or HCFC blowing agents in the manufacturing process and be formaldehyde free.
- .7 Glass mineral wool products shall have a recycled content of a minimum of 50 percent recycled glass content.
- .8 Low Emitting Materials: For all thermal and acoustical applications of glass mineral wool insulation, insulation shall be UL GREENGUARD Certified.

2.3 Intermediate Temperature Range Insulation

- .1 External rigid Insulation (TIAC C-1):
 - .1 Service temperature 5°C to 232°C (41°F to 450°F)
 - .2 Glass mineral wool board for low and medium temperature applications.
 - .3 Complying with ASTM C1071 and CGSB 51-GP-52MA
 - .4 All service aluminum foil-scrim kraft (FSK) jacket with glass fibre reinforcement, factory applied.
 - .5 Density 36kg/m³ (2.25 PCF)
 - .6 Minimum RSI 0.76/25mm (R 4.3/in)
- .2 External flexible duct wrap insulation (TIAC C-2):
 - .1 Service temperature 5°C to 121°C (41°F to 250°F)
 - .2 For service temperatures above 121°C refer to 2.4 High Temperature Insulation
 - .3 Glass mineral wool flexible blanket for low and medium temperature applications.
 - .4 Complying with CGSB 51-GP-52MA, ASTM C1071 and ASTM C553.
 - .5 All service aluminum foil-scrim kraft (FSK) jacket with glass fibre reinforcement, factory applied.
 - .6 Density 12kg/m³ (0.75PCF),
 - .7 Minimum RSI 0.49/25mm (R 2.8/in) (installed)
- .3 Internal rigid duct liner:

- .1 Rigid glass mineral wool board, for low and medium temperature acoustical applications.
- .2 Complying with ASTM C1071 and CGSB 51-GP-52MA
- .3 Airstream surface faced with a black mat bonded to the glass mineral wool substrate.
- .4 Air velocity rating 25.4 m/s (5,000 ft/min)
- .5 Density 48kg/m³ (3 PCF),
- .6 Minimum RSI 0.76/25mm (R 4.3/in)
- .7 Sound absorption coefficients (type 'A' mounting):

Thickness		Frequency (Hz.)						
mm	inches	125	250	500	1000	2000	4000	NRC
25	1	0.13	0.24	0.56	0.83	0.92	0.98	0.65
40	1.5	0.19	0.41	0.89	1.02	1.03	1.04	0.85
50	2	0.33	0.67	1.07	1.07	1.03	1.06	0.95

- .4 Internal flexible duct liner:
 - .1 Flexible glass mineral wool blanket, for low and medium temperature acoustical applications.
 - .2 Complying with CGSB 51-GP-52MA, ASTM C1071 and ASTM C553.
 - .3 Airstream surface faced with non-woven fiberglass mat bonded to the glass mineral wool substrate.
 - .4 Air velocity rating 25.4 m/s (5,000 ft/min)
 - .5 Density 24kg/m³ (1.5 PCF)
 - .6 Minimum RSI 0.74/25mm (R 4.2/in)
 - .7 Sound absorption coefficients (type 'A' mounting):

Thickness		Frequency (Hz.)						
mm	inches	125	250	500	1000	2000	4000	NRC
25	1	0.18	0.36	0.59	0.86	0.95	0.9	0.7
40	1.5	0.35	0.51	0.83	0.93	0.97	0.96	0.8
50	2	0.34	0.64	0.96	1.03	1	1.03	0.9

2.4 High Temperature Range

- .1 External flexible insulation (TIAC C-2):
 - .1 Service temperature 121°C to 538°C (250°F to 1000°F)
 - .2 Rock mineral wool or glass mineral wool flexible blanket for medium and high temperature applications.
 - .3 Complying with ASTM C553 and ASTM C1290.
 - .4 Density 25.6kg/m³ (1.6PCF),
 - .5 Minimum RSI 0.76/25mm (R 4.3/in)
- .2 External flexible fire barrier insulation:
 - .1 Service temperature to 538°C (1000°F)

- .2 Glass fiber or mineral fiber flexible batt and blanket, encapsulated in an aluminum foil fibreglass reinforced scrim covering.
- .3 Nominal 40mm (1.5") thick
- .4 Fire Resistance: For use in 1 hour fire resistant systems (single layer).
- .5 Fire Resistance: For use in 2 hour fire resistant systems (double layer)
- .6 Density 93.6 kg/m³ (6PCF),
- .7 Minimum RSI 0.89 (R 6.4)
- .8 Complying with ASTM E 2336 - Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems

2.5 Fastenings, Adhesives and Coatings

- .1 Insulation Fastenings:
 - .1 Min. 1.6 mm thick (16 ga) galvanized wire , 0.6 mm thick aluminium wire, 0.6 mm thick type 304 stainless steel wire or 1.6 mm thick copper wire.
 - .2 Mechanical fasteners, welded fasteners or adhesive fasteners to meet SMACNA HVAC Duct Construction Standard for mechanical fasteners.
- .2 Corner Beads: Galvanized steel or aluminum 38 mm x 38 mm x 0.37 mm thick.
- .3 Jacket Fastenings:
 - .1 Thermocanvas and All Service Jacket: Staples (flare type), compatible jacket finishing tape, contact adhesives recommended by the jacket manufacturer.
 - .2 Metal Jackets: Sheet metal screws, pop rivets.
- .4 Adhesives:
 - .1 Fabric adhesive to insulation covering, water based, ultra white, washable, anti-microbial.
 - .2 Internal elastomeric insulation adhesive shall be as per manufacturer's recommendations.
- .5 Coatings: Vapour barrier coating on reinforcing membrane.

2.6 Finish Jackets

- .1 Thermocanvas Jacket: fire rated, 170g (6 oz) fire retardant canvas jacket for covering mechanical insulation indoors, 25/50 fire class, plain wave cotton, no dyes.
- .2 Aluminum Jacket: 51 mil (22 ga.) thick stucco or smooth aluminum jacketing with longitudinal slip joints and 50mm (2") end laps with factory applied protective liner on interior surface.
- .3 Bitumen Membrane: 55 mil composite membrane consisting of a multiply embossed UV-resistant aluminum foil/polymer laminate over a layer of rubberized asphalt specially formulated for use on insulated duct and piping applications.

3. EXECUTION

3.1 General

- .1 Installation shall be to Thermal Insulation Association of Canada (TIAC): National Insulation Standards and the following:

3.2 Rigid Insulation External Application

- .1 Heating only Duct and Plenum – Service Temperature 20° to 65°C (CER/1)
 - .1 Fix mechanical fasteners to both horizontal and vertical surfaces at approximately 300 mm centers, each direction.
 - .2 Provide insulation without integral vapor retarder with horizontal surfaces overlapping vertical surfaces and edges tightly butted together. Secure insulation by impaling on mechanical fasteners.
 - .3 In areas of limited space wire fastenings, insulation adhesive, or other suitable methods of attachment may be substituted.
- .2 Cooling only or Combined Cooling and Heating Duct and Plenum - Service Temperature 5°C to 65°C (CER/2)
 - .1 Fix mechanical fasteners to both horizontal and vertical surfaces at approximately 300 mm centers, each direction.
 - .2 Install vapor retarder toward the ambient atmosphere with horizontal surfaces overlapping vertical surfaces tightly butted together. Secure insulation by impaling on mechanical fasteners.
 - .3 Where mechanical fasteners penetrate vapor retarder, and at all corners and joints, apply self adhesive vapor retarder tape or vapor retarder strips adhered with vapor retarder adhesive. Where raised seams are encountered, add a strip of insulation above seam termination on each side of the seam, secure to the seams an overlapping strip of insulating material of equal thickness to the one required to provide a continuous vapor retarder. Seal all joints and edges with self adhesive vapor retarder tape.
 - .4 In areas of limited space wire fastenings, insulation adhesive, or other suitable methods of attachment may be substituted.
- .3 Outside Air Duct and Plenum - -40°C to Ambient (CER/3)
 - .1 As per CER/2 application but firstly apply a layer of rigid insulation without vapor retarder before applying layer of rigid insulation with vapor retarder. All joints shall be staggered.

3.3 Flexible Insulation External Application

- .1 Heating only Duct and Plenum – Service Temperature 20°C to 65°C (CEF/1)
 - .1 On rectangular ducts ≥ 600 mm in width, apply mechanical fasteners to the bottom surface at approximately 300 mm centres.
 - .2 Apply insulation without integral vapour retarder with 50 mm overlap at each joint. Secure insulation with wire fastening on approximately 300 mm centres, or by stapling laps.
- .2 Cooling only or Combined Cooling and Heating Duct and Plenum – Service Temperature 5°C to 65°C (CEF/2)
 - .1 On rectangular ducts ≥ 600 mm in width, apply to bottom surface mechanical fasteners at approximately 300 mm centers.
 - .2 Apply insulation with vapor retarder to the outside.
 - .3 Where mechanical fasteners or staples penetrate the vapor retarder and at all joints apply vapor retarder tape or vapor retarder strips adhered with vapor retarder adhesive.
 - .4 All joints shall be overlapped a minimum of 50 mm and stapled on approximately 100 mm centers.

- .5 Secure insulation with wire fastening on approximately 300 mm centers.
- .3 Heating only Duct and Plenum Fire Barrier – ambient to 538°C (1000°F)
- .1 As per manufacturers installation instructions

3.4 Duct Insulation Minimum Thickness Table (ASHRAE 90.1-2016 Zone 5)

Rigid Exterior Duct Insulation				
Duty	Plenum-Concealed (4)	Duct Location		
		Interior		Exterior
		Conditioned Space	Unconditioned Space	
Minimum Insulation Thickness in mm (in.)				
Cooling Only Air Supply	25 (1")	25 (1")	40 (1-1/2")	50 (2")
Heating or H/C Air Supply	25 (1")	25 (1")	40 (1-1/2")	75 (3")
Outdoor Air Supply	40 (1-1/2")	40 (1-1/2")	40 (1-1/2")	0
Combustion Air	40 (1-1/2")	40 (1-1/2")	40 (1-1/2")	0
Return Air	0	0	40 (1-1/2")	75 (3")
Exhaust Air (1)(2)	0	0	25 (1")	25 (1")
Grease Hood Exhaust (5)	N/A	40 (1-1/2")	40 (1-1/2")	0
Tempered Air Supply or Makeup Air	0	0	40 (1-1/2")	75 (3")
Mixed Air (3)	25 (1")	25 (1")	40 (1-1/2")	75 (3")
See note (6) for factory installed duct and plenums				

Flexible Exterior Duct Insulation				
Duty	Plenum-Concealed (4)	Duct Location		
		Interior		Exterior
		Conditioned Space	Unconditioned Space	
Minimum Insulation Thickness in mm (in.)				
Cooling Only Air Supply	25 (1")	25 (1")	56 (2-3/16")	75 (3")
Heating or H/C Air Supply	25 (1")	25 (1")	56 (2-3/16")	115 (4.5")
Outdoor Air Supply	50 (2")	50 (2")	56 (2-3/16")	0
Combustion Air	50 (2")	50 (2")	56 (2-3/16")	0
Return Air	0	0	56 (2-3/16")	115 (4.5")
Exhaust Air (1)(2)	0	0	40 (1-1/2")	40 (1-1/2")
Grease Hood Exhaust (5)	N/A	40 (1-1/2")	40 (1-1/2")	0
Tempered Air Supply or Makeup Air	0	0	56 (2-3/16")	115 (4.5")
Mixed Air (3)	40 (1-1/2")	40 (1-1/2")	56 (2-3/16")	115 (4.5")
See note (6) for factory installed duct and plenums				

Note (1): Air temperatures 15°C to 49°C (60°F to 120°F)

Note (2): Provide 40mm (1-1/2") flexible duct insulation on all exhaust air ductwork from outside wall or roof to damper but a minimum of 3 m (10 ft.) inside building.

Note (3): Mixed Air includes tempered air downstream of heat recovery units

Note (4): Plenums located outside the building shall be insulated to the values listed in the exterior column.

Note (5): Provides 1 hour fire rating. Thickness shall be doubled for 2 hour applications.

Note (6): Factory installed ductwork and plenums provided with equipment need not comply with this table provided they meet the requirements of the relevant CSA Standard for that equipment and is insulated to RSI 0.58 (R3.3) or greater. Refer to NECB article 5.2.12.1 for relevant CSA Standards.

3.5 Liner Internal Application

.1 General

- .1 Where an interior duct liner is used, external insulation shall not be applied unless noted otherwise.
- .2 Where an interior duct liner is used, the thickness shall be selected to match the thickness specified for external rigid insulation. Where no external insulation is required internal acoustic duct liner shall be a minimum 25mm (1").

.2 Rigid Duct Liner (CIR/1)

- .1 Fix mechanical fasteners to both horizontal and vertical surfaces at approximately 300 mm centers each direction.
- .2 Apply insulation with surfaces overlapping vertical surfaces and with edges tightly butted together.
- .3 Insulation shall be applied to the ductwork with a minimum 90% coverage of adhesive and mechanical fasteners.
- .4 Where mechanical fasteners penetrate factory finish and at all joints, apply a heavy layer of seal coating.
- .5 On high velocity duct systems 20 m/s to 30 m/s (4000 fpm -6000 fpm) apply reinforcing membrane over the entire insulation joint surface.
- .6 Seal off leading edge of insulation to duct surface on low velocity ductwork with reinforced seal coating or metal nosing. On high velocity duct systems, (over 20 m/s (4000 fpm) use metal nosing.

.3 Flexible Duct Liner (CIF/1)

- .1 Fix mechanical fasteners to both horizontal and vertical surfaces at approximately 300 mm centers each direction.
- .2 Apply insulation with edges tightly butted together.
- .3 Insulation shall be applied to the ductwork with a minimum 90% coverage of adhesive and mechanical fasteners.
- .4 Where mechanical fasteners penetrate factory finish and at all joints, apply a heavy layer of seal coating.
- .5 On high velocity duct systems 20 m/s to 30 m/s (4000 fpm -6000 fpm) apply reinforcing membrane over the entire insulation joint surface.
- .6 Seal off leading edge of insulation to duct surface on low velocity ductwork with reinforced seal coating or metal nosing. On high velocity duct systems, (over 20 m/s (4000 fpm) use metal nosing.

3.6 Finishes

.1 General

- .1 Insulation on concealed ductwork shall be left with factory finish. No further finish is required.
- .2 The following finishes apply to exposed ductwork and plenums only.
- .2 Canvas Jacket – Indoor (CRF/1) (CRD/1)
 - .1 Use over rigid insulation for rectangular ductwork and flexible insulation for round ductwork, all with an integral vapor retarder. Apply continuous metal corner bead to all corners. Adhere vapor retarder tape over all joints and breaks in vapor retarder, and at all corners.
 - .2 Secure canvas jacket over insulation using fire resistive lagging coating and adhesive, and finish with one (1) coat of fire resistive lagging coating adhesive.
- .3 Utility Finish – Indoor (CRF/2) (CRD/2)
 - .1 Use over rigid insulation for rectangular ductwork and flexible insulation for round ductwork, all with an integral vapor retarder. Apply continuous metal corner bead to all corners. Adhere vapor retarder tape over all joints and breaks in vapor retarder, and at all corners.
- .4 Aluminum Jacket – Outdoor (CRF/3) (CRD/3)
 - .1 Adhere vapour retarder tape over all joints and breaks in vapor retarder and at all corners on cold or dual temp ductwork.
 - .2 Apply over the insulation surface a stucco embossed aluminum jacket secured with pop rivets or stainless steel self tapping screws. All joints sealed or flashed to prevent water infiltration.

3.7 Duct Finishes Table

- .1 Conform to the following:

Duty	Rectangular Duct		Round Duct	
	Type	TIAC Code	Type	TIAC Code
Indoor Concealed	None	None	None	None
Indoor Exposed in Mechanical Room & Elsewhere except Utility Areas	Canvas Jacket	CRF/1	Canvas Jacket	CRD/1
Indoor Exposed in Utility Areas, Parkade, Etc.	Utility Finish	CRF/2	Utility Finish	CRD/2
Outdoor Exposed to Precipitation	Aluminum Jacket	CRF/3	Aluminum Jacket	CRD/3

END OF SECTION

1. GENERAL

1.1 Summary

.1 Section Includes:

- .1 Materials and installation for piping, valves and fittings for gas fired equipment.

1.2 Related Requirements:

- .1 This section of the Specification forms part of the Contract Documents and shall be read, interpreted, and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical.
- .3 Section 23 05 01 - Acceptable Manufacturers.
- .4 Section 23 05 15 – Common Installation Requirements for HVAC Pipework.
- .5 Section 23 08 01 – Performance Verification of Mechanical Piping Systems.

1.3 References

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.3 – 2016, Malleable Iron Threaded Fittings: Classes 150 and 300
 - .2 ASME B16.5 - 2017, Pipe Flanges and Flanged Fittings.
 - .3 ASME B16.18 - 2012, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .4 ASME B16.22 - 2013, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
 - .5 ASME B18.2.1 - 2012, Square and Hex Bolts and Screws Inch Series.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A47/A47M – 99 (2014), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M - 18, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
 - .3 ASTM A106/A106 M – 18, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
 - .4 ASTM A179/A179M – 90a (2012), Standard Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes
 - .5 ASTM B75M - 11, Standard Specification for Seamless Copper Tube [Metric].
 - .6 ASTM B837 - 10, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.
 - .7 ASTM B88 – 16, Standard Specification for Seamless Copper Water Tube
- .3 Canadian Standards Association (CSA International)
 - .1 CSA W47.1 - 2009, Certification of Companies for Fusion Welding of Steel.
- .4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)
 - .1 CAN/CSA B149.1 - 20, Natural Gas and Propane Installation Code
 - .2 CAN/CSA B149.2 - 20, Propane Storage and Handling Code

- .3 ANSI/LC 1-2018/CSA 6.26 – 2018, Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.4 Scope of Work

- .1 Connect to the utility company's gas meter set.
- .2 Provide all natural gas piping, fittings, valves, pressure regulators, unions, hangers and supports, and all other components as required for a complete installation generally as depicted on the drawings.
- .3 Distribute natural gas to all natural gas outlets, appliances and equipment that require gas service including gas fired air handling units,.
- .4 Connect natural gas piping to existing gas piping at locations indicated on the drawings.
- .5 Remove all unused or redundant natural gas piping throughout the renovated or demolished areas of the project where access is readily available, or cap off and abandon in place as referenced on the drawings.

1.5 Quality Assurance

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29. 06 - Health and Safety Requirements.
- .2 Submit to the required authority all documentation and detailed drawings as required, pay for and obtain a permit and approval for the natural gas installation prior to commencing work.
- .3 All materials and installations shall comply with CAN/CSA B149.1 Natural Gas and Propane Installation Code and amendments and material and equipment manufacturer's specifications and referenced documents.

1.6 Delivery, Storage and Handling

- .1 Waste Management and Disposal:
 - .1 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard and packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Place materials defined as hazardous or toxic in designated containers.
 - .4 Fold up metal banding, flatten and place in designated area for recycling.

1.7 Painting and Colour Coding

- .1 Painting of all natural gas piping, equipment and material installed under this Division of the specification shall be included under this Division of the work.
- .2 Paint all exterior piping including the section of piping from the gas meter to the building entry, piping installed above the roof, piping installed in underground parking garages and all exterior pressure regulating valve vent piping.
- .3 Painting shall consist of one coat of Rust-Oleum 769 damp proof red primer, one coat of Rust-Oleum 960 zinc chromate and two finish coats of Rust-Oleum 850 grey enamel paint.

- .4 Provide yellow colour coding identification banding of the natural gas piping as required by the gas code. Also refer to Section 23 05 53 Identification for Mechanical Piping and Equipment.

1.8 Gas Utility Connection

- .1 Arrange and pay for the natural gas connection to the gas utility's distribution system. The contractor shall obtain shop drawings for all gas fired appliances and equipment and supply all gas input load information based upon the actual equipment being supplied and installed.
- .2 Coordinate with the gas utility company for natural gas service including installation of a meter set located as shown on the drawings.
- .3 Connect to the gas utility's natural gas meter set and enter the building above grade. Seal the space around the pipe with backer rod and silicone sealant to provide a weatherproof seal and leave a neat finished appearance.

1.9 Submittals

- .1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheets for fixtures and equipment.
 - .2 Indicate dimensions, performance, construction details and materials for specified items.
- .3 Shop Drawings:
 - .1 Submit shop drawings to indicate materials, finishes, method of anchorage, dimensions, construction and assembly details and accessories for the following:
 - .1 Shut off valves (including manual, solenoid and seismic actuated shut off valves)
 - .2 Pressure regulators
 - .3 Pressure relief valves
 - .4 Corrugated stainless steel tubing (CSST) and fittings
 - .5 Strainers.
 - .6 Emergency gas control valves and boxes
 - .7 Manufactured pipe supports
 - .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .5 Instructions: submit manufacturer's installation instructions.
 - .6 Closeout submittals:
 - .1 Closeout submittals shall be in accordance with Section 01 78 00 Closeout Submittals.
 - .2 Submit maintenance and engineering data for incorporation into maintenance manuals.

1.10 Closeout Procedures:

- .1 Closeout procedures shall be in accordance with Section 01 77 00 Closeout Procedures.

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 Comply with Section 23 05 01 – Acceptable Manufacturers.

2.2 Pipe and Tubing

- .1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:
 - .1 NPS 1/2 to 2, screwed.
 - .2 NPS 2 1/2 and over shall be welded.
- .2 Tubing:
 - .1 Copper tube:
 - .1 Type G tube: to ASTM B837.
 - .2 Type K and L tube: to ASTM B88.
 - .3 Copper tubing for underground use shall be Type K, Type L or Type G. Type L or Type G shall be externally coated with extruded polyethylene or PVC resin at the time of manufacturer.
 - .2 Corrugated stainless steel tubing (CSST):
 - .1 To ANSI/LC 1 “Fuel Gas Piping Systems Using CSST” and CSA 6.26.
 - .2 Maximum operating pressure of 34.5 kPa (5 psi).
 - .3 Material: ASTM A240 type 304 corrugated stainless steel tubing with minimum wall thickness of .010”.
 - .4 UV resistant polyethylene jacketing meeting the requirements of ASTM E84 for flame spread and smoke density.
 - .3 Seamless steel tubing: to ASTM A179/A179M.

2.3 Jointing Material

- .1 Screwed fittings: pulverized lead paste.
- .2 Welded fittings: to CSA W47.1.
- .3 Flange gaskets: non-metallic flat.
- .4 Brazing: to ASTM B837.

2.4 Fittings

- .1 Steel pipe fittings, screwed, flanged or welded:
 - .1 Fittings used with steel pipe shall be either malleable iron or steel and shall comply with ANSI/ASME B16.3 or shall be certified to Standard ANSI LC-4/CSA 6.32.
 - .2 Steel pipe flanges and flanged fittings: to ASME B16.5.
 - .3 Welding: butt-welding fittings.
 - .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.
 - .5 Bolts and nuts: to ASME B18.2.1.
 - .6 Nipples: schedule 40, to ASTM A53/A53M.
 - .7 Flare nuts shall be forged from UNS C37700 brass and shall not be externally machined.

- .2 Tubing:
 - .1 Copper tube fittings:
 - .1 Screwed, flanged or soldered:
 - .1 Cast copper fittings: to ASME B16.18.
 - .2 Wrought copper fittings: to ASME B16.22.
 - .2 Corrugated stainless steel tubing (CSST): to ANSI/LC 1/CSA 6.26:
 - .1 Mechanical tube fittings manufactured from ASTM B16 type 360 brass with double wall flare sealing for gas tight seal and continuous conductivity.
 - .2 Threads according to ASME B1.20.1 for connection to threaded pipe or fittings.
 - .3 Seamless steel tubing: to ASTM A179/A179M.
 - .4 Tube fittings shall be rated for a working pressure of not less than 860 kPa (125 psi) for operating pressures of 860 kPa (125 psi) or less. For operating pressures above 860 kPa (125 psi), tubing and fittings shall be rated for a minimum of 1725 kPa (250 psi).

2.5 Manual Isolation Valves

- .1 Provincial Code approved, lubricated plug, ball or eccentric type suitable for the temperature to which they are exposed.

2.6 Pressure Regulating Valves

- .1 High tensile iron body with synthetic rubber diaphragm and valve disc.
- .2 CSA listed for use with natural gas.

2.7 Strainers

- .1 Y strainer suitable for natural gas application and system pressure requirements.
- .2 Carbon steel construction with stainless steel screens.
- .3 Up to NPS 2: Threaded or socket welded.
- .4 NPS 2-1/2 and over: Flanged.

2.8 Seismic Actuated Shut-off Valves

- .1 Seismic actuated automatic shut-off valves, 20 mm [3/4"] to 150 mm [6"]:
 - .1 CSA, UL and State of California certified seismic gas shut-off valve with acceleration trigger mechanism, soft seat construction, visual open/close indicator and a manual reset capable of operating between -23°C [-10°F] to 65°C [150°F].
 - .2 The sensing means of the valve shall actuate the shut off within 5 seconds when subjected to a horizontal sinusoidal oscillation having a peak acceleration of 0.3 G (2.94 metres/second² [9.65 feet/second²]) and a period of 0.4 seconds.

3. EXECUTION

3.1 Manufacturer's Instructions

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 Piping

- .1 Install in accordance with Section 23 05 15 – Common Installation Requirements for HVAC PIPework, CAN/CSA B149.1, CAN/CSA B149.2.
- .2 Piping and fittings shall be clear and free from cutting burrs, threading burrs, scale and defects.
- .3 The ends of all piping shall be reamed.
- .4 Piping or tubing shall not be supported by other piping or tubing and shall be installed with individual supports of sufficient strength and quality spaced as required by CSA B149.1
- .5 No gas piping shall be installed below the building.
- .6 Install drip points:
 - .1 At low points in piping system.
 - .2 At connections to equipment.
- .7 Corrugated stainless steel tubing (CSST) shall not be used as a gas connector.
- .8 Any portion of copper tubing that extends above ground shall be protected against physical damage.
- .9 Above Ground Exterior Piping
 - .1 Allow for expansion with suitable anchors, guides and expansion loops to prevent undue stress on any part of the system. Rigidly fasten anchors and guides to structural members through the roof deck for roof mounted piping. Set roof supports in sheet metal gum pans wrapped into the roofing. Coordinate with the roofing subtrade.
 - .2 All piping shall be welded with approved flexible connectors at the point of connection to gas fired equipment.
 - .3 Paint exterior piping as noted above.

3.3 Pipe Jointing

- .1 Cut pipe ends square utilizing proper pipe cutting tools. Ream pipe ends and clean scale and dirt from inside and outside the pipe before and after assembly.
- .2 Protect all openings in piping and equipment, by capping or plugging to prevent the entry of dirt or debris during construction.
- .3 Slope piping down in the direction of flow to low points and provide dirt legs with capped ends.
- .4 Interior gas piping - screw or weld up to 50 mm [2"]; weld 65 mm [2½"] and larger.
- .5 Interior gas piping located in unvented spaces, in supply or return air ceiling plenums, or operating at 34.5 kPa [5 psi] pressure or higher - weld all sizes.
- .6 Exterior gas piping - weld all sizes except for polyethylene pipe which shall have no joints other than those allowed in CSA B149.1, Natural Gas and Propane Installation Code.
- .7 Use welding tees to make all branch connections, except those less than half the diameter of the main. Branch connections less than half the diameter of main may be made with weldolets or threadolets.
- .8 Use eccentric reducers at changes in pipe size, to provide for positive drainage.
- .9 Remake all leaking joints.
- .10 Do not paint dielectric isolating couplings.

- .11 Provide pressure regulators and lockable shut-off valves at the discharge of the gas meter before entry into the building.
- .12 Provide heat shrink factory extruded polyethylene sleeves over bare metallic pipe at welds.

3.4 Connections to Equipment, Appliances and Specialty Components

- .1 Provide a manual isolation valve on each branch line to an individual piece of equipment, appliance and gas outlet or specialty component upstream of dirt legs, unions and flanges.
- .2 Install unions or flanges on connections to all pressure regulators, equipment, appliances and specialty components.
- .3 Arrange piping connections to allow ease of access and for removal of equipment.
- .4 Align and independently support piping connections to prevent piping stresses being transferred to equipment.

3.5 Manual Isolation Valves

- .1 Install valves with stems upright or horizontal unless otherwise approved by Consultant.
- .2 Install natural gas manual isolation valves complete with handles at the following locations:
 - .1 At branch take-offs to isolate pieces of equipment, and as indicated.
 - .2 At all locations shown on the drawings.
 - .3 At each branch supply line from a common meter set.
 - .4 At the service entry point to each building immediately prior to entry.
 - .5 At each branch or riser connection from the main.
 - .6 Immediately upstream of all pressure regulating valves.
 - .7 At each service to a classroom, laboratory or similar facility (install valves in a readily accessible location within that room).
 - .8 At each service to each laboratory bench (install valves in readily accessible locations).
- .3 All building isolation valves shall possess locking lugs.

3.6 Seismic Actuated Shut-off Valves

- .1 Install natural gas seismic actuated automatic shut-off valves at the service entry point to each building immediately prior to entry.

3.7 Pressure Regulating Valves

- .1 Install pressure regulating valves in each equipment room or at each piece of equipment where the natural gas supply pressure exceeds low pressure ("W.C.).
- .2 Pipe the relief vent ports full diameter to atmosphere in accordance with the requirements of CSA B149.1, Natural Gas and Propane Installation Code.

3.8 Natural Gas Outlets

- .1 Provide natural gas outlets at all locations shown on the drawings.

3.9 Emergency Gas Control Valves

- .1 Provide emergency natural gas control valves at all locations shown on the drawings.

3.10 Vent Terminals

- .1 Terminate vent outlets to atmosphere at the following minimum lateral distances:
 - .1 1.5 metres [5 feet] from any door, openable window or building opening including building mechanical exhaust openings and louvers.
 - .2 3.0 meters [10 feet] from any mechanical forced air intake.

3.11 Testing

- .1 Pressure test all piping in accordance with CSA B149.1, Natural Gas and Propane Installation Code.
- .2 Examine all joints for leaks and remake all leaking joints with new materials.
- .3 Purge all piping after pressure tests in accordance with CSA B149.1, Natural Gas and Propane Installation Code.
- .4 Submit copies of pressure test reports for all sections of piping.

3.12 Adjusting

- .1 Purging: purge after pressure test in accordance with CAN/CSA B149.1.
- .2 Pre-Start Up Inspections:
 - .1 Check vents from regulators and control valves. Terminate outside of building in approved locations protected against damage and blockage.
 - .2 Check gas trains, entire installation is approved by authority having jurisdiction.

3.13 Cleaning

- .1 Cleaning: in accordance with CAN/CSA B149.1, supplemented as specified. Clean all piping systems to remove all dirt, coatings and debris. Remove all valves, controls etc., and reinstall after piping system has been cleaned.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. GENERAL

1.1 Section Scope

- .1 Materials and installation of low-pressure and high pressure metallic ductwork, flexible ductwork, underground ductwork, joints and accessories.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical
- .3 Section 23 32 00 – Air Plenums and Casings
- .4 Section 23 33 00 – Duct Accessories

1.3 References

- .1 The latest revisions of the following standards shall apply unless noted otherwise.
 - .1 National Fire Protection Association (NFPA)
 - .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
 - .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
 - .2 SMACNA - HVAC Air Duct Leakage Test Manual.

1.4 Submittals

- .1 Comply with Division 01 – Submittal Procedures and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and in addition the following:
 - .1 Shop Drawings:
 - .1 Sealants, tapes, proprietary joints.

1.5 General Requirements

- .1 Duct sizes on drawings indicate clear inside dimensions. For acoustically lined or internally insulated ducts, maintain inside duct dimensions.
- .2 Where duct sizes are shown in nominal metric sizes, round and oval duct sizes may be supplied in nearest available sizes in equivalent imperial units.
- .3 Provide openings of correct size and locations through slabs and walls. Openings shall be planned to include installation of fire dampers at all rated fire separations.
- .4 Where ducts penetrate roofs, provide roof curbs with flashing, and counter flashing. Ensure that penetration details are coordinated with the Building Envelope Consultant and Architect.
- .5 The project drawings are diagrammatic and although efforts have been made to provide information regarding the number of offsets and transitions, not all are necessarily shown. Changes may be required in duct routings, elevation and duct shape to eliminate interference with structure and other services. All required adjustments shall be established when coordinating and field measuring the work prior to fabrication and must be provided as part of the contract and all associated costs must be considered and included.

- .6 Ductwork shall be clean and free from scale, corrosion, and deposits. Ductwork shall be degreased and wiped clean of all oil and other surface films with appropriate solvents prior to installation.
- .7 Ductwork shall be delivered clean to the site and maintained in clean condition. Dirty ductwork shall be removed from site.
- .8 Where welded ductwork is indicated, the welding shall be continuous. Tack welding is unacceptable, except as specifically noted. Paint damaged areas with zinc coating after welding.
- .9 In exposed ductwork installations, the contractor shall have a consistent ductwork fabrication methodology. Longitudinal seam ducts shall not be intermixed with spiral seamed ductwork. Slip joint seams shall not be intermixed with flanged type seams where practical. Shop drawing submittals shall also indicate the duct fabrication type - spiral seam versus longitudinal seam, and duct joining method etc.
- .10 The contractor shall allow for the design, supply, and installation of all transition fittings required to connect ductwork to all mechanical equipment (both inlet and outlet connections). Where feasible, the fittings shall be fabricated per SMACNA standards in terms of maximum angles of convergence and divergence. Flexible connections shall be provided for all equipment / duct connections.

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 Refer to Section 23 05 01 – Acceptable Manufacturers.

2.2 Ductwork and Plenum Pressures

- .1 Provide ductwork constructed, reinforced, sealed and installed to withstand 1½ times the working static pressure
- .2 Low Pressure Galvanized Steel Ductwork 500 Pa (2" W.G.) and under
 - .1 Supply ductwork and plenums on systems without terminal mixing boxes or air valves.
 - .2 Supply ductwork downstream from terminal mixing boxes or air valves.
 - .3 Outdoor air ductwork and plenums, unless noted otherwise.
 - .4 Return air ductwork and plenums, unless noted otherwise.
 - .5 Exhaust and relief air ductwork and plenums, unless noted otherwise.

2.3 Duct Sealing Galvanized Steel.

- .1 Low Pressure Ductwork 500 Pa (2" W.G.) and under shall be SMACNA seal class A. Seal all supply, return and exhaust duct joints, longitudinal as well as transverse joints as follows:
 - .1 Slip Joints: Apply heavy brush-on high pressure duct sealant. Apply second application after the first application has completely dried out. Where metal clearance exceeds 1.5 mm (1/16") use heavy mastic type sealant.
 - .2 Flanged Joints: Soft elastomer butyl or extruded form of sealant between flanges followed by an application of heavy brush-on high pressure duct sealant.
 - .3 Other Joints: Heavy mastic type sealant.
- .2 Medium Pressure Ductwork to 1000 Pa (4"W.G.) shall be SMACNA seal class A. Seal all supply, return and exhaust duct joints, longitudinal as well as transverse joints as follows:

- .1 Combination of woven fabrics and sealing compound followed by an application of high pressure duct sealant.
- .3 Duct tapes as sealing method are not permitted, except on residential ductwork – minimum 2 wraps of 2" wide (50mm) foil duct tape is acceptable.
- .4 Surfaces to receive sealant should be free from oil, dust, dirt, moisture, rust and other substances that inhibit or prevent bonding.
- .5 Do not insulate any section of the ductwork until it has been inspected and approved of duct sealant application, by the Consultant.

2.4 Rigid Ductwork - 500 Pa (2" W.G.) Static Pressure

- .1 Provide galvanized steel ductwork for system operating pressures 500 Pa (2" W.G.) and less. Ductwork shall be constructed, reinforced, sealed, and installed to withstand 1½ times the working static pressure.
- .2 Construct rectangular ductwork in accordance with SMACNA Duct Standards Section I.
- .3 Nomasco "Ductmate System, Lockformer TDC" or Exanno "Nexus System" may be used for rectangular duct joints.
- .4 Construct rectangular duct fittings in accordance with the SMACNA Duct Standards Section II.
- .5 Construct round ductwork in accordance with the SMACNA Duct Standards Section III, but excluding beaded crimp joints and snaplock seams.
- .6 Construct flat oval ductwork in accordance with the SMACNA Duct Standards Section III. Joints and seams shall be similar to those indicated for round ducts. Flat oval duct to be used for positive pressure application only.
- .7 Construct round and flat oval duct fittings in accordance the SMACNA Duct Standards Section III. Round elbows shall have a centreline radius of 1.0 times duct diameter. Sheet metal gauge of fittings and elbows shall be not less than the thickness of that specified for longitudinal seam straight duct. Adjustable elbows are not permitted.

2.5 Metallic Fittings

- .1 Fabrication: to SMACNA HVAC Duct Construction Standards - Metal and Flexible, latest edition.
- .2 Radius elbows.
 - .1 Rectangular: standard radius with single thickness turning vanes Centreline radius: 1.5 times width of duct.
 - .2 Round: smooth radius piece.
 - .1 Centreline radius: 1.5 times diameter for ductwork 750 Pa (3" W.G.) and greater
 - .2 Centreline radius: 1 times diameter for ductwork 500 Pa (2" W.G.) and less.
- .3 Mitred elbows, rectangular:
 - .1 Install mitred elbows where space will not permit the use of full radius elbows.

- .2 Provide single thickness turning vanes. Vanes in galvanized sheet metal ducts shall be constructed from galvanized steel, minimum thickness 0.76 mm (22 ga). Vanes shall be spaced at 40 mm (1½") centres and shall turn through 90 deg., with a radius of 50 mm (2"). Vanes shall not include a straight trailing edge. The maximum supported vane length shall be 750 mm (30"). Use multiple single thickness turning vane sections for wider ducts. Install vanes tangent to airflow. Refer to Figs. 2-3 and 2-4 of the SMACNA Duct Construction Standards. Vanes and runners in aluminum ducts shall be constructed from aluminum. Aluminum vanes shall be 0.86 mm (18 ga) thick.
- .4 Branches:
 - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct and 45 degrees entry on branch.
 - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
- .5 Transitions:
 - .1 In accordance with Fig. 2-9 of the SMACNA Duct Construction Standards.
 - .2 Diverging: 20 degrees maximum included angle.
 - .3 Converging: 30 degrees maximum included angle.
 - .4 Maximum divergence upstream of equipment to be 30 deg. and 45 deg. Convergence downstream.
- .6 Offsets:
 - .1 Short radius elbows.
 - .2 Obstruction deflectors: maintain full cross-sectional area.

2.6 Ductwork – Acoustically Lined

- .1 Where round ductwork is indicated to be acoustically insulated, it shall consist of two concentric round ducts with 25 mm (1") thick flexible fibrous glass duct liner between the two ducts. The inner duct shall be perforated and correspond to the duct diameter noted on the drawings. The outer duct shall be suitable for the static pressure and shall be sealed airtight where it joins the adjacent ductwork.

2.7 Ductwork – Outdoors

- .1 The internally or externally insulated supply, return and exhaust ducts (down stream of heat recovery coils) including silencers, located outdoors on the roof, shall be constructed watertight.
- .2 All joints shall be caulked with a water impervious sealant. TDC clips should be continuous on the top and sides of the ducts.
- .3 The top of the finished product (waterproof membrane) should be pitched to avoid pooling of water.

2.8 Hangers and Supports

- .1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for Mechanical Piping and Equipment.
- .2 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
 - .1 Maximum size duct supported by strap hanger: 500 mm.
- .3 Hanger configuration: to SMACNA.

- .4 Hangers: galvanized steel angle with galvanized steel rods to SMACNA per the following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

- .5 Upper hanger attachments:
- .1 For concrete: manufactured concrete inserts.
 - .2 For steel joist: manufactured joist clamp.
 - .3 For steel beams: manufactured beam clamps.

END OF SECTION

1. GENERAL

1.1 Section Scope

- .1 Materials and installation for duct accessories including flexible connections, access doors, and collars.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical
- .3 Section 23 31 00 – HVAC Ducts and Casings
- .4 Section 23 32 00 – Air Plenums and Casings

1.3 References

- .1 The latest revisions of the following standards shall apply unless noted otherwise.
 - .1 National Fire Protection Association (NFPA)
 - .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
 - .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
 - .3 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S112, Fire Test of Fire Damper Assemblies.
 - .2 CAN/ULC-S112.2, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
 - .3 ULC-S505, Fusible Links for Fire Protection Service.

1.4 Submittals

- .1 Comply with Division 01 – Submittal Procedures and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and in addition the following:
 - .1 Submit shop drawings for the following:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Instrument test ports.
 - .4 Control dampers
 - .5 Balancing dampers
 - .6 Backdraft dampers

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 Refer to Section 23 05 01 – Acceptable Manufacturers

2.2 General

- .1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

2.3 Backdraft Dampers – Light Duty

- .1 Minimum Requirements:
 - .1 1.4 mm thick (16 ga) galvanized steel or aluminum channel frame.
 - .2 0.41 mm thick (24 ga) embossed aluminum blades.
 - .3 Full blade length shafts, brass bearings.
 - .4 Felt or neoprene anti-chatter blade strips.
 - .5 Maximum blade height per section, 610 mm (24"), uses multiple sections for larger dimensions.
 - .6 Maximum blade length of 460 mm (18"), use multiple sections for larger dimensions.
 - .7 Manufacturer's label.
 - .8 Where a balanced backdraft damper (BBD) is indicated, the damper shall incorporate an adjustable counterbalance weight and lever.
 - .9 Maximum pressure drop across damper at 4.06 m/s (800 FPM) shall be 62 Pa (0.25" w.g.).

2.4 Backdraft Dampers – Medium Duty

- .1 Minimum Requirements:
 - .1 1.4 mm thick (16 ga) galvanized steel or aluminum channel frame.
 - .2 1.2 mm thick (15 ga) aluminum blades, complete with stiffening ribs/bends.
 - .3 Full blade length shafts; brass, ball, or nylon bearings.
 - .4 Felt or neoprene anti-chatter blade strips.
 - .5 Blade connecting linkage with eyelet and pin bearings.
 - .6 Maximum blade length of 760 mm (30"), use multiple sections for larger dimensions.
 - .7 Manufacturer's label.
 - .8 Where a balanced backdraft damper (BBD) is indicated, the damper shall incorporate an adjustable counterbalance weight and lever.
 - .9 Maximum pressure drop across damper at 4.06 m/s (800 FPM) shall be 62 Pa (0.25" w.g.)

2.5 Balancing Dampers

- .1 Minimum Requirements:
 - .1 Rectangular ducts:
 - .1 Up to 300 mm (12") deep - single blade (butterfly type).
 - .2 330 mm (13") to 400 mm (16") deep - two opposed blades, mechanically interlocked with pivots at quarter points.
 - .3 430 mm (17") deep and over - multiple opposed blades, mechanically interlocked with blades not greater than 200 mm (8") deep and pivots equally spaced.
 - .2 Round Ducts:

- .1 Single blade (butterfly type).
- .3 Material:
 - .1 Minimum 1.47 mm (16 ga) thick galvanized steel blade on all butterfly dampers.
 - .2 Minimum 1.47 mm (16 ga) thick galvanized steel blades on multi-blade dampers with rigidly constructed galvanized steel frame (no frame required on single blade dampers).
 - .3 Minimum 1.14 mm (18 ga) thick stainless steel blades for fume exhaust ducts.
- .4 Bearings:
 - .1 End bearings on all low pressure single blade dampers above 300 mm (12") dia.
 - .2 Bearings on multiple blade dampers shall be bronze oilite type.
- .5 Operating Mechanism:
 - .1 Lockable quadrant type with end bearing on accessible rectangular ducts up to 400 mm (16") deep and on accessible round ducts.
 - .2 Wide pitch screw mechanism type with crank operator on accessible rectangular ducts 430 mm (17") and over in depth and on inaccessible rectangular and round ducts.
 - .3 Override limiting stops.
 - .4 No blade movement in set position.
- .6 Concealed Regulators:
 - .1 For all drywall ceilings, which do not have access panels, provide concealed balancing damper regulators embedded in the finished ceiling, mounted behind grilles, on or inside plenum slot diffusers and various types of diffusers. Concealed damper regulator to be connected to balancing damper by means of flexible cable and to be installed flush with ceiling. Cover plate to be held in place with 2 screws and to be easily removed for damper adjustment.
 - .2 Optional concealed regulator shall be either remotely accessible as coordinated on the drawings, or accessible at the face of the diffuser/grille to meet installation requirements of the concealed regulator.

2.6 Duct and Plenum Access

- .1 Locations: Refer to Part 3 (Execution).
- .2 Dimensions:
 - .1 Doors:
 - .1 500 mm (20") wide x 1370 mm (54") high.
 - .2 Head of door 1780 mm (70") above floor.
 - .2 Panels:
 - .1 380 mm x 500 mm (15"x20").
 - .2 Where the far corners of the duct are closer than 500 mm (20") and the equipment within the duct is closer than 300 mm (12") the size may be reduced to 400 mm x 300 mm (16"x12") or 450 mm x 250 mm (18"x10") elliptical.
 - .3 Where space will not permit the above dimensions to be attained they should be matched as closely as possible and where necessary additional access be provided.

- .3 Products:
 - .1 Doors - construct in accordance with SMACNA Duct Standards. 40 mm (1½") thick insulation.
 - .2 Panels:
 - .1 Non-Insulated Duct: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.7 mm (22 ga) thick complete with sheet metal angle frame.
 - .2 Insulated Duct: as above with 25 mm (1") thick insulation.
 - .3 Gaskets - neoprene or foam rubber.
- .4 Hardware:
 - .1 Panels up to 400 mm x 300 mm (16"x12") - 2 Cam locks complete with safety chain.
 - .2 Panels - 380 mm x 500 mm (15"x20") - 4 Cam locks complete with safety chain.
 - .3 Doors - piano hinge and Ventlok 310 latches c/w front and inside handles and front door pull.

2.7 Duct Connectors – Thermal breaks

- .1 Provide flexible duct connections to provide thermal breaks in all sheet metal ducts and plenums passing through or terminating at the exterior of the building. Install inside the building.
- .2 Minimum Requirements:
 - .1 Pre-assembled 75 mm (3") long thermal barrier with 75 mm (3") long, 0.61 mm (24 ga) galvanized steel duct connectors on each side of the thermal break.
 - .2 Thermal break – heavy duty glass fabric with elastomer coating.

2.8 Duct Connectors – Vibration Isolation

- .1 Provide flexible duct connections to provide vibration isolation at all duct and plenum connections to fan and air handling units. See Figure 2-19 SMACNA Duct Standards.
- .2 Minimum Requirements:
 - .1 Pre-assembled 75 mm (3") minimum long flexible connection with 75 mm (3") long 0.62 mm (24 ga) galvanized steel duct connectors on each side of the flexible connection. Flexible connector - fiber glass fabric with elastomer coating.
 - .2 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m².
- .3 Centrifugal fans with 900 mm (36") diameter and larger fan wheels, use 150 mm (6") long flexible connection.
- .4 Do not install connectors on perchloric acid fume exhaust systems.

2.9 Instrument Test Ports

- .1 1.35 mm (16 ga) thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 25 mm (1") minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

2.10 Spin-In Collars

- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- .2 Sheet metal thickness to co-responding round duct standards.

2.11 Control Dampers

- .1 Unless otherwise specified elsewhere, shall be as follows.
- .2 Type: Control dampers shall be the parallel or opposed-blade type as specified below or as scheduled on drawings or as per the following:
 - .1 Outdoor and return air mixing dampers and face-and-bypass dampers shall be parallel-blade and shall direct airstreams toward each other.
 - .2 Other modulating dampers shall be opposed-blade.
 - .3 Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.
- .3 Frame: Damper frames shall be 2.38 mm (13 gauge) galvanized steel channel or 3.175 mm (1/8 in.) extruded aluminium with reinforced corner bracing.
- .4 Blades: Damper blades shall not exceed 20 cm (8 in.) in width or 125 cm (48 in.) in length. Blades shall be suitable for medium velocity (10 m/s (2000 fpm)) performance. Blades shall be not less than 1.5875 mm (16 gauge).
- .5 Shaft Bearings: Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.
- .6 Seals: Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than 50 L/s·m² (10 cfm per ft²) at 1000 Pa (4 in. w.g.) differential pressure. Blades shall be air foil type suitable for wide-open face velocity of 7.5 m/s (1500 fpm).
- .7 Sections: Individual damper sections shall not exceed 125 cm × 150 cm (48 in. × 60 in.). Each section shall have at least one damper actuator.
- .8 Modulating dampers shall provide a linear flow characteristic where possible.
- .9 Linkages: Dampers shall have exposed linkages.
- .10 Sizing and Selection: Refer to Control Damper Schedule.
- .11 Control dampers subjected to outdoor air conditions, including but not limited to outdoor air intake, exhaust air and relief air dampers shall be provided complete with thermally insulated blades and thermally broken frames, suitable for operation to -40°C.

2.12 Air Distribution Plates

- .1 Provide perforated air distribution plates at the discharge of supply fans as shown on the drawings.
- .2 Modify and reposition plates as necessary to balance airflow through downstream filters and coils to plus or minus 15%.

2.13 Wire Mesh Screens

- .1 Provide wire mesh screens in all air intake openings where noted on the drawings.
- .2 Screens shall be constructed from aluminum wire 1.3 mm diameter (16 ga).
- .3 Screen mesh shall be 15 mm (1/2").
- .4 Mount screens in 0.66 mm thick (20 ga) folded aluminum frames.

2.14 Counter Flashings

- .1 Counter Flashings – galvanized sheet steel of 0.8 mm (22 ga) minimum thickness.
- .2 Counter flashings are attached to mechanical equipment and lap the base flashings on the roof curbs.
- .3 All joints in counter flashings shall be flattened and solder double seam. Storm collars shall be adjustable to draw tight to pipe with bolts. Caulk around the top edge. Storm collars shall be used above all roof jacks.
- .4 Vertical flange section of roof jacks shall be screwed to face of curb.

3. EXECUTION

3.1 Manufacturer's Instructions

- .1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 Balancing Dampers

- .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's recommendations.
- .2 Provide balancing dampers at points on low pressure supply, return and exhaust systems where branches are taken from larger duct as required for proper air balancing.
- .3 Provide balancing dampers at each run out to a grille or diffuser. Install damper as close to branch take-off as possible.
- .4 Identify the airflow direction and blade rotation and open and closed position.
- .5 On all round ductwork larger than 300 mm (12") diameter and on externally insulated rectangular ductwork, provide sheet metal bridge to raise quadrant type operators above the insulation thickness (coordinate with Duct Insulation Section 23 07 13). Provide an open end bearing where bridges are used. Bridges on uninsulated round ducts shall be at least 25 mm (1") high.
- .6 Where quadrant type operators are used, the lever shall be arranged parallel with the damper blade.
- .7 Where balancing dampers are located above hard-ceilings (e.g. drywall), provide access panels or a remote operating device actuated by a socket or screwdriver.
- .8 Coordinate the installation of all dampers with the balancing contractor to ensure all dampers are accessible for system balancing.

3.3 Backdraft Dampers

- .1 Install backdraft dampers on all exhaust and relief openings through the building walls and roof on all exhaust fans where control dampers are not called for or indicated.

3.4 Control Dampers – Automatic

- .1 Packaged equipment specified to be complete with control dampers, shall include control dampers as normally supplied by the equipment manufacturer unless otherwise noted.
- .2 All other automatic control dampers shall be provided and installed under this Section.
- .3 Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.

- .4 Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure 6 mm (¼ in.) larger than damper dimensions and shall be square, straight, and level.
- .5 Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 3 mm (1/8 in.) of each other.
- .6 Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
- .7 Install extended shaft or jackshaft according to manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
- .8 Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
- .9 Support ductwork in area of damper when required to prevent sagging due to damper weight.
- .10 After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.
- .11 The indicated size of control dampers is the dimension outside the frame. Oversize the ductwork to include the depth of the damper frame if the pressure drop across the damper exceeds 25 Pa (0.1" w.g.).
- .12 Control damper frames shall be fitted tightly into ductwork and sealed airtight.
- .13 Check that dampers are installed square and true. Ensure that damper end linkages are easily accessible.
- .14 Do not install control dampers within the thickness of any wall unless otherwise indicated.

3.5 Duct and Plenum Access

- .1 Locations: Provide access doors and panels as follows:
 - .1 Doors: where shown on the drawings.
 - .2 Panels:
 - .1 Every 12 m (40 ft) on all ductwork.
 - .2 At the base of each duct riser.
 - .3 Both sides of equipment blocking the duct e.g.
 - .1 Air flow measuring stations
 - .2 Coils
 - .4 At or to one side of other equipment in duct e.g.
 - .1 Backdraft dampers (counter weight side)
 - .2 Balance dampers serving multiple outlets/inlets
 - .3 Bearings (fans/motors)
 - .4 Control dampers
 - .5 Control sensors

- .6 Fire dampers (rectangular ducts and round ducts 330 mm (13") dia. and larger - latch side)
- .7 Heat detectors (upstream from device)
- .8 Smoke dampers (operator side)
- .9 Smoke detectors (upstream from device)
- .5 Panels need not be provided where access is available through a door or a register mounted on the side of the duct.
- .3 Patches:
 - .1 Where required for cleaning and where access panels are not specified, e.g. on both sides of turning vanes.
 - .4 Flexible duct - on round duct and round fire dampers up to 300 mm (12") dia.
- .2 Seal frames airtight.
- .3 Install so as not to interfere with airflow.
- .4 Install to provide easiest possible access for service and cleaning.
- .5 Do not use sheet metal screws for attaching access panels to ductwork.
- .6 Round ducts 330 mm (13") dia. and larger shall include a short collar for the installation of access panels.
- .7 Small rectangular ducts shall be transitioned to a minimum dimension across the duct of 330 mm (13") for the installation of access panels.

3.6 Duct Connectors – Vibration Isolation

- .1 Install in the following locations:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 Inlets and outlets of exhaust and return air fans.
 - .3 As indicated.
- .2 Ensure flexible duct connectors do not reduce free area on suction side of fans.
- .3 Ducting on sides of flexible connection to be in alignment.
- .4 Ensure slack material in flexible connection.

3.7 Ductwork – Flexible

- .1 Installed lengths shall be limited to 6 times duct diameter but not longer than 900 mm (3 ft). Do not use for changes in direction greater than 60°.
- .2 Connect to ductwork and diffusers with stainless steel worm drive clamps or Panduit adjustable clamps or Thermaflex duct strap applied over two wraps of duct tape. Use stainless steel clamps on connections to fire dampers.
- .3 Minimum centreline radius of flexible ductwork bends shall be 1.5 times the duct diameter, alternatively, sheet metal elbows may be used at branch takeoffs and boot/diffuser connections. Very sharp turns and reduction in the area of the duct will not be permitted.
- .4 Support with 25 mm x 0.76 mm (1"x22 ga) galvanized steel straps at a maximum of 600mm (24"). Straps shall completely encircle duct. Support to prevent sagging of duct.
- .5 Support clear of ceiling assembly, light fixtures, and hot surfaces.
- .6 Do not use flexible ductwork in secure areas.

3.8 Instrument Test Ports

- .1 Locate to permit easy manipulation of instruments.
- .2 Install insulation port extensions as required.
- .3 Locations:
 - .1 For traverse readings:
 - .1 Ducted inlets to roof and wall exhausters.
 - .2 Inlets and outlets of other fan systems.
 - .3 Main and sub-main ducts.
 - .4 As indicated.
 - .2 For temperature readings:
 - .1 At outside air intakes.
 - .2 In mixed air applications in locations as approved by the Consultant.
 - .3 At inlet and outlet of coils.
 - .4 Downstream of junction of two converging air streams of different temperatures.
 - .5 As indicated.
 - .3 In addition to the locations specified, install instrument test ports in ductwork as directed by the Testing and Balancing Contractor. Test port covers are to be installed after the balancing is complete, however insure the insulation is repaired at test port locations. Install heavy duty locking quadrant handles at all balancing dampers (except splitter dampers). Ensure handles are marked in the final set position by the Testing and Balancing Contractor.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Section Includes:
 - .1 Fans, motors, accessories, and hardware for commercial use.
 - .2 Sustainable requirements for construction and verification.
- .2 Related Sections:
 - .1 Section 21 05 01 Common Work Results for Mechanical.
 - .2 Section 23 05 01 Acceptable Manufacturers.
 - .3 Section 23 05 48 Vibration and Seismic Control for Mechanical.
 - .4 Section 23 33 00 Duct Accessories.
 - .5 Section 25 09 01 Control Systems.
 - .6 Section 25 90 00 Integrated Automation Control Sequences.

1.2 References

- .1 Air Movement and Control Association International, Inc. (AMCA)
 - .1 AMCA Publication 99, Standards Handbook.
 - .2 AMCA 300, Reverberant Room Method for Sound Testing of Fans.
 - .3 AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/AMCA 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181, Ready-Mixed Organic Zinc-Rich Coating.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 System Description

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.
 - .2 Capacity: flow rate, static pressure, bhp, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
 - .3 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.
 - .4 Sound ratings: comply with AMCA 301, tested to AMCA 300. Supply unit with AMCA certified sound rating seal.
 - .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210. Supply unit with AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

1.4 Submittals

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Provide:
 - .1 Fan performance curves showing point of operation, BHP, and efficiency.
 - .2 Sound rating data at point of operation.
- .4 Indicate:
 - .1 Motors, sheaves, bearings, shaft details.
 - .2 Minimum performance achievable with variable speed controllers and variable inlet vanes as appropriate.
- .5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .6 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 Quality Assurance

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.6 Maintenance

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Spare parts to include:
 - .1 Matched sets of belts.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
 - .1 Bearings and seals.
 - .2 Addresses of suppliers.
 - .3 List of specialized tools necessary for adjusting, repairing, or replacing.

1.7 Delivery, Storage, and Handling

- .1 Packing, shipping, handling, and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 – Common Product Requirements.

- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

2. PRODUCTS

2.1 Fans General

- .1 Motors:
 - .1 In accordance with Section 21 05 01 - Common Work Results for Mechanical supplemented as specified herein.
 - .2 Sizes as indicated.
- .2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet safety screens as indicated and as specified in Section 21 05 01 - Common Work Results for Mechanical.
- .3 Factory primed before assembly in colour standard to manufacturer.
- .4 Scroll casing drains: as indicated.
- .5 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .6 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Control for Mechanical.
- .7 Flexible connections: to Section 23 33 00 - Duct Accessories.

2.2 Ceiling Ventilators (High volume, low speed)

- .1 Complete Unit
 - .1 Regulatory Requirements: The entire fan assembly shall be TUV-certified and built pursuant to the construction guidelines set forth by UL standard 507 and CSA standard 22.2. No. 113.
 - .2 Sustainability Characteristics: The fan shall be designed to move an effective amount of air for cooling and destratification of conditioned commercial applications over an extended life. The fan components shall be designed specifically for high volume, low speed fans to ensure lower operational noise. Sound levels from the fan operating at maximum speed measured in a laboratory setting shall not exceed 40 dBA. Actual results of sound measurements in the field may vary due to sound reflective surfaces and environmental conditions.
 - .3 Color: Custom colors can be selected by the architect or Departmental Representative.
 - .4 Good workmanship shall be evident in all aspects of construction. Field balancing of the airfoils shall not be necessary.
- .2 Controls
 - .1 The fan controller shall be incorporated into the fan assembly and housed in an enclosure independent of the motor to prevent overheating or electrical interference. The fan controller shall be factory programmed to minimize starting and braking torques and shall be equipped with a simple diagnostic program and an LED light to identify and relay faults in the system.
- .3 Airfoil System

- .1 The fan shall be equipped with eight (8) high volume, low speed airfoils of precision extruded, anodized aluminum alloy. Each airfoil shall be of the high-performance Mini-Elipto design. The airfoils shall be connected to the hub and interlocked with eight (8) stainless steel retainers and two (2) sets of stainless steel bolts and lock washers per airfoil.
 - .2 The fan shall be equipped with eight (8) upswept winglets designed to redirect outward airflow downward, thereby enhancing efficiency. The winglets shall be molded of high strength polymer and shall be attached at the tip of each airfoil with a stainless steel screw. The standard color of the winglets shall be silver or black.
 - .3 As an option, the fan shall be equipped with eight (8) plug-style airfoil tips, molded of high strength polymer, in place of the eight (8) upswept winglets. The airfoil tips shall be attached at the tip of each airfoil with a stainless steel screw. The standard color of the airfoil tips shall be black.
- .4 Motor
- .1 The fan motor shall be a permanent magnet brushless motor rated for continuous operation at maximum speed with the capability of modulating the fan speed from 0–100% without the use of a gearbox or other mechanical means of control. The motor shall operate from any voltage ranging from 100–120 VAC or 200–240 VAC, single phase, and 50/60Hz, without requiring adapters or customer selection. The motor shall be a non-ventilated, heat sink design with the capability of continuous operation in -13°F to 131°F (-25°C to 55°C) ambient condition. The standard color of the motor unit shall be white with silver trim or silver with black trim.
 - .2 The motor shall be rated at one of the following:
 - .1 8-ft fan average power @ max speed = 475 Watts
 - .2 10-ft fan average power @ max speed = 425 Watts
 - .3 12-ft fan average power @ max speed = 350 Watts
 - .4 14-ft fan average power @ max speed = 300 Watts
- .5 Mounting System
- .1 The fan mounting system shall be designed for quick and secure installation from a variety of structural supports. All components in the mounting system shall be of formed metal design using low-carbon steel no less than 3/16" (0.5 cm) thick and containing no critical welds. The mounting system shall be powder coated for appearance and resistance to corrosion. All mounting bolts shall be metric stainless steel or equivalent. The fan extension tube shall be a round, extruded aluminum tube. The extension tube shall include a chrome plate with forward and reverse controls and a fan status indicator light that is visible from the floor.
- .6 Hub
- .1 The fan hub shall be constructed of zinc plated steel for high strength and durability. The hub shall be precision machined to achieve a well-balanced and solid rotating assembly.
- .7 Safety Cable
- .1 The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be Ø3/16" (0.5 cm) diameter and fabricated out of 7 x 19 stranded galvanized steel, pre-loaded and tested to 3,200 lbf (13,345 N).
 - .2 Field construction of safety cables is not permitted.
- .8 Wall Control

- .1 Wired (standard). The fan shall be equipped with a low-voltage wired remote wall control providing control of all fan functions. The wall control shall be capable of mounting to a standard electrical box or directly to a wall surface. The wall control shall include a rotary-style dial for controlling the fan's power and speed and an LED light to identify and relay faults in the system. Communication with the fan drive and controller shall be by a standard, commercially available CAT5 (or higher) Ethernet cable that is field installed and provided by the installer.
 - .2 Wireless (optional). As an option, the fan shall be equipped with an optional radio frequency (RF) remote wall control in place of the wired wall control. The wall control shall provide control of all fan functions. The wall control shall be capable of mounting to a standard electrical box with an owner-supplied wall plate and shall include a capacitive touch display for controlling the fan's power and speed. Communication with the fan drive and controller shall be wireless
- .9 Guy Wires
- .1 Guy wires shall be included for installations with extension tubes 4 ft (1.2 m) or longer to limit the potential for lateral movement.
- .10 Accessories and Options:
- .1 6' extension tube.
 - .2 Controls hardware for permitting the BMS to start, stop, and control the speed of the fan based on occupancy schedule and room temperature.
 - .3 "No Ass" factory labelling.

3. EXECUTION

3.1 Manufacturer's Instructions

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 Ceiling Ventilators (High volume, low speed)

- .1 Mount fan from roof structure. Consult the seismic engineer for required structural members needed to attach the fan to the roof structure.
- .2 Install the fan according to the manufacturer's Installation Guide, which includes acceptable structural dimensions and proper sizing and placement of angle irons for bar joist applications. Big Ass Fans recommends consulting a structural engineer for installation methods outside the manufacturer's recommendation and a certification, in the form of a stamped print or letter, submitted prior to installation.
- .3 Minimum Distances
 - .1 Airfoils must be at least 10 ft (3 m) above the floor.
 - .2 Installation area must be free of obstructions such as lights, cables, sprinklers, or other building structures with the airfoils at least 2 ft (0.61 m) clear of all obstructions.
 - .3 The structure the fan is attached to shall be capable of supporting a torque load of up to 40 ft·lb (54 N·m) of torque.
- .4 The fan shall not be located where it shall be continuously subjected to wind gusts or in close proximity to the outputs of HVAC systems or radiant heaters. Additional details are in the Big Ass Fans 3.2 Installation Manual.
- .5 The fan is suitable for use in wet locations when installed on a GFCI protected branch circuit.

- .6 In buildings equipped with sprinklers, including ESFR sprinklers, fan installation shall comply with all of the following:
 - .1 The HVLS fan shall be centered approximately between four adjacent sprinklers.
 - .2 The vertical clearance from the HVLS fan to the sprinkler deflector shall be a minimum of 3 ft (0.9 m).

3.3 Anchor Bolts and Templates

- .1 Size anchor bolts to withstand seismic acceleration and velocity forces as specified.

END OF SECTION

1. GENERAL

1.1 Section Scope

- .1 Supply, return, and exhaust grilles, registers, diffusers, and louvres for commercial and residential use.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical
- .3 Section 23 05 01 – Acceptable Manufacturers

1.3 References

- .1 The latest revisions of the following standards shall apply unless noted otherwise.
 - .1 Applicable Building Code - Refer to Section 21 05 01
- .2 American Society for Testing and Materials (ASTM):
 - .1 ASTM B209-14, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate
 - .2 ASTM B211/B211M-19, Standard Specification for Aluminum and Aluminum Alloy Rolled or Cold Finished Bar, Rod, and Wire
 - .3 ASTM B221-14, Standard Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
 - .4 ASTM E90-09(2016), Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
- .3 Canadian Standards Association (CSA):
 - .1 CAN/CSA-S157-05/S157.1-05 (R2015), Strength Design in Aluminum / Commentary on CSA S157-05, Strength Design in Aluminum
 - .2 CAN/CSA-S136-16, North American Specification for the Design of Cold-Formed Steel Structural Members
- .4 Air Movement and Control Association International Inc. (AMCA):
 - .1 AMCA Standard 500-L-12 (R2015), Laboratory Methods of Testing Louvers for Rating
 - .2 AMCA Publication 501-17, Louver Application Manual and Design Guide
 - .3 AMCA Publication 511-10 (Rev. 12/15), Certified Ratings Program - Product Rating Manual for Air Control Devices
- .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

1.4 Submittals

- .1 Comply with Division 01 – Submittal Procedures and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and in addition the following:
 - .1 For all grilles, diffusers and louvres provide manufacturer's printed product literature; specifications and datasheet include product characteristics, performance criteria, and limitations.
 - .2 Indicate following:

- .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.
 - .6 Material types and thickness.
 - .7 Finishes
 - .8 For louvers, AMCA Certified Air Flow, Water Penetration, and Wind Driven Rain performance test results.
- .3 Closeout submittals: submit all reviewed shop drawings for incorporation into manual specified in Section 21 05 01 – Common Work Results - Mechanical

1.5 Quality Assurance

- .1 Air flow tests and sound level measurement shall be made in accordance with applicable ADC equipment test codes, ASHRAE Standards and AMCA Standards.
- .2 Unit rating shall be approved by ADC and AMCA.
- .3 Manufacturer shall certify catalogued performance and ensure correct application of air outlet types.
- .4 Outside louvres shall bear AMCA seal for free area and water penetration.

1.6 Delivery, Storage and Handling

- .1 Delivery: At the time of delivery, visually inspect all materials for damage. Note any damaged boxes, crates, diffusers, grilles or louver sections on the receiving ticket and immediately report to the shipping company and the material manufacturer.
- .2 Storage: Store products raised off the ground and cover with a weather proof flame resistant sheeting or tarpaulin.
- .3 Handling:
 - .1 Material shall be handled in accordance with sound material handling practices and in such a way as to minimize racking.
 - .2 Louver sections may be hoisted by attaching straps to the jambs and lifting the section while it is in a vertical position.
 - .3 Louver sections should only be lifted and carried by the jambs. Heads, sills and blades are not to be used for lifting or hoisting louver sections.

1.7 Project Conditions

- .1 Review requirements of outlets as to size, finish, and type of mounting prior to submitting shop drawings and schedules of outlets.
- .2 Positions indicated are approximate only. Check locations of outlets and make necessary adjustments in position to conform to Architectural features, symmetry, and lighting arrangement.
- .3 Review exterior wall details and structural requirements/drawings. Ensure exterior louvre installation is fully coordinated with all other building elements.

1.8 Maintenance

- .1 Provide keys for volume control adjustment and/or keys for air flow pattern adjustment as applicable.

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 Refer to Section 23 05 01 – Acceptable Manufacturers

2.2 General

- .1 Base air outlet application on space noise level of NC 20 maximum.
- .2 Provide supply outlets with sponge rubber seal around the edge.
- .3 Provide baffles to direct air away from walls, columns or other obstructions within the radius of diffuser operation.
- .4 Provide plaster frame for diffusers located in plaster surfaces.
- .5 Provide anti-smudge frames or plaques on diffusers located in rough textured surfaces such as acoustical plaster.
- .6 Provide 30 mm margin frame with concealed fastening.
- .7 Fabricate with heavy aluminum extrusions.
- .8 Provide grilles with integral, gang-operated opposed blade dampers with removable key operator, operable from face.
- .9 Finish in factory baked enamel finish color by Architect if indicated on schedule.
- .10 Refer to Air Outlet Schedule on drawings for capacities.

2.3 Supply Air Registers

- .1 Supply Register “S-1”:
 - .1 Aluminum double deflection supply register.
 - .2 Two sets of fully adjustable deflection blades on 19mm (3/4”) centres.
 - .3 Face blades to run parallel to the long dimension unless noted otherwise.
 - .4 White powder coat finish.
 - .5 Integral opposed blade steel volume damper, operable from the grille face
 - .6 32mm (1-1/4”) curved border, surface mount with concealed fastening.

2.4 Return Air Grilles

- .1 Return Grille “R-1”:
 - .1 Louvered return grille, 12mm (1/2”) blade spacing.
 - .2 Fixed 45° deflection contoured blade parallel with the long dimension
 - .3 Construction shall be of steel.
 - .4 Drywall mount: 32mm (1-1/4”) border for surface mount with counter sunk screw fastening.
 - .5 T. Bar mount: 32mm (1-1/4”) border for drop in ceiling.
 - .6 The finish shall be white, baked anodic acrylic paint.

- .7 Tested in accordance with ANSI/ASHRAE Standard 70

2.5 Wall Caps

- .1 0.025 Aluminum natural finish wall cap.
- .2 Built in spring loaded backdraft damper for exhaust applications only
- .3 Built in spring loaded backdraft damper without bird screen for dryer venting
- .4 Bird screen without backdraft damper for supply applications
- .5 Refer to drawings and schedules for size and capacities.

3. EXECUTION

3.1 Examination

- .1 Verify that conditions are suitable for installation.
- .2 Louvers:
 - .1 Examine openings to receive work and surrounding adjacent surfaces for conditions affecting installation. Coordinate with related sections providing openings to ensure proper dimensions are maintained.
 - .2 Verify dimensions of supporting structure by accurate field measurements so that work will be accurately designed, fabricated and fitted to the structure.
 - .3 Notify Consultant in writing of any conditions that are not acceptable.
 - .4 Proceed with installation after verification and correction of surface conditions acceptable to manufacturer.

3.2 Priming

- .1 Paint ductwork visible behind air outlets matte black.

3.3 Sizing

- .1 Size outside air louvres as indicated on drawings.
- .2 Size air outlets as indicated on drawings.

3.4 Air Terminals

- .1 Install with cadmium plated screws in countersunk holes where fastenings are visible.
- .2 Install ductwork as high as practical, using offsets where required to obtain maximum duct neck lengths for diffusers.
- .3 Refer to Architectural Reflected Ceiling plans for exact locations of air terminals.
- .4 Attach registers and grilles to branch ducts with duct necks having minimum length to prevent grille or register damper from protruding into branch duct.
- .5 Where air terminals are installed in mechanical grid ceilings, provide at least two 12 ASWG galvanized steel wire seismic security bridles per air terminal tied either to the building structure or to ceiling hanger wires. Attach security bridles at opposite corners of each air terminal and in such a manner that the air terminal cannot fall.
- .6 Hand over door grilles to the General Contractor for installation.

3.5 Protection

- .1 Protect installed materials to prevent damage by other trades. Use materials that may be easily removed without leaving residue or permanent stains.

3.6 Cleaning

- .1 Progress Cleaning: Leave work area clean at the end of each work day, ensuring safe movement of passing pedestrians.
- .2 Final Cleaning: At completion of installation, clean all surfaces so they are free of foreign matter using cleaners recommended by material manufacturer.
- .3 Restore louvers and accessory components damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by the Consultant, remove and replace damaged systems with new at no additional cost to the Departmental Representative.
- .4 Waste Management: Co-ordinate recycling of waste materials and packaging at appropriate facility, diverting waste from landfill. Certified installer shall be responsible for ensuring waste management efforts are practiced.

END OF SECTION

GENERAL

1.1 Section Scope

- .1 Section Includes:
 - .1 Materials, components, and installation for packaged heating/cooling ventilating units. Packaged units shall be dual fuel capable for propane and heat pump.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical
- .3 Section 23 05 48 - Vibration and Seismic Control for Mechanical
- .4 Section 23 11 23 - Facility Natural Gas Piping
- .5 Section 23 33 00 - Duct Accessories

1.3 References

- .1 The latest revisions of the following standards shall apply unless noted otherwise.
 - .1 Applicable Building Code - Refer to Section 21 05 01
 - .2 Air Movement and Control Association (AMCA)
 - .1 AMCA 210-16, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating (ASHRAE Standard 51-16).
 - .3 American Society of Heating, Refrigeration and Air Condition Engineers (ASHRAE)
 - .1 ASHRAE 52.2-2017, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
 - .2 ASHARE Standard 62.1 - Ventilation for Acceptable Indoor Air Quality.
 - .3 ANSI/ASHRAE 90.1-2016, (I-P) Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - .4 American National Standards Institute/Air-Conditioning, Heating and Refrigeration Institute (ANSI/AHRI)
 - .1 ANSI/AHRI 210/240-2017, Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment.
 - .2 ANSI/AHRI Standard 260 - Sound rating of Ducted Air Moving and Conditioning Equipment.
 - .3 AHRI 270-15, Sound Performance Rating of Outdoor Unitary Equipment.
 - .5 Canadian Standards Association (CSA)
 - .1 CSA B52-13, Mechanical Refrigeration Code
 - .2 CSA B149.1 - 15, Natural Gas and Propane Installation Code
 - .3 CSA C22.1 HB-18, Canadian Electrical Code Handbook
 - .6 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181, Ready-Mixed Organic Zinc-Rich Coating

1.4 Submittals

- .1 Comply with Division 01 – Submittal Procedures and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals.
- .2 Product Data: For each type of outdoor roof mounted unit indicated. Include the following:
 - .1 Manufacturer's printed product literature, specifications and datasheet for packaged rooftop HVAC units.
- .3 Shop Drawings:
 - .1 Submit shop drawings to indicate project layout and dimensions; include:
 - .1 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.
 - .2 Piping, valves, fitting shipped loose showing final location in assembly.
 - .3 Control equipment shipped loose, showing final location in assembly.
 - .4 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.
 - .5 Certified fan-performance curves with system operating conditions indicated.
 - .6 Certified fan-sound power ratings.
 - .7 Certified burner ratings with system operating conditions indicated.
 - .8 Motor ratings, electrical characteristics, and motor and fan accessories.
 - .9 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices of ancillaries, accessories, controllers.
 - .10 Material gages and finishes.
 - .11 Filters with performance characteristics.
 - .12 Type of refrigerant used.
 - .4 Operation and Maintenance Data:
 - .1 Submit operation and maintenance data for each unit. Include a copy in the O&M manual.
 - .2 Submit startup and operating instructions for each unit.

1.5 Quality Assurance

- .1 Meet the requirements of CSA, CGA, Provincial and Municipal Codes and be CSA listed.
- .2 Units shall be products of manufacturers who provide local service personnel from factory representative, franchised dealer or certified maintenance service shop.
- .3 Provide start-up service and report.

1.6 Coordination

- .1 Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.7 Delivery, Storage and Handling

- .1 Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- .2 Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Shipping splits shall be clearly defined on submittal drawings. Cost associated with non-conformance to shop drawings shall be the responsibility of the manufacturer. Each section shall have lifting lugs and shipping skid for lifting and forklift transport to allow for field rigging and final placement of section.
- .3 Deliver units to jobsite with fan motor(s), sheave(s), and belt(s) completely assembled and mounted in units.
- .4 Unit shall be shipped in a clear shrink-wrap or stretch-wrap to protect unit from in-transit rain and debris per ASHRAE 62.1 recommendations.
- .5 Installing contractor shall be responsible for storing units in a clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.8 Extra Materials

- .1 Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - .1 Filters: One set for each air-handling unit.
 - .2 Fan Belts: One set for each air-handling unit fan.

1.9 Warranty

- .1 Provide five (5) year unconditional parts warranty on heat exchangers.
- .2 Refrigeration compressors to be warrantied for five [5] years.

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 Refer to Section 23 05 01 – Acceptable Manufacturers

2.2 Packaged Heating/Cooling and Ventilating Units (Dual Fuel, Propane fired with Heat pump)

- .1 General:
 - .1 Unit shall be self-contained, packaged factory assembled and pre-wired, consisting of a cabinet and frame, supply fan, heat exchanger and burner, controls, air filters, BMS interface and curb. Provide starters, VFDs and point power wiring as indicated on the drawings. Provide single point power connection where indicated.
- .2 Construction:
 - .1 Cabinet: Weatherproof, watertight, heavy gauge steel with baked enamel finish, access doors or panels with locking door handle type.
 - .2 Insulation: minimum 25 mm [1"] neoprene coated glass fibre. Protect edges from erosion.
 - .3 Heat Exchangers: Stainless steel of welded construction.
 - .4 Supply Fan: Centrifugal type rubber mounted V-belt drive. Complete fan assembly mounted on vibration isolators.

- .5 Air Filters: 50 mm [2"] thick glass fibre disposable media minimum 30% efficiency in metal frames arranged for easy replacement.
- .6 Provide secure attachment points for seismic.
- .3 Burner:
 - .1 Gas Burner: Forced or induced draft (or atmospheric) type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device and automatic 100% shut-off. Burner shall be CGA approved. Provide 15:1 turndown burner control.
 - .2 Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven. Stop gas flow on ignition failure. Energize blower motor. After proven airflow and time delay, gas valve to open.
 - .3 High Limit Control: With fixed stop at maximum permissible setting, de-energize burner on excessive bonnet temperature and energize burner when temperature drops to lower safe value. Include automatic high limit reset.
 - .4 Control supply fan in accordance with bonnet temperatures and independent of burner controls. Include switch for continuous fan operation.
 - .5 Capacity as scheduled.
- .4 Control Dampers:
 - .1 Provide manual outside air dampers for fixed outside air quality.
 - .2 Provide remote controlled outside air dampers with damper operator and remote rheostat package for adjusting minimum outside air quality.
 - .3 Provide outside, return and relief dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper shall fail to closed position. Relief dampers may be gravity balanced, and shall be sized to relieve 100% of the design air volume.
 - .4 Provide tight fitting dampers with edge gaskets.
 - .5 Damper Operator: 24 V, spring return.
 - .6 Mixed Air Controls: Maintain selected mixed air temperature, return dampers to minimum position above approximately 13.9°C [57°F] or 23.9°C [75°F] ambient.
- .5 Operating Controls:
 - .1 Low voltage, adjustable thermostat shall control burner operation and supply fan to maintain temperature setting.
 - .2 Thermostat shall include system selector switch heat-off and fan control switch on-auto.
 - .3 Single acting thermostat shall have minimum 2 stage heating.
 - .4 Provide remote mounted fan control switch on-auto.
 - .5 Provide in supply air low limit thermostat to close outside air damper and stop supply fan.
 - .6 Locate thermostat in room as shown.
- .6 Dampers
 - .1 General: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating", shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.
 - .2 Damper Operators: Electric specified in Section 25 09 01 Control Systems.

- .3 Low-Leakage, Outside-Air Dampers: Double-skin, airfoil-blade galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals, in parallel-blade arrangement with steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.
- .4 Combination Filter and Mixing Box: Parallel-blade galvanized-steel dampers mechanically fastened to steel operating rod in reinforced, galvanized-steel cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously. Provide hinged access panels or doors to allow removal of filters from both sides of unit.
- .7 Filter Section
 - .1 Filter Section: Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side.
 - .2 Extended-Surface, Disposable Panel Filters: Factory-fabricated, dry, extended-surface filters with holding frames.
 - .1 Media: Fibrous material formed into deep-V-shaped pleats and held by self-supporting wire grid. MERV 8 per filter, MERV 13 final filter.
 - .2 Media and Media-Grid Frame: Non-flammable cardboard.
 - .1
- .8 Remote Panel:
 - .1 Provide remote readout panels containing: signal lights indicating: system status, heating system failure and dirty filters; check switches proving signal light operation; system on-off switch cooling system on-off switch.
 - .2 Provide in panel manual 12 hour timer to override night control, remote damper control, low limit manual reset, and remote thermostat temperature set point.

3. EXECUTION

3.1 General

- .1 Install units as indicated and to manufacturers' recommendations.

3.2 Equipment Installation

- .1 Maintain proper clearance around equipment to permit performance of service maintenance.
- .2 Install units in accordance with manufacturer's instructions and as indicated.
- .3 The Mechanical Contractor shall be responsible to coordinate ALL of his installation requirements with the Departmental Representative and the General Contractor to ensure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or welded joints, and all other installation and assembly requirements.
- .4 Install in accordance with the gas code.
- .5 Ensure curb interior is insulated and through-curb service connections are in place before placement of unit.
- .6 Ensure through-roof service connections (HWS & R pipes, gas pipe as applicable and electrical) are in place before placement of unit.

- .7 Connect units to ductwork with flexible connections.
- .8 Install fan sheaves required for final air balance.
- .9 Pipe from condensate drains to roof deck complete with 'P' trap.

3.3 Drip Pans

- .1 Install deep seal P-traps on drip lines.
 - .1 Depth of water seal to be 1.5 times static pressure at this point.

3.4 Equipment Preparation and Start-Up

- .1 Provide services of manufacturer's field engineer to set and adjust equipment for operation as specified.
- .2 Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.
 - .1

3.5 Field Quality Control

- .1 Performance Verification:
 - .1 Rooftop Mounted Units:
 - .1 Set outside air and return air dampers for minimum outside air.
 - .2 Check for smooth, vibration less correct rotation of supply fan impeller.
 - .3 Measure supply fan capacity.
 - .4 Adjust impeller speed as necessary and repeat measurement of fan capacity.
 - .5 Measure pressure drop each component of air handling unit.
 - .6 Set outside air and return air dampers for the % of outside air required by design and repeat measurements of fan capacity.
 - .7 Reduce differences between fan capacity at minimum and maximum outside air less than [5]%.
 - .1
 - .8 Set face and bypass dampers to full bypass and repeat measurement of fan capacity.
 - .9 Reduce difference between fan capacity with F BPD fully closed to bypass and fully open to bypass to less than [5]%.
 - .1
 - .10 Reduce difference between fan capacity at full cooling and fan capacity at full heating to less than [5]%.
 - .1
 - .11 OAD: verify for proper stroking, interlock with RAD.
 - .12 Measure DBT, WBT of SA, RA, EA.
 - .13 Measure air cooled condenser discharge DBT.
 - .14 Measure flow rates (minimum and maximum) of SA, RA, EA, relief air.
 - .15 Simulate maximum cooling load and measure refrigerant hot gas and suction temperatures and pressures.
 - .16 Use smoke test to verify no short-circuiting of EA, relief air to outside air intake or to condenser intake.
 - .17 Simulate maximum heating load and:
 - .1 Verify temperature rise across heat exchanger.

- .2 Perform flue gas analysis. Adjust for peak efficiency.
- .3 Verify combustion air flow to heat exchanger.
- .4 Simulate minimum heating load and repeat measurements.
- .18 Measure radiated and discharge sound power levels under maximum heating demand and under maximum cooling demand with compressors running.
- .19 Verify operating control strategies, including:
 - .1 Heat exchanger operating and high limit.
 - .2 Early morning warm-up cycle.
 - .3 Freeze protection.
 - .4 Economizer cycle operation, temperature of change-over.
 - .5 Alarms.
 - .6 Voltage drop across thermostat wiring.
 - .7 Operation of remote panel including pilot lights, failure modes.
- .20 Set zone mixing dampers for full heating and repeat measurements.
- .21 Measure leakage past zone mixing dampers by taking temperature measurements. Reduce leakage to less than [5] %.
- .22 Check capacity of heating unit.
- .23 Measure DX refrigeration system performance as specified Section [____].
- .24 Refer to other sections of these specifications for PV procedures for other components.
- .2 Verify accessibility, serviceability of components including motorized dampers, filters coils, fans, motors, operators, humidifiers, sensors, electrical disconnects.
- .3 Verify accessibility, clean ability, drainage of drain pans for coils, humidifiers.
- .2 Commissioning Reports:

3.6 Cleaning

- .1 Clean units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.
- .2 After completing system installation and testing, adjusting, and balancing modular indoor air-handling and air-distribution systems, clean filter housings and install new filters.

END OF SECTION

1. GENERAL

1.1 General

- .1 This Section specifies general conditions for Divisions 25 and is to be read, interpreted, and coordinated with all other sections of Division 25 and Section 21 05 01 – Common Work Results for Mechanical.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification Sections apply to work specified in this section.
- .3 Section 23 05 53 - Identification for Mechanical Piping and Equipment.
- .4 Section 23 08 00 – Commissioning of Mechanical Systems.

1.3 References

- .1 Work, materials, and equipment shall comply with the most restrictive of local, provincial, and National authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:
- .2 British Columbia Codes:
 - .1 British Columbia Electrical Code
 - .2 British Columbia Safety Authority

1.4 General Scope

- .1 'Provide' shall mean 'supply and install'.
- .2 Provide complete, fully tested, and operational systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.
- .3 Contract documents and drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material, and installation quality but are not detailed installation instructions.
- .4 Follow manufacturers' recommended installation instructions, details, and procedures for equipment, supplemented by requirements of the Contract Documents.
- .5 Install equipment to provide: service access, maintain service clearances and for ease of maintenance.
- .6 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Departmental Representative.

1.5 Coordination of Work

- .1 Products furnished but not installed under this division
 - .1 Division 23 – Heating, Ventilation and Air Conditioning
 - .1 Control Valves
 - .2 Flow Switches
 - .3 Pressure and Temperature Sensor Wells and Sockets

- .4 Automatic Damper Actuators
- .5 Airflow Stations
- .6 Terminal Unit Controls
- .2 Products installed but not furnished under this division
 - .1 Division 26 – Electrical
 - .1 Duct smoke detectors
- .3 Products not furnished or installed under but integrated with the work of this division
 - .1 Division 23 – Heating, Ventilation and Air Conditioning
 - .1 Rooftop air-handling equipment discharge air temperature control
 - .2 Rooftop air-handling equipment economizer control
 - .2 Division 26 – Electrical
 - .1 Fire alarm panel

1.6 Submittals

- .1 Comply with Division 01 – Submittal Procedures and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and in addition the following:
- .2 Provide submittals on all hardware, software, and installation. No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent. Provide drawings as files on optical disk (file format: .dwg, .dxf, pdf, or comparable). When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Submittals shall include a complete bill of materials of equipment to be used indicating quantity, manufacturer, model number, and other relevant technical data and the following:
 - .1 BAS Hardware:
 - .1 Manufacturer's description and technical data, performance curves, product specification sheets, and installation/maintenance instructions for:
 - .1 Control Panels
 - .2 Transducers/Transmitters
 - .3 Sensors (including accuracy data)
 - .4 Actuators
 - .5 Valves
 - .6 Relays/Switches
 - .7 Operator Interface Equipment
 - .8 Wiring
 - .9 Other relevant items
 - .2 Wiring diagrams and layouts for each control panel. Show all termination numbers.
 - .3 Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware.
 - .2 Central System Hardware and Software:

- .1 Manufacturer's description and technical data, product specification sheets and installation/maintenance instructions for:
 - .1 Central Processing Unit
 - .2 Monitors, Printers
 - .3 Interface Equipment between CPU and Control Panels
 - .4 Operating System Software and/or Operator Interface Software
 - .5 Color Graphic Software and/or Third-Party Software
 - .6 Other relevant items
- .2 Provide a schematic drawing of the central system. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
- .3 Riser diagrams of wiring between central control unit and all control panels.
- .4 A list of the color graphic screens to be provided. For each screen, provide a conceptual layout of pictures and data and show or explain which other screens can be directly accessed.
- .3 Controlled Systems
 - .1 A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
 - .2 A schematic wiring diagram for each BAS. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the BAS schematic, it shall be labeled with the same name. All terminals shall be labeled.
 - .3 An instrumentation list for each controlled system. Each element of the BAS shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.
 - .4 A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
 - .1 Submitted sequence of operations shall not be direct copy of sequences in section 25 90 00 Integrated Automation Control Sequences. Submittal shall include sufficient information to clarify items including but not limited to; deadbands, deadband intervals, ramp up/down times, loop types (PID/PI), comparisons for resets, Equipment starting stopping, capacity staging and control, delays, interlocks, loss of power results, interfacing with packaged equipment, etc.
 - .5 A point list for each system controller including both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, and the location of the I/O device. Software flag points, alarm points, etc.
- .4 Quantities of items submitted shall be reviewed but are the responsibility of the Division 25 Contractor.
- .5 A description of the proposed process along with all report formats and checklists to be used in Section 25 08 00 "Commissioning of Integrated Automation "BAS Demonstration" and "BAS Acceptance."

- .6 Instrumentation and Data Point Summary Table. Contractor shall submit in table format with the following information for each instrument and data point. The table is to be reviewed and approved by the Departmental Representative's representative prior to hardware and software installation and programming.
 - .1 Point name
 - .2 Point description: provide building designation, system type, equipment type, engineering units, and functionality; include a description of its physical location
 - .3 Expected range (upper and lower limit)
 - .4 Instrumentation (as applicable): manufacturer, model number, range, and accuracy specification
 - .5 Type
 - .1 AI: analog input
 - .2 BI: binary input
 - .3 NAI: network analog input
 - .4 NBI: network binary input
 - .5 CP: Configuration Property
 - .6 P: Programmed (e.g., soft or virtual point in control sequence such as a PID input or output)
 - .7 C: Calculated value; a soft or virtual point. If calculated value, provide logic diagrams or code and any constants used in formula. If time-based integrated values are required, provide time periods: minutes, daily, weekly, monthly, and yearly. Also, indicate if it is a running average.
 - .6 Input resolution
 - .7 Graphic display resolution
 - .8 Data trend interval
- .3 Schedules:
 - .1 Within one month of contract award, provide a schedule of the work indicating the following:
 - .1 Intended sequence of work items.
 - .2 Start dates of individual work items.
 - .3 Duration of individual work items.
 - .4 Planned delivery dates for major material and equipment and expected lead times.
 - .5 Milestones indicating possible restraints on work by other trades or situations.
 - .2 Provide monthly written status reports indicating work completed, revisions to expected delivery dates, etc. An updated project schedule shall be included.
- .4 Provide Record drawings and maintenance data in compliance with Division 01 - Closeout Submittals and the following:
 - .1 Submit project record documents upon completion of installation. Co-ordinate quantity to suit number of O&M manuals required. The documents shall be submitted for approval prior to final completion and shall include:

- .2 Project Record Drawings. As-built versions of the submittal shop drawings provided as files on optical media and as 11" x 17" prints.
- .3 Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Section 25 08 00 Commissioning of Integrated Automation "BAS Demonstration" and "BAS Acceptance".
- .4 Operation and Maintenance (O & M) Manual.
- .5 As-built versions of submittal product data.
- .6 Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
- .7 Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
- .8 Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
- .9 Graphic files, programs, and database on magnetic or optical media.
- .10 List of recommended spare parts with part numbers and suppliers.
- .11 Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
- .12 Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
- .13 Licenses, guarantees, and warranty documents for equipment and systems.
- .14 Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

1.7 Acceptable Control System Primary Manufacturers

- .1 Controls on this project shall be solely "Reliable Controls" product to match the existing facility building controls.
- .2 Quality Assurance
 - .1 Installer and Manufacturer Qualifications
 - .1 Installer shall have an established working relationship with BAS Manufacturer of not less than three years.
 - .2 Installer shall have successfully completed BAS control system training. Upon request, Installer shall present certification of completed training including hours of instruction and course outlines.
 - .3 Installer must be able to respond to the site within a 90 minute timeframe upon being contracted, 24/7 and be within 90km of the project site.

1.8 Identification

- .1 All components of the Building Management System shall be identification tagged. Comply with Section 23 05 53 - Identification for Mechanical Piping and Equipment.

1.9 Warranty

- .1 Warrant work as follows:

- .1 Warrant labor and materials for specified BAS free from defects for a period of 12 months after final acceptance. BAS failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Departmental Representative. Respond during normal business hours within 24 hours of Departmental Representative's warranty service request.
- .2 Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Departmental Representative can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Departmental Representative's written authorization.
- .2 Special warranty on instrumentation:
 - .1 All instrumentation shall be covered by manufacturer's transferable [one-year] "No Fault" warranty. If manufacturer warranty is not available, the BAS installer shall provide the same.

1.10 Substantial & Total Performance

- .1 Comply with Section 21 05 01 Common Work Results for Mechanical – Substantial and Total Performance.
- .2 A certificate of Substantial Performance will not be granted unless the controls systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation. Commissioning checklists must be submitted prior to the request by the Contractor to have a substantial completion inspection.

1.11 Ownership of Proprietary Material

- .1 Project-specific software and documentation shall become Departmental Representative's property. This includes, but is not limited to graphics, record drawings, database, application programming code, and documentation.

2. PRODUCTS

2.1 Not used

3. EXECUTION

3.1 Examination

- .1 The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Consultant for resolution before rough-in work is started.

3.2 Co-ordination

- .1 Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.
- .2 Coordinate final graphics floor plans, room names and numbering with Architectural drawings including any changes made during construction. These graphics should be provided to the Engineers and the Departmental Representative for sign off before the graphics are completed.
- .3 The contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.

- .4 Duct smoke detectors required for air handler shutdown are supplied under Division 26. The contractor shall interlock smoke detectors to air handlers for shutdown.
- .5 Fire/smoke dampers and actuators required for fire rated walls are provided under Division 23. Fire/smoke dampers powered by Div 26. Wiring for end-switch by Div 25.
- .6 Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the BAS specified in this section. These controls shall be integrated into the system and coordinated by this Contractor as follows:
 - .1 Each supplier of a controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.
 - .2 The Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.
 - .3 The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
 - .4 The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.3 General Workmanship

- .1 Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- .2 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- .3 Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).
- .4 Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- .5 All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
- .6 All work, materials, and equipment shall comply with the rules and regulations of applicable local, provincial, and federal codes and ordinances as identified in Part 1 of this specification.

3.4 Existing Equipment

- .1 Unless otherwise directed, the contractor is not responsible for the repairs or replacement of existing energy equipment and systems, valves, dampers, or actuators. Should the contractor find existing equipment that requires maintenance, the Consultant is to be notified immediately.
- .2 All redundant wiring and equipment as a result of this project, that is not identified for either salvage or reuse, shall be removed and become the property of the contractor, unless otherwise noted.
- .3 The mechanical system must remain in operation based on the Departmental Representative requirements within the building (i.e. between the hours of 6 a.m. and 6 p.m., Monday through Friday). Any interruptions to the operation of existing building systems must be co-ordinated with the Departmental Representative and the design team in advance of any interruptions.

- .4 The scheduling of fans through existing or temporary time clocks or BAS shall be maintained throughout the BAS installation.
- .5 Modify existing starter control circuits, if necessary, to provide hand/off/auto control of each starter controlled. If new starters or starter control packages are required, these shall be included as part of this contract.

3.5 Training

- .1 Provide training sessions period for personnel designated by the Departmental Representative. The number of training sessions required should be agreed with the Engineers and Departmental Representative prior to commencement of training
- .2 Provide two additional training sessions at 6 and 12 months following building's turnover. Each session shall be one day in length and must be coordinated with the building Departmental Representative.
- .3 Train the designated staff of the Departmental Representative to enable them to do the following:
 - .1 Day-to-day Operators:
 - .1 Proficiently to operate the system
 - .2 Understand BAS architecture and configuration
 - .3 Understand BAS system components
 - .4 Understand system operation, including BAS control and optimizing routines (algorithms)
 - .5 Operate the workstation and peripherals
 - .6 Log on and off the system
 - .7 Access graphics, point reports, and logs
 - .8 Adjust and change system set points, time schedules, and holiday schedules
 - .9 Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
 - .10 Understand system drawings and Operation and Maintenance manual
 - .11 Understand the job layout and location of control components
 - .12 Access data from BAS controllers and ASCs
 - .13 Operate portable operator's terminals
 - .2 Advanced Operators:
 - .1 Make and change graphics on the workstation
 - .2 Create, delete, and modify alarms, including annunciation and routing of these
 - .3 Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
 - .4 Create, delete, and modify reports
 - .5 Add, remove, and modify system's physical points
 - .6 Perform BAS field checkout procedures
 - .7 Perform BAS unit operation and maintenance procedures
 - .8 Perform workstation and peripheral operation and maintenance procedures
 - .9 Perform BAS diagnostic procedures

- .10 Maintain, calibrate, troubleshoot hardware
- .11 Adjust, calibrate, and replace system components
- .3 System Managers/Administrators:
 - .1 Maintain software and prepare backups
 - .2 Interface with job-specific, third-party operator software
 - .3 Add new users and understand password security procedures
- .4 These objectives will be divided into three logical groupings. Participants may attend one or more of these, depending on level of knowledge required.
- .5 Provide course outline and materials. The instructor(s) shall provide one copy of training material per student.
- .6 The instructor(s) shall be factory-trained instructors experienced in presenting this material.

END OF SECTION

1. GENERAL

1.1 Section Scope

- .1 Section includes commissioning process requirements for control systems, assemblies, and equipment.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical
- .3 Section 23 08 00 – Commissioning of Mechanical Systems
- .4 Section 25 09 01 - Controls Systems
- .5 Section 25 90 00 – Integrated Automation Control Sequences

1.3 References

- .1 Commissioning Agency (CxA)
- .2 The latest revisions of the following standards shall apply unless noted otherwise.
 - .1 Applicable Building Code - Refer to Section 21 05 01

1.4 Submittals

- .1 Comply with Division 01 – Submittal Procedures and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and in addition the following:
 - .1 Certificates of readiness.
 - .2 Certificates of completion of installation, prestart, and start-up activities.

1.5 Contractor's Responsibilities

- .1 Provide Project-specific construction checklists and commissioning process test procedures for actual control systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- .2 Perform commissioning tests
- .3 Hold construction phase controls coordination meeting.
- .4 Attend testing, adjusting, and balancing review and coordination meeting.
- .5 Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection.
- .6 Provide information requested by the CxA for the final commissioning documentation.
- .7 Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 CxA's Responsibilities

- .1 Attend construction phase controls coordination meeting.
- .2 Verify and participate in commissioning testing.
- .3 Verify testing, adjusting, and balancing of work are complete.

1.7 Commissioning Documentation

- .1 Provide the following information to the CxA for the inclusion in the commissioning plan:
 - .1 Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - .2 Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - .3 Process and schedule for completing construction checklists for controls systems, assemblies, equipment, and components to be verified and tested.
 - .4 Certificate of completion certifying that installation, start-up checks, and start-up procedures have been completed.
 - .5 Certificate of readiness, certifying that controls systems, subsystems, and equipment are ready for testing.
 - .6 Test and inspection reports and certificates.
 - .7 Corrective action documents.
 - .8 Documented verification of testing, adjusting, and balancing reports.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 BAS Start-up Testing

- .1 All testing listed in this article shall be performed by the Division 25 contractor and shall make up part of the necessary verification of an operating BAS. This testing shall be completed before the Departmental Representative's representative is notified of the system demonstration.
 - .1 The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
 - .2 Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 - .3 Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
 - .4 Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
 - .5 Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
 - .6 Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum start/stop routines. DO NOT call for system demonstration prior to these detailed tests being completed and systems properly functioning as per the sequence of operations and design intent.

- .7 Verify that all graphics are complete and meet the Departmental Representative's Representative's requirements. Add or adjust graphics to suit the specific project requirements and Departmental Representative's requests.
- .8 Alarms and Interlocks:
 - .1 Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - .2 Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - .3 Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.2 BAS Demonstration

- .1 Prior to acceptance, the BAS shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
- .2 The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in "Start-up Testing" of this specification. The CxA will be present to observe and review these tests. The CxA shall be notified at least 10 days in advance of the start of the testing procedures.
- .3 The demonstration process shall follow that approved in Article 1.10, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
- .4 The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
- .5 As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
- .6 Demonstrate compliance with Section 25 09 01 Control Systems - Part 1, "BAS Performance."
- .7 Demonstrate compliance with Section 25 90 00 Integrated Automation Control Sequences through all modes of operation.
- .8 Demonstrate complete operation of operator interface.
- .9 Additionally, the following items shall be demonstrated:
 - .1 DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
 - .2 Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of shed equipment outputs.

- .3 Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
- .4 Interface to the building fire alarm system.
- .5 Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/BAS designer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
- .10 Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

3.3 BAS Acceptance

- .1 All tests described in this specification shall have been performed to the satisfaction of both the Consultant and CxA prior to the acceptance of the BAS as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the BAS designer. Such tests shall then be performed as part of the warranty.
- .2 The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Section 25 09 01 Control Systems, "Submittals."

END OF SECTION

1. GENERAL

1.1 Section Scope

- .1 A description of the sequence of operation for each system, including ramping periods and reset schedules.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical.
- .3 Section 25 05 00 – Common Work Results for Integrated Automation.

1.3 General

- .1 The control sequences contain a general description of the operational intent for the systems to be controlled. The Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.
- .2 Refer to control diagrams and equipment schedules in the contract drawings for additional requirements. Refer to Mechanical Motor list and points list in the contract drawings, and detailed specification sections for additional requirements.
- .3 The Controls Contractor shall provide all necessary programming and equipment required to meet this sequence of operation.
- .4 Contractor shall not remove or override any manufacturer's safeties.
- .5 This Section includes control sequences for HVAC, equipment.
- .6 Note that the sequences in this section outline overall operational intent. Coordinate all interface requirements with equipment for the sequences in this section to be successfully executed.
- .7 Consult with the Mechanical Consultant during the shop drawing stage to finalize the control sequences for each system. The controls contractor shall submit the final sequence of operation during shop drawing phase.

1.4 Abbreviations

- .1 The following abbreviations may be used in graphics, schematics, point names, and other control applications where space is at a premium.

AC	Air Conditioning	CW	Condenser Water
ACU	Air Conditioning Unit	CWP	Condenser Water Pump
AHU	Air Handling Unit	CWR	Condenser Water Return
AI	Analog Input	CWS	Condenser Water Supply
AO	Analog Output	DA	Discharge Air
AV	Analog Value	DI	Digital Input
AVG	Average (mean)	DO	Digital Output
AUTO	Automatic	DV	Digital Value
AUX	Auxiliary	EA	Exhaust Air
C	Common	EF	Exhaust Fan
CHW	Chilled Water	EVAP	Evaporator
CHWP	Chilled Water Pump	FCU	Fan Coil Unit
CHWR	Chilled Water Return	HOA	Hand / Off / Auto
CHWS	Chilled Water Supply	HP	Heat Pump
COND	Condenser	HRU	Heat Recovery Unit

HTEX	Heat Exchanger	RF	Return Fan
HW	Hot Water	RH	Relative Humidity
HWP	Hot Water Pump	RTU	Roof-top Unit
HWR	Hot Water Return	SA	Supply Air
HWS	Hot Water Supply	SF	Supply Fan
MAX	Maximum	SP	Static Pressure
MIN	Minimum	TEMP	Temperature
MISC	Miscellaneous	UH	Unit Heater
N/C	Normally Closed	UV	Unit Ventilator
N/O	Normally Open	VAV	Variable Air Volume
OA	Outdoor Air	VVTU	Variable Volume Terminal Unit
OAT	Outdoor Air Temperature	W/	With
OAH	Outdoor Air Humidity	W/O	Without
PIU	Powered Induction Unit	WSHP	Water Source Heat Pump
RA	Return Air		

1.5 Programming Requirements

- .1 Provide all programming required to implement the control sequences and to make system operational, as well to meet design intent.
- .2 Programs shall be modular in nature and shall be as structured as the language will permit.
 - .1 Unconditional "GOTO" statements shall be used sparingly and shall always jump forwards. All jumps from the body of a module shall target the end of that module. Similarly, jumps from the body of a sub-module shall target the end of that sub-module.
 - .2 All conditional "GOTO" statements, which make a single choice from multiple choice sub-module options, shall form the opening lines of code of the module. Each succeeding conditional jump shall direct the execution of software to the relevant sub-module, which shall be in the reverse order of the conditional jump statement. The exit from each sub-module shall jump to the end of the module.
 - .3 All conditional "GOTO" statements, for "AND"/"OR" choices between sub-modules, shall form the opening line of code in each sub-module which the conditional statement controls.
 - .4 Do not use double negatives in programming language.
- .3 All programs must include a sufficient number of comments to allow another person to make changes to the strategies at a later time.
- .4 Additional programming may be provided by the Contractor as desired, so long as it does not affect the intended operation of the specified sequences. Ensure that all equipment will operate in a safe manner.
- .5 Programming required for equipment safety may be installed by the Contractor as necessary. The Departmental Representative shall be notified of these changes as soon as practical.
- .6 All deviations from the specified programming, except those related to equipment safety, must receive prior written approval from the Mechanical Consultant.
- .7 All control loops shall be tuned such that they are stable through all seasons and operating conditions including start-up.
- .8 All HVAC controls shall implement Building operating modes. Unit system description is modifications to the Building operation modes.
- .9 Staggered starting:

- .1 Motors must not be allowed to start at the same time. Under all conditions of start-up, return from power failure or panel reset, there must be at least a 15 second delay between the time one motor starts and another is allowed to start.
- .10 Motor and equipment status:
 - .1 All mechanical equipment motors that are enabled by the BMS shall be provided with status and alarm indication by a current sensor. This includes all pumps, fans, and electric motor driven devices.
 - .2 Equipment status may also be indicated by flow switches as an alternate status indication, with prior acceptance by the Consultant, or where specifically indicated in the Contract Documents.
 - .3 Exclude small unitary bathroom exhaust fans, domestic range hoods and manually operated fans and devices, unless noted otherwise.
 - .4 Current sensors shall provide status and an out of range alarm.

2. PRODUCTS

- .1 Refer to Section 25 09 01 – Control Systems.

3. EXECUTION

3.1 Building Operating Modes

- .1 Four operating modes are required: Purge, Occupied, Unoccupied, and Fire. Mode flags are required for the purge, occupied and fire modes. By definition, unoccupied mode occurs when both purge and occupied mode flags are not set (i.e. off).
- .2 An optimum start routine shall be used to determine when the air systems are to begin operation such that adequate comfort conditions are reached just before occupancy begins.
- .3 Occupied Mode:
 - .1 The beginning and ending time of this mode shall be determined by a weekly schedule. An annual holiday schedule shall be used to bypass statutory holidays.
 - .2 One weekly/annual schedule is required. Required flags: OCCUP (units yes/no).
 - .3 During this mode, all spaces within the building are to be at occupied comfort conditions. Air systems are to be running. Heating and cooling are to be used as required.
 - .4 The optimum start routine enables the occupied mode flag prior to scheduled occupancy. This allows the air systems to condition the spaces such that they are comfortable at the time of scheduled occupancy.
- .4 Purge Mode:
 - .1 This mode, indicated by flag PURGE (units yes/no), is used to purge the spaces with cool morning air on warm days or general purge due to high chloramines levels.
 - .2 Purge is allowed to start as soon as 3 hours before normal occupancy and is stopped as soon as the occupied mode starts or the time is later than 9:00 am. Once started it shall not stop until at least 30 minutes have elapsed or occupied mode has begun.
 - .3 This mode is allowed only if the outside air temperature is above 8°C and is at least 5°C lower than the average space temperature for free cooling purge. Chloramine purge may happen any time however do not allow space temperature to drop below 23°C.
 - .4 During this mode, no mechanical cooling or heating shall be allowed.

- .5 Purging shall be optimized such that it is only active long enough to bring space temperatures well into the comfort range. A reasonable initial estimate of this time in hours is:
 - .1 $(RTa - 22.5) / (RTa - (OAT + 2)) * 8$
 - .1 Where RTA = average room temperature
 - .2 OAT = outside air temperature.
- .5 Fire Mode:
 - .1 Refer to specific equipment control sequences and drawings in addition to the requirements of this sub-section.
 - .2 Fire Alarm Systems in buildings will override BMS control of designated equipment in an alarm condition. The BMS shall monitor a set of contacts output from the fire alarm system for status indication of a building fire alarm. Control sequences of all components that participate during all Fire Alarm modes (such as Smoke Exhaust) shall be hard-wired where possible. Where not possible (such as position of dampers in various positions depending on fire alarm mode), once the signal has been received from the fire alarm control panel the BMS system shall modulate the Fan speed and damper positions as noted below to put the systems in fire mode before fire alarm control panel is to operate unit. The BMS Controls Contractor shall coordinate building equipment that is shut down by the Fire Alarm System.
 - .3 Prior to control of systems by the fire alarm control panel the following operations are performed by the BAS system:
 - .1 Supply and return fans are to operate at design air flow speed as noted on the mechanical equipment schedules.
 - .2 Outside air and relief air dampers are to open up 100%.
 - .3 Mixed air damper is to close.
 - .4 The supply and return fan high duct pressure cut off shall remain active to protect the fan and ductwork.
 - .4 Upon detection of air handling unit shut down the BMS shall close associated valves and stop associated pumps unless otherwise noted.
 - .5 Alarms shall be annunciated by the BMS to indicate the equipment failure/shut down and the building fire alarm condition. The BMS shall not annunciate nuisance alarms for monitored input points on systems shut down by the BMS or fire alarm system (e.g. high supply air temperature, low duct static pressure, etc.).
 - .6 Equipment shut down by the fire alarm system shall not be automatically restarted until the following has occurred:
 - .1 Building fire alarm condition has been cleared and a registered signal has been received from the fire alarm panel to the BMS.
 - .2 BMS Operator acknowledges the fire alarm.
 - .3 BMS Operator with appropriate access level resets the BMS system shut down software point.
 - .7 Once the above conditions have been satisfied and the BMS receives a Post Fire Alarm Equipment restart command, the BMS shall initiate the restart of any equipment shut down by the fire alarm system. The restart sequence shall provide an orderly start-up of the motors for each individual system with time delay between restarts of individual systems. Start of systems shall be according to normal system start up sequences. Only those motors, which should be operational in accordance with the Occupancy Schedule or application software programming requirements, shall be restarted.

3.2 General Building Conditions

- .1 Monitor the following parameters:
 - .1 Building pressure differential sensors.
- .2 Points: Provide all hardware and software points required to achieve the specified sequence including, but not limited to, the following points:

Point Name	Hardware Points				Software Points					Show On Graphic
	AI	AO	DI	DO	AV	DV	Sched	Trend	Alarm	
Building Differential Pressure	X							X		X
Sensor Failure									X	

3.3 Variable Frequency Drive (VFD) Interface

- .1 All variable frequency drives (VFDs) shall be native BACnet.
- .2 The VFD interface shall be connected directly to the main BMS network trunk to monitor, display, trend and report the following minimum points. VFD interface shall not be networked indirectly to the main BMS through equipment controllers:
 - .1 Speed Output
 - .2 Hand / Auto selection indication
 - .3 Drive Amps
- .3 kW (compare instantaneous value, the connected motor nameplate HP/kW (constant) and the ratio).
 - .1 kWh
 - .2 Operating hours
 - .3 Warnings
 - .4 Faults
- .4 The following points shall be hardwired to the BMS independently of Serial Communications interface so they can be monitored in the event network connection has failed.
 - .1 VFD Start/Stop
 - .2 VFD speed and feedback
 - .3 VFD Fault

3.4 Zone Sensors and Setpoints and Control Loops

- .1 General:
 - .1 Refer to drawings for sensor locations
- .2 Zone Temperature
 - .1 Each zone shall have separate unoccupied and occupied setpoints, and separate heating and cooling setpoints. All setpoints shall be adjustable.
 - .2 Unless noted otherwise the occupied heating setpoint shall be 21°C and the occupied cooling setpoint shall be 25°C. The unoccupied heating setpoint shall be 16°C and the unoccupied cooling setpoint shall be 30°C.
- .3 Room Temperature Occupied Set-points

Room Type	Set point (°C)	
	Summer	Winter
Dish Production Facility	20 (50-60%RH)	20 (50-60%RH)

- .1 Setpoint Overlap Restriction:
 - .1 The software shall maintain a minimum 1°C (adj.) deadband between the heating and cooling setpoints at all times.
 - .2 Each zone shall have a local occupant setpoint adjustment knob / button limited in software and active only in occupied mode:
 - .1 As a default, the occupied cooling setpoint shall be limited to 20°C (adj.).
 - .2 As a default, the occupied heating mode setpoint shall be limited 20°C (adj.).
 - .3 The adjustment shall move both the existing heating and cooling set points upward or downwards by the same amount unless the limit has been reached.
 - .3 In zones that have 2 or more temperature sensors, the BMS operator shall be able to easily select (globally and individually) between min-average-max comparative control functions. The default shall be set for average unless noted otherwise.
- .4 Zone Modes:
 - .1 Occupied Mode: A zone is in occupied mode when the time of day is between the system's scheduled occupied start and stop times AND occupancy is detected by the zone motion sensor.
 - .2 Stand-By Mode: A zone is in stand-by mode when the time of day is between the system's scheduled occupied start and stop times AND occupancy has not been detected in the zone for more than 15 minutes (adj.).
 - .3 Occupant Override Mode: A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule. The time of temporary occupied mode shall be initially set to 60 minutes. Timer shall reset each time the zone override button is pressed.
 - .4 Optimal Start: The unit shall use an adaptive optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period. The learning adaptive algorithm shall compare the zone temperature to its setpoint at beginning of scheduled occupied period and shall automatically adapt the warm-up or cool-down response time for the next unoccupied period. Refer to the Air handling unit sequence of operation for more information.
 - .5 Unoccupied Mode: A zone is in unoccupied mode when not in any other mode.
- .5 Alarms
 - .1 High zone temperature: if zone temperature is greater than cooling setpoint by 3°C (adj.) for a minimum of 60 minutes (adj.) continuously, modulate damper to maximum position and annunciate alarm.
 - .2 Low zone temperature: if zone temperature is less than heating setpoint by 3°C (adj.) for a minimum of 60 minutes (adj.) continuously, modulate damper to minimum position and annunciate alarm.
 - .3 High Zone CO2 concentration: If the zone CO2 concentration is, greater than 10% (adj.) above setpoint for more than 30 minutes (adj.) annunciate alarm.

- .4 Unstable PID loop: If any PID loop continues to cycle its output more than 40% or its range (adj.) 3 times (adj.) in any 60 minute interval, annunciate alarm.
- .5 Inhibit alarms after zone set point is changed for a period of 20 minutes per degree of change (e.g. if set point changes from 21°C to 23°C, inhibit alarm for 40 minutes after the change) and while the System is in Warm-up or Cool-down Modes.
- .6 Points List

Point Name	Hardware Points				Software Points					Show On Graphic
	AI	AO	DI	DO	AV	DV	Sched	Trend	Alarm	
Zone Temp	X							X		X
Zone CO2 Concentration	X							X		X
Zone Relative Humidity	X							X		X
Zone Override			X					X		X
Zone Heating Setpoint					X			X		X
Zone Cooling Setpoint					X			X		X
Schedule							X			
High Zone Temp									X	
Low Zone Temp									X	
High Zone CO2 Concentration									X	

3.5 Heating During Unoccupied Periods

- .1 During unoccupied periods in certain areas of the building where air-handling units are not required to run continuously, the AHU's shall be shut down unless space temperature falls below the unoccupied set point at which time the AHU will start in full recirculation mode and the heating coil modulated to maintain set point. Provide a suitable deadband to prevent fan cycling.

3.6 Air System Shutdown

- .1 This sequence shall be used for all air systems with central supply and return fans. This sequence is general in nature and shall apply unless noted specifically otherwise. System shut down shall be initiated automatically by the BMS according to Occupancy Schedule requirements, by manual Operator command, or via hardwired interlocks.
 - .1 On system shut down the BMS shall ramp down the supply and return fan (where applicable) speeds and return the system to the state described for System Off.
 - .2 The BMS shall shut down the supply fan and the return fan (where applicable) and generate an appropriate alarm message on detection of a supply air temperature of less than 5 Deg. C. This BMS software shutdown sequence shall be disabled during the first ten (10) minutes following system start-up.
 - .3 System Off - When the system is off:
 - .1 The return fan (as applicable) shall be off.
 - .2 The supply fan shall be off.
 - .3 The outside air dampers and the relief air dampers shall be fully closed.
 - .4 The dx heating/cooling shall be off.
 - .5 The gas heating section valve shall be closed.
 - .6 VSD's shall be set to the minimum speed.

- .7 System control loops shall be disabled.

3.7 Fire Event Mode (RTU-1 & RTU-2)

- .1 Refer to the Post Fire Alarm Equipment Restart section in addition to the requirements noted here.
- .2 Prior to control of systems by the fire alarm control panel the following operations are to be performed by the DDC system.
- .3 Supply and Return Fans are to operate at design air flow speed as noted on the mechanical equipment schedules.
- .4 Outside air and relief air dampers are to open up 100%.
- .5 Mixed air damper is to close.
- .6 The supply and return fan high duct pressure cut off shall remain active to protect the fan and ductwork.

3.8 Rooftop Unit (RTU-1 & RTU-2)

- .1 General:
 - .1 The rooftop unit is designed as a heating/ cooling/ mixed air and supply air reset, single duct, constant volume air handling unit. Unit will have supply fan on variable speed drive for soft start and balancing purposes. The unit has both a modulating gas heating sections and a heat pump dx oil (heating and cooling). The heat pump section shall always be the primary source of heating unless the OAT is at 5°C or less. The propane fired section shall be the main source of heating when the OAT is less than 5°C.
 - .2 Run Conditions – Scheduled:
 - .1 The RTU shall run according to a user defined and adjustable schedule.
 - .2 Default schedule shall be confirmed with the Departmental Representative, but initially set for 6AM to 6PM, 7 days per week.
 - .3 Components:
 - .1 Outdoor air control damper.
 - .2 Economizer air control damper.
 - .3 Return air control damper.
 - .4 Prefilter-outdoor air
 - .5 Final filter-outdoor air
 - .6 Gas Heating section.
 - .7 Heat pump DX section
 - .8 Supply fan
 - .9 Economizer/Power exhaust
 - .10 Supply fan variable speed drive
 - .4 Normal Operation:
 - .1 Fan Stopped:
 - .1 Outdoor air damper closed.
 - .2 Economizer air control damper open.
 - .3 Return air control open.

- .4 Gas heating section off.
- .5 Supply fan stopped.
- .6 Exhaust fan stopped.
- .2 Start-up: (start switches activated by BMS or by manual override):
 - .1 Outdoor air damper remains 0% open position initially.
 - .2 Exhaust fan remains off initially.
 - .3 Supply fan starts at minimum delivery position.
 - .4 Supply fan to run initially at minimum speed of 30%.
 - .5 Supply fan to run as per static pressure set point.
 - .6 The outdoor air damper and exhaust air damper to open to minimum outdoor air position.
- .5 Supply Air Temperature Control:
 - .1 The BMS shall generate a supply air temperature setpoint. This setpoint shall be automatically reset to the highest air temperature that will meet the cooling demand of the spaces served from the air handling unit. Calculate this setpoint based on the highest deviation (positive) from cooling setpoint. Calculate this setpoint every 10 minutes and use a filter to dampen sudden changes in the setpoint. Control the modulated components in sequence to maintain setpoint as per the following:
 - .1 Free cooling mode: On a call for cooling, the BMS shall modulate the mixed air dampers (outdoor & exhaust damper) open to maintain supply air setpoint. If outdoor air temperature exceeds return air temperature then the mixed air dampers shall go to minimum position (see below).
 - .2 Mechanical cooling mode: On a call for cooling while free cooling is no longer possible, the outdoor air and exhaust air dampers shall remain at minimum position (see below) and the BMS shall engage the refrigerant compressors to provide mechanical cooling with a minimum supply air temperature of 12.8°C.
 - .3 Heating mode: on a call for heating, the outdoor air and exhaust air dampers shall remain at minimum position (see below) and the BMS shall modulate the gas heating section to maintain a maximum supply air setpoint of 35°C (95°F).
- .6 Minimum Outdoor Air Flow Control
 - .1 The B.A.S. shall monitor the supply air, return air and outdoor air CO₂ levels as well as the supply air flow of RTU. From these values, the BMS shall calculate the outdoor air flow (OAF) for the fan.
 - .2 The total minimum outdoor air flow shall be calculated by the BMS based on the total minimum ventilation requirement.
 - .1 Ventilation requirement: the minimum ventilation requirement is the larger of either the makeup air for the RTU's associated exhaust fans or to maintain the return air CO₂ level to a maximum of 700 ppm above ambient. Calculate every 30 minutes.
 - .3 The BMS shall monitor outdoor air, return air and supply air CO₂ levels with a CO₂ sensor.
- .7 Volume Control:

- .1 The supply air and return air flows shall be measured and the outdoor air damper modulated to provide sufficient outdoor air for associated exhaust fan(s) makeup air in order to maintain building neutral to slight positive pressurization.
- .8 Static Pressure Control:
 - .1 The volume of supply air being delivered by the fan shall be adjusted to maintain a duct static pressure in the ductwork required to maintain control at all air valves on a normal operating cooling load design day.
 - .2 The approximate duct static pressure setpoint shall be 125 Pa (adjustable), in the main supply duct upstream of the last air valve.
 - .3 Adjust this setpoint during the commissioning period, to determine the minimum possible settings.
 - .4 Setpoint reset – the BMS shall reset the static pressure setpoint determined above based on the VAV box requiring the most pressure. That is, the setpoint shall be incrementally lowered until one VAV box damper is 90% open.
 - .5 The static pressure on the discharge of the fan shall be monitored. If the discharge pressure reaches +1000Pa (adjustable), the supply fan shall be stopped. Fans shall be manually restarted from the BMS.
 - .6 The power exhaust shall be energized during economizer operation.
- .9 Heating Control:
 - .1 The unit will operate in heating mode using its indirect fired gas heating section when the space is below set point. The gas valve shall modulate to deliver the required heat.
- .10 Freeze Protection:
 - .1 Low temperature alarm to be monitored at BMS.
- .11 Fire Mode Operation:
 - .1 Division 26 shall provide shut down contacts to shut down the RTU upon activation of any fire alarm device such as smoke detector, pull station or sprinkler flow switch.
- .12 Smoke Detectors in Ductwork:
 - .1 Smoke detectors will be furnished, installed, and wired to fire alarm control panel by electrical contractor.
 - .2 Wire contact on fire alarm system provided by the electrical contractor to air handling unit supply fan starter to shut down unit fan when fire alarm system is in alarm.
 - .3 Wire auxiliary contact on smoke detector to air handling unit supply fan starter or contact on variable frequency drive. Each air handling units' smoke detector upon detection of smoke shall stop its respective air handling unit.
 - .4 Smoke detectors will be provided in the supply air discharge duct of air handling unit [RTU-1 and RTU-2].
- .2 Points:
 - .1 Provide all hardware and software points required to achieve the specified sequence including, but not limited to, the following points:

Point Name	Hardware Points	Software Points	Show
------------	-----------------	-----------------	------

	AI	AO	DI	DO	AV	DV	Sched	Trend	Alarm	On Graphic
Unit start/stop				X				X		X
Unit status			X					X		X
Unit Failure									X	
Schedule							X			
Supply Fan start/stop				X				X		X
Supply Fan Status			X					X		X
Supply Fan VFD output		X								X
Supply Fan VFD alarm			X							X
Supply VFD feedback	X									X
Outdoor Air Damper		X								X
Return Air Damper		X								X
Economizer Air Damper		X								X
Outdoor Air Temperature (via weather station)	X							X		X
Heating command		X								X
Heating/Cooling enable/disable (each compressor)				X						X
Compressor Status (each compressor)			X					X		X
Supply air CO ₂ concentration	X							X		X
Return air CO ₂ concentration	X							X		X
Mixed air temp	X							X		X
Supply air temp setpoint					X					X
Supply air leaving temp	X							X		X
Supply air Static Pressure Setpoint					X					X

Supply air Static Pressure	X							X		X
Filter pressure differential	X									X
Filter alarm									X	
High zone CO2 level									X	

3.9 Ceiling Fan (CF-1 to CF-5)

.1 General:

.1 The ceiling fans are designed to mitigate temperature stratification within the space. Three (3) temperature sensors at high level and two RTU (2) thermostats at low level will be utilized to measure the temperature difference between the elevations. If a temperature difference of 2°C (adjustable), is calculated then all ceiling fans shall operate at low speed and shall increase speed if the temperature difference is not maintained a minimum 1°C for 10 minutes then the fan speed shall increase at a rate of 10% until setpoint is maintain. Provide 1 minute dead band for temperature adjustment. Provide a local, manual override switch with ON/OFF/AUTO options.

.2 Run Conditions – Scheduled:

- .1 The ceiling fans shall be enabled continuously and run according to a user defined and adjustable schedule.
- .2 Fans shall operate when a differential temperature of 1°C is calculated between the high level temperature sensors and the low level RTU thermostats.
- .3 Default schedule shall be confirmed with the Departmental Representative, but initially set for 6AM to 6PM, 7 days per week.

.2 Points:

.1 Provide all hardware and software points required to achieve the specified sequence including, but not limited to, the following points:

Point Name	Hardware Points				Software Points					Show On Graphic
	AI	AO	DI	DO	AV	DV	Sched	Trend	Alarm	
Unit start/stop				X				X		X
Unit status			X					X		X
Unit Failure									X	
Schedule							X			
Supply Fan start/stop				X				X		X
Supply Fan Status			X					X		X
High level zone temp	X							X		X
Low level zone temp	X							X		X

3.10 Standby Power Operation

- .1 Upon loss of offsite power, hardwired loss of power signals from Power Distribution Control System (PDCS). Loss of power signal is also input to BMS via BACnet connection.
- .2 The BMS, upon loss of offsite power, will inhibit all major loads which are backed up by standby diesel generator from restarting upon availability of standby power. Upon verification of adequate and sufficient bus voltage, and PDCS is in "Emergency Power" position, the BMS shall reclose start/stop contacts, in predetermined sequence, for critical loads.
- .3 All air handling units, all exhaust fans, all environment room systems, all pumps and heat pumps are powered from standby power bus. Refer to the motor list on drawings. This equipment will function during loss of normal power.
- .4 Upon signal to the BMS that only one of the two diesel standby generators is operational, the BMS shall initiate a load limiting sequence to regulate supply fans and chiller capacity. VAV boxes serving Type 2 and Type 3 spaces will be set to box minimum positions.
- .5 Mechanical systems shall restart automatically starting with equipment connected with vital power followed by equipment connected with delayed vital power followed by equipment connected with conditional power. Time interval between starts shall be 10 seconds (adjustable).
- .6 The BMS shall automatically restart equipment upon transfer to or from standby power without nuisance alarms or lockouts.
- .7 Return to normal power operation:
 - .1 All equipment operating on standby power will continue to operate without interruption.

END OF SECTION

1. GENERAL

1.1 Summary

- .1 Section Includes:
 - .1 Buried gas service piping from the point of connection to the gas meter outlet to the point of building entry all in accordance with the Canadian Standards Association CSA B149.1 Natural Gas and Propane Installation Code.
 - .2 Scope of work shall also include all above ground piping and accessories between gas meter discharge and buried piping.

1.2 Related Requirements

- .1 This section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Section 21 05 01 – Common Work Results for Mechanical

1.3 References

- .1 The latest revisions of the following standards shall apply unless noted otherwise.
 - .1 Applicable Building Code - Refer to Section 21 05 01
 - .2 Canadian Standards Association (CSA Group)
 - .1 CSA B137 Series – Thermoplastic Pressure Piping Compendium
 - .2 CSA B149.1-20 - Natural Gas and Propane Installation Code
 - .3 American Society for Testing and Materials International, (ASTM):
 - .1 ASTM A53/A53M-18 – Standard Specification for Pipe, Steel Black and Hot Dipped, Zinc-Coated, Welded and Seamless
 - .2 ASTM B88-16 – Standard Specification for Seamless Copper Water Tube
 - .3 ASTM C136/C136M-14 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
 - .4 ASTM D698-12e2 - Standard Test Methods for Compaction Characteristics of Soil Using Standard Effort (12 400ft-lbf/ft³ (600kN-m/m³))
 - .5 ASTM D2513-18a – Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing and Fittings
 - .4 American Society of Mechanical Engineers (ASME):
 - .1 ASME B16.3-2016 – Malleable Iron Threaded Fittings: Classes 150 and 300
 - .2 ASME B16.40–2013 - Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems

1.4 Quality Assurance

- .1 All materials shall comply with manufacturer's specifications and referenced documents.

1.5 Painting and Colour Coding

- .1 Painting of all exposed exterior natural gas piping, equipment, and material installed under this section of the specification shall be included under this section of the work.
- .2 Paint all exposed exterior piping including the section of piping from the gas meter to the building entry and all exterior pressure regulating valve vent piping.

- .3 Painting shall consist of one coat of Rust-Oleum 769 damp proof red primer, one coat of Rust-Oleum 960 zinc chromate and two finish coats of Rust-Oleum 850 grey enamel paint.
- .4 Provide yellow colour coding identification banding of the natural gas piping as required by the gas code. Also, refer to Section 23 05 53 Identification for Mechanical Piping and Equipment.

1.6 Submittals

- .1 Comply with Division 01 – Submittal Procedures and Closeout Procedures, Section 21 05 01 Common Work Results for Mechanical – Submittals and in addition the following:
 - .1 Shop Drawings:
 - .1 Submit shop drawings for the following:
 - .1 Pipe and fittings
 - .2 Shut off valves
 - .3 Valve boxes
 - .4 Pressure regulators
 - .5 Seismic valves
 - .2 Test Reports:
 - .1 Submit certified test reports from approved independent testing laboratories indicating compliance with specifications.
 - .3 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with the specified performance characteristics and physical properties.

1.7 Delivery, Storage and Handling

- .1 Do not deliver system components until time needed for installation, and after proper protection can be provided.
- .2 Protect components from damage and corrosion.
- .3 Leave protective coverings in place until just prior to installation.
- .4 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

1.8 Measurement Procedures

- .1 Excavation and backfill will be measured under Section 31 23 33.01 – Excavating, Trenching and Backfilling.
- .2 Supply of gas pipe will be measured in metres of each type and size indicated and in authorized quantities delivered to designated storage area.
- .3 Bedding material will be measured in cubic metres of material incorporated into work. No deduction to be made for volume normally occupied by pipe.
- .4 Horizontal measurement will be made from point of entry to the ground from the storage tank to the entry point to the building over the surface after work has been completed.

1.9 Restoration of Pavement & Landscaping

- .1 Before excavation, adequate permanent support and protection shall be given to structures in close proximity to the pipe route.

- .2 Before starting the trenching, any utility lines crossing the natural gas piping route shall be located and exposed and steps shall be taken to ensure that these lines are not damaged in the course of trenching operations.
- .3 Temporary bridges for the passage of traffic over any trenches shall be provided where necessary. Temporary crossings at walkways shall be provided in order to maintain all existing access-ways. Barriers, signs, and lights shall also be provided as required.
- .4 Sufficient earth shall be mounded over the excavation to allow for subsequent settling to surrounding grade, and it shall be the responsibility of this section to provide any additional backfill within six months after completion of the contract, if earth should settle below surrounding grade.
- .5 During no stage of the work shall excavated material or backfill be piled against existing structures. All surplus excavated material existing on site both during and on completion of the contract shall be removed from the site.
- .6 All landscaping, including paving, gravel, culverts, lawns, etc., shall be restored to the original state of strength, finished appearance, and function.

1.10 Existing Services

- .1 Protect all existing services encountered. Every effort has been made to show the known existing services. However, excavation operations may reveal other existing services. Work with the Departmental Representative's staff to trace the originating source and points served. Obtain instructions from the Consultant when existing services require relocation or modifications, other than those already indicated in the Contract Documents.
- .2 Contractor shall be responsible for employing a ground penetrating radar (GPR) survey of the proposed natural gas distribution piping route prior to the start of excavating and trenching to determine possible conflicts with other buried services. If conflicts are found, the contractor shall review with the consultant to mitigate possible stopping work during construction due to unknown utility or any conflict. If unforeseen conflict comes up, a change order will be issued.
- .3 Arrange work to avoid shutdowns of existing services. Where shutdowns are unavoidable, obtain the Departmental Representative's approval of the timing, and work to minimize any interruptions.
- .4 In order to maintain existing services in operation, temporary relocations and/or bypasses of piping may be required.
- .5 Be responsible for any damages to existing system by this work.
- .6 For existing piping systems, the continuity of the existing cathodic protection shall be maintained when any additions or replacements are undertaken.
- .7 The Departmental Representative reserves the right to withhold permission for a reasonable period with respect to any shutdown, if the shutting off of a service will interfere with important operations.

1.11 Temporary Drainage & Pumping

- .1 Temporary drains and/or offset sumps or dewatering, either by pumping or other means, shall be employed as may be necessary to keep water away from work under all conditions.
- .2 Trenches shall be kept water-free during joining and for a sufficient period thereafter to allow the jointing material to become fully set and completely resistant to water penetration.
- .3 Temporary drains shall not be discharged to sanitary sewers.

1.12 Preparation of Trench

- .1 Trench shall be dug to the alignment and depth required in advance of the pipe laying. Width of the trench shall be 300 mm [12"] greater than the outside diameter of the pipe. Where shoring is required, the width of the trench shall be extended by an amount equal to the thickness of the shoring material. The floor of the trench shall be devoid of all lumps or irregularities and shall extend a minimum of 150 mm [6"] below pipe.
- .2 Trench width at any point shall not be less than trench width at any depth below such point.

2. PRODUCTS

2.1 Acceptable Manufacturers

- .1 Refer to Section 23 05 01 – Acceptable Manufacturers.

2.2 Pipe Bedding Materials

- .1 Bedding material shall conform to MMCD requirements and be free of sharp objects, large stones or any other material that can damage the piping.
- .2 Granular material, general:
 - .1 Gradation to be within specified limits when tested to ASTM C136/C136M-14 and giving a smooth curve without sharp breaks when plotted on a semi log grading chart.
 - .2 Bedding Sand: Natural sand or crushed rock screenings to following grading requirements:

ASTM Sieve Size	Percent Passing
9.525 mm [3/8"]	100
4.7625 mm [3/16"]	50 – 100
2.00 mm [0.0787"]	30 – 90
0.425 mm [0.0167"]	10 – 50
0.075 mm [0.003"]	0 – 10

Liquid Limit: ASTM D4318-17e1 Maximum 25.

Plasticity Index: ASTM D4318-17e1 Maximum 6.

- .3 Bedding Stone: Crushed stone or crushed gravel to following grading requirements:

ASTM Sieve Size	Percent Passing
22.40 mm [0.882"]	100
19.00 mm [3/4"]	70 - 100
16.00 mm [0.63"]	50 – 100
9.50 mm [3/8"]	25 – 75
4.75 mm [3/16"]	0 - 20
2.00 mm [0.0787"]	0 – 10

2.3 Backfill Materials

- .1 Backfill materials shall conform to MMCD requirements and be free of organic matter, frozen materials, building debris, sharp objects, large stones or any other materials that can damage the piping.
- .2 Type 1 and Type 2 fill:
 - .1 Crushed, pit run or screened stone, gravel or sand.

- .2 Gradations shall be within limits when tested to ASTM C136/C136M-14.
- .3 Table:

ASTM Sieve Size	Type 1 % Passing	Type 2 % Passing
75 mm	-	100
50 mm	-	-
37.5 mm	-	-
25 mm	100	-
19 mm	75-100	-
12.5 mm	-	-
9.5 mm	50-100	-
4.75 mm	30-70	22-85
2.00 mm	20-45	-
0.425 mm	10-25	5-30
0.180 mm	-	-
0.075 mm	3-8	0-10

- .3 Clean native excavated soil free from organic matter, frozen materials, stones larger than 75mm, building debris and other foreign substances.

2.4 Pipe and Fittings

- .1 Schedule 40 carbon steel to ASTM A53/A53M-18 complete with factory extruded polyethylene jacket.
- .2 Polyethylene pipe and fittings to CSA B137 Series
- .3 Type L copper pipe to ASTM B88-16 complete with factory extruded polyethylene jacket.
- .4 Fittings for steel pipe shall be malleable iron to ANSI/ASME B16.3.
- .5 Pipe and fittings shall comply with the requirements of CSA B149.1 Natural Gas and Propane Installation Code.

2.5 Valves

- .1 High pressure isolation valves shall be of the plug, ball, or eccentric type.
- .2 Polyethylene ball valves to ASME-B16.40 and ASTM D2513.
- .3 Pressure regulator valves shall be sized for required flow at the extremes of inlet pressures.
- .4 All valves shall comply with the requirements of CSA B149.1 Natural Gas and Propane Installation Code.

2.6 Valve Boxes

- .1 Valve boxes shall be in accordance with natural gas code requirements.
- .2 Valve boxes shall:
 - .1 Be made of materials that are long lasting and do not rust, rot or corrode.
 - .2 Not transmit external loads to buried pipe.
 - .3 Be of full throat and unobstructed upper tube design and complete with cast iron locking lid marked GAS.
 - .4 Have heavy duty cast iron flange where installed in areas subjected to vehicular traffic.
 - .5 Be manufactured with tracer wire holes.

- .3 Provide extensions if required to suit depth of bury of valve.

2.7 Tracer Wire

- .1 No. 14 gauge stranded copper wire.

2.8 Warning Tape

- .1 Underground warning tape shall be heavy duty yellow B-720 polyethylene with black overcoated graphics. Wording on tape shall read: CAUTION BURIED GAS LINE BELOW.

2.9 Transition Risers

- .1 Epoxy coated (4 mil) transition steel risers with one pound anodes shall be used.

2.10 Pressure Regulators

- .1 Main regulator suitable to lower pressure from the incoming service pressure from meter to service pressure within building.

2.11 Seismic Actuated Shut-Off Valves

- .1 Seismic actuated automatic shut-off valves:
 - .1 CSA, UL and State of California certified seismic gas shut-off valve with acceleration trigger mechanism, soft seat construction, visual open/close indicator and a manual reset capable of operating between -23°C (-10°F) to 65°C (150°F).
 - .2 The sensing means of the valve shall actuate the shut off within 5 seconds when subjected to a horizontal sinusoidal oscillation having a peak acceleration of 0.3 G (2.94 metres/second² (9.65 feet/second²)) and a period of 0.4 seconds.
- .2 Seismic shut off valve shall not be installed for buildings using natural gas for emergency power.

3. EXECUTION

3.1 Pipe Installation

- .1 Weld steel pipe or join polyethylene pipe in accordance with manufacturer's recommendations.
- .2 Align pipes carefully before jointing. Maintain a minimum of 900 mm separation between natural gas line and any adjacent buried services.
- .3 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as otherwise approved by Authority Having Jurisdiction.
- .4 Upon completion of pipe laying and after Authority Having Jurisdiction has inspected work in place, surround and cover pipes between joints with approved granular material placed to dimensions indicated or directed.
- .5 For pipe bedding:
 - .1 Bottom bedding shall be a quarter of pipe diameter or 150mm thick, whichever is larger. Top bedding shall be a minimum 300mm thick. Side bedding shall be 300mm thick. (If shoring used in pipe trench, side bedding shall be extended to allow for thickness of shoring.)
 - .2 Hand place granular bedding material in uniform layers. Dumping of material directly on top of pipe is not permitted.
 - .3 Shape bed true to grade and to provide continuous uniform bearing surface for length of pipe. Do not use blocks when bedding pipe.

- .4 Place layers of bedding material uniformly and simultaneously on each side of pipe to prevent lateral displacement of pipe.
- .5 Compact each layer to at least 95% maximum density ASTM D698-12e2.
- .6 Backfill of piping shall not be commenced until tests have been accepted by the Authority Having Jurisdiction.
- .7 Where crossing electrical ductbank, run natural gas pipe above ductbank with a minimum vertical clearance of 150mm (6") from the top of ductbank to underside of gas pipe and cross ductbank at a 90° angle. If crossing cannot be done in this manner, encase natural gas pipe in one larger size plastic pipe sleeve projecting 500mm from either side of ductbank.
- .8 Heat shrink factory extruded polyethylene sleeves over bare metallic pipe at weld.
- .9 Employ an independent testing agency to test the continuity of the polyethylene jacket, when metallic piping is installed in the pipe trench, using a 12,000 volt Holiday Detector. Repair any breaks in polyethylene jacket with two layers of polyken tape. Submit report from testing agency certifying continuity of polyethylene jacket.
- .10 Do not paint dielectric isolating couplings used for cathodic protection.
- .11 Piping shall be purged with nitrogen after installation of new distribution piping.
- .12 Any existing piping that is repaired, altered, or abandoned shall be purged with nitrogen.

3.2 Placement and Compaction of Backfill Material

- .1 Backfill trenches using backfill materials specified.
- .2 Place backfill material in uniform layers not exceeding 150mm and uniformly compact each layer of backfill to 95% Standard Proctor Density.
- .3 Installation of backfill material shall avoid damage and displacement of services.

3.3 Valve Installation

- .1 Install valves to manufacturer's recommendations at locations indicated.
- .2 Seismic actuated shut off valves shall be installed in the horizontal position.

3.4 Tracer Wire Installation

- .1 Provide tracer wire to all underground plastic natural gas piping.
- .2 Mount on the top surface of the pipe and secure with plastic straps at two meter intervals.
- .3 Bond to steel supply main at connection with plastic run.
- .4 Bring tracer wire to grade in a valve box adjacent to the shut-off valve. Wire shall be coiled loosely in box, not cut off.
- .5 Wire shall be run up the transition riser and taped to the steel pipe.
- .6 Check the continuity of the tracer wire and provide a confirmation report.

3.5 Warning Tape

- .1 Provide warning tape to all underground natural gas piping.
- .2 Underground warning tape is to be placed the full length of the pipe trench at a depth of 1 foot (300 mm) below finished grade.

3.6 Safety Procedure

- .1 Whenever the Contractor metallically separates piping components for any reason, the corrosion protection system must be shut off at the breaker before separation and re-energized after metallic continuity is restored. Failure to do this could lead to severe arcing.

3.7 Metallic Gas Piping Cathodic Protection

- .1 Cathodically protect all buried metallic gas piping downstream of gas meter as required and approved by Technical Safety BC.
- .2 An approved testing agency shall be retained within the contract and under this section of the work to confirm by actual measurement the effectiveness of the cathodic protection system installed. Implement corrective measures as may be necessary and as ordered by the approved testing agency. Submit a report from testing agency certifying effectiveness of the cathodic protection upon completion of testing program.
- .3 For existing piping systems, the continuity of the existing cathodic protection shall be maintained when any additions or replacements are undertaken.

3.8 Building Connections

- .1 Building service shall terminate at building wall opposite point of connection to interior piping. If interior piping is already installed, make connection with dielectric coupling otherwise cap or seal end of pipes.
- .2 Do not install building connections until satisfactory completion of tests.

3.9 Field Quality Control

- .1 Provide labour, equipment and materials required to perform tests hereinafter described.
- .2 Notify Authority Having Jurisdiction at least 48 hours in advance of all proposed tests. Perform tests in presence of the authority having jurisdiction.
- .3 Perform tests required in accordance with the Canadian Standards Association, CSA B149.1 - Natural Gas and Propane Installation Code.
- .4 Examine piping for leaks. Remake all leaking connections and joints and retest piping system.

END OF SECTION

1. SCOPE OF WORK

- .1 Work under this contract covers the installation of new HVAC system in the “CHORD Antenna Production Facility – Spanmaster Building” at the National Research Council’s Dominion Radio Astrophysical Observatory (DRAO) at 717 White Lake Road, Kalden, BC, Canada.
- .2 The Canadian Hydrogen Observatory and Radio-transient Detector (CHORD) Project is currently under construction at the National Research Council (NRC) - Dominion Radio Astrophysical Observatory (DRAO) located close to Penticton, BC. Part of this project involves the construction of the Antenna Production Facility, where 640 six-metre-diameter radio-astronomical composite antennas will be manufactured. The process to manufacture antennas requires stable temperature conditions inside its two adjoined tensioned-membrane buildings.
- .3 The Spanmaster™ building (see **Error! Reference source not found.** and **Error! Reference source not found.**) is the main structure where antenna production will take place. This is a tensioned-membrane metal structure building that measures 180 x 70 feet in its footprint. This building was recently constructed, completed on March 31, 2023. It is anchored to a reinforced concrete slab. At the time of writing this document the Spanmaster building has no electrical installations, lighting or HVAC system installed.



Figure 1: Spanmaster building

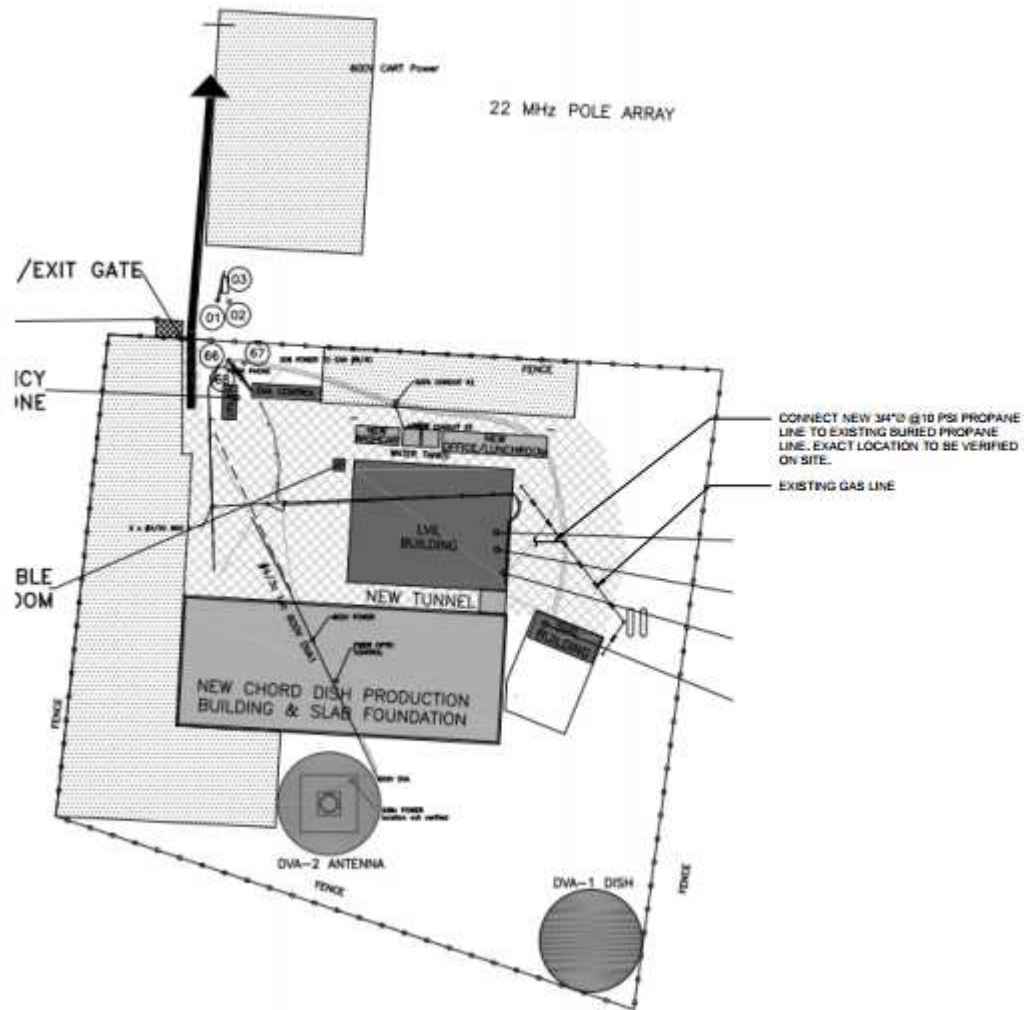


Figure 2: Site Plan at NRC-DRAO CHORD Antenna Production Site

2. DRAWINGS

- .1 The following drawing illustrates the work and forms part of the contract documents:

Mechanical Drawing (SPANMASTER) M1 (Issued for Tender) NRC DRAO – DISH PRODUCTION FACILITY PROJECT NO.: 447b-022-22. Prepared by AME Group Consulting Mechanical Engineers.

3. SPECIFICATIONS

- .1 The following specification defines the work and forms part of the contract documents:

Mechanical Specification (Issued for Tender) NRC DRAO – DISH PRODUCTION FACILITY PROJECT NO.: 447b-022-22. Prepared by AME Group Consulting Mechanical Engineers.

4. COMPLETION

- .1 Complete construction of ductwork within 4 weeks after receipt of notification of acceptance of tender.
- .2 Complete all work within 34 weeks after receipt of notification of acceptance of tender.

5. GENERAL

- .1 The word "provide" in this Specification means to supply and install.
- .2 Provide items mentioned in either the drawings or the specification.

6. RADIO-FREQUENCY INTERFERENCE (RFI) MITIGATION

- .1 No emitting devices such as cellular phones, car GPS, Fit Bits, personal computers and tablets are allowed to be used on site unless they are specifically needed for the work and are approved by the Departmental Representative.
- .2 Unless specific devices are approved for use on site by the Departmental Representative, the Contractor must ensure the compliance of their staff, subcontractors, representatives and agents no unauthorized RFI- emitting devices are brought onsite or energized onsite.

The HVAC construction will take place in the vicinity of operating radio astronomical telescopes that are extremely sensitive to radio-frequency energy. The observational data can be corrupted by radiated signals more than 10 billion times smaller in power ratio than signals compliant with Federal requirements for emissions limits (FCC Part 15b and ICES-003). Aside from data loss, strong levels of RFI have the potential to cause irreversible damage to the receiving equipment. Consequently, many commercial electronics such as computers, controllers and other non-intentional radiators either cannot be operated on site, or measures must be taken to reduce the emission levels by placing them inside a RF shielded enclosure in order to protect the integrity of telescope data. Some common HVAC components that are known RFI emitters are actuators, VFDs, control boards and spark igniters.

- .3 Following delivery of materials to the site, the Contractor must provide the Departmental Representative with access the RTUs and any other identified RFI-producing components or subsystems and allow three weeks for the Departmental Representative to install all required shields and filters on the RFI-producing elements before they are commissioned.

7. SPECIFIED ACCEPTABLE & ALTERNATIVE EQUIPMENT & MATERIALS

- .1 Materials and equipment scheduled and/or specified on the drawings or in the specifications have been selected to establish a performance, quality standard and acceptable level of RFI emission. In most cases, acceptable manufacturers are stated for any material or equipment specified by manufacturer's name and model number. Contractors may base their tender price on materials and equipment supplied by any of the manufacturers' names as acceptable for the particular material or equipment.

- .2 In addition to the manufacturers specified or named as acceptable, you may propose alternative manufacturers of materials or equipment to the Departmental Representative for acceptance. For a product to be considered as an alternative product substitute, make a written application to the Departmental Representative during the tender period, not later than ten (10) working days before tender closing.
- .3 Certify in writing that the alternative meets all requirements of the specified material or equipment. This includes the requirement that devices do not emit RFI, or their RFI emissions are within limits or are appropriately mitigated to the satisfaction of the Departmental Representative. In addition, it shall be understood that all costs required by or as a result of acceptance or proposed alternatives, will be borne by the Contractor.
- .4 Approval of alternatives will be signified by issue of an Addendum to the Tender Documents.
- .5 Any alternative manufacturers or materials submitted which are incomplete and cannot be evaluated, or are later than ten (10) working days before tender closing date or after the tender period, will not be considered.

8. MINIMUM STANDARDS

- .1 Conform to or exceed minimum acceptable standards of the various applicable federal, provincial and municipal codes such as The National Building Code, The National Fire Code, Canadian Plumbing Code, Canadian Electrical Code, Canadian Code for Construction Safety and the Provincial Construction Safety Act.
- .2 Work to conform to referenced standards and codes as reaffirmed or revised to date of specification.

9. WORKPLACE HAZARDOUS MATERIAL INFORMATION SYSTEM (WHMIS)

- .1 The Contractor shall comply with Federal and Provincial legislation regarding the WHMIS. The Contractor's responsibilities include, but are not limited to the following:
 - .1 To ensure that any controlled product brought on site by the Contractor or sub-contractor is labeled;
 - .2 To make available to the workers and the Departmental Representative, Material Safety Data Sheets (MSDS) for these controlled products;
 - .3 To train own workers about WHMIS, and about the controlled products that they use on site;
 - .4 To inform other Contractors, sub-contractors, the Departmental Representative, authorized visitors and outside inspection agency personnel about the presence and use of such products on the site.
 - .5 The site foreman or superintendent must be able to demonstrate, to the satisfaction of the Departmental Representative, that he/she has had WHMIS training and is knowledgeable in its requirements. The Departmental Representative can require replacement of this person if this condition or implementation of WHMIS is not satisfactory.

10. DESIGNATED SUBSTANCES

Comply with Provincial legislation if encountering specifically listed designated substances on the work site while performing the work described in these contract documents:

- .1 It is the responsibility of the Contractor to ensure that each prospective sub-contractor for this project has received a copy of the listed designated substances which may be present on site.

11. COST BREAKDOWN

- .1 Submit, for approval by the Departmental Representative, a cost breakdown of tender 72 hours after the contract is awarded.
- .2 Use the approved cost breakdown as the basis for submitting all claims.
- .3 Request Departmental Representative's verbal approval to amount of claim prior to preparing and submitting the claim in its final form.
- .4 Contractor costs associated with compliance with occupational health and safety requirements (Canada Labour Code) related to the Coronavirus/COVID-19 pandemic must be included in the initial bid price. These costs may include, but are not limited to, the provision of additional personal protective equipment (PPE) and social distancing requirements as required to complete the project. Contractor must review and incorporate into initial bid pricing compliance with any Coronavirus/COVID-19 related health and safety guidance issued by the local Medical Officer of Health (applicable in the jurisdiction of the project), the Public Health Agency of Canada, Health Canada and/or the provincial Ministry of Health, as applicable.

12. SUB-TRADES

- .1 Submit no later than 72 hours after tender closing, a complete list of sub trades for the Departmental Representative's review.

13. PERSONNEL SECURITY AND IDENTIFICATION

- .1 All persons employed by the Contractor, or by any sub-contractor and present on the site must be security cleared in accordance with the requirements of the Section entitled Special Instructions to Tenderers.
- .2 All such persons must wear and keep visible identification badges as issued by the Security Office of NRC.

14. WORKING HOURS AND ESCORTING REQUIREMENTS

- .1 Normal working hours on the NRC property are from 7:00 a.m. until 5:00 p.m., Monday to Friday inclusive, except statutory holidays and December 27, 28 and 29, 2023.
- .2 At all other times, special written passes are required for access to the building site.

- .3 Before scheduling any work outside normal working hours, obtain permission from the Departmental Representative to perform the specific tasks.
- .4 An escort may be required whenever working outside normal hours. Contractor to bear the associated costs.

15. SCHEDULE

- .1 The Contractor shall prepare a detailed schedule, fixing the date for commencement and completion of the various parts of the work and update the said schedule. Such schedule shall be made available to the Departmental Representative not later than two weeks after the award of the contract and prior to commencement of any work on site.
- .2 Notify Departmental Representative in writing of any changes in the schedule.
- .3 10 days before the scheduled completion date, arrange to do an interim inspection with the Departmental Representative.

16. PROJECT MEETINGS

- .1 Hold regular project meetings at times and locations approved by the Departmental Representative.
- .2 Notify all parties concerned of meetings to ensure proper coordination of work.
- .3 Departmental Representative will set times for project meetings and assume responsibility for recording and distributing minutes.

17. SHOP DRAWINGS

- .1 Submit to Departmental Representative for review, shop drawings, product data and samples specified within 3 weeks after contract award.
- .2 Submit to Departmental Representative for review a complete list of all shop drawings, product data and samples specified and written confirmation of corresponding delivery dates within one (1) week after shop drawings, product data and samples approval date. This list shall be updated on a weekly basis and any changes to the list shall be immediately notified in writing to the Departmental Representative.
- .3 Review shop drawings, data sheets and samples prior to submission.
- .4 Submit electronic copy of all shop drawings and product data and samples for review, unless otherwise specified.
- .5 Review of shop drawings and product data by the Departmental Representative does not relieve the Contractor of the responsibility for errors and omissions and for the conformity with contract documents.

18. SAMPLES AND MOCK-UPS

- .1 Submit samples in sizes and quantities as specified.
- .2 Where colour, pattern or texture is criterion, submit full range of samples.
- .3 Construct field samples and mock-ups at locations acceptable to Departmental Representative.
- .4 Reviewed samples or mock-ups will become standards of workmanship and material against which installed work will be checked on the project.

19. MATERIALS AND WORKMANSHIP

- .1 Install only new materials on this project unless specifically noted otherwise.
- .2 Only first class workmanship will be accepted, not only with regard to safety, efficiency, durability, but also with regard to neatness of detail and performance.

20. WORK & MATERIALS SUPPLIED BY OWNER

- .1 Work and materials not included in this contract are described on drawings and in this specification.
- .2 Deliver to a storage place, as directed by the Departmental Representative, all materials returned to the Owner.
- .3 Unless otherwise specified, accept owner-supplied materials at their storage location and provide all transportation as required.
- .4 General Contractor's duties:
 - .1 Unload at site.
 - .2 Promptly inspect products and report damaged or defective items.
 - .3 Give written notification to the Departmental Representative for items accepted in good order.
 - .4 Handle at site, including uncrating and storage.
 - .5 Repair or replace items damaged on site.
 - .6 Install, connect finished products as specified.

21. SITE ACCESS

- .1 Make prior arrangements with the Departmental Representative before starting work or moving materials and equipment on site.
- .2 Obtain approval of Departmental Representative for regular means of access during the construction period.

- .3 Obtain approval of Departmental Representative before temporarily suspending operations on site; before returning to the site and before leaving the site at the end of the job.
- .4 Provide and maintain access to site.
- .5 Build and maintain temporary roads and provide snow removal during period of work.
- .6 Provide snow clearing and removal as required during the contract period
- .7 Make good any damage and clean up dirt, debris, etc., resulting from Contractor's use of existing roads.

22. USE OF SITE

- .1 Restrict operations on the site to the areas approved by the Departmental Representative
- .2 Locate all temporary structures, equipment, storage, etc., to the designated areas.
- .3 Restrict parking to the designated areas.

23. ACCEPTANCE OF SITE

- .1 Inspect the site before commencing work, review any unexpected conditions with the Departmental Representative.
- .2 Commencement of work will imply acceptance of existing conditions.

24. SITE OFFICE & TELEPHONE

- .1 Contractor to erect a temporary site office at his own expense.
- .2 A land line phone will be provided for use by the Contractor for essential communications and in the case of an emergency.

25. SANITARY FACILITIES

- .1 Obtain permission from the Departmental Representative to use the existing washroom facilities in the building .

26. TEMPORARY SERVICES

- .1 A source of temporary power will be made available in the area. Bear all costs to make connections to the power source and perform distribution on site.
- .2 Provide all load centres, breakers, conduit, wiring, disconnects, extension cords, transformers, as required from the source of power.
- .3 Power is to be used only for power tools, lighting, controls, motors, and not for space heating.

- .4 A source of temporary water will be made available if required.
- .5 Bear all costs associated with distributing the water to the required locations.
- .6 Comply with NRC requirements when connecting to existing systems in accordance with the articles entitled "Co-operation" and "Service Interruptions" of this section.

27. DOCUMENTS REQUIRED AT WORK SITE

- .1 The Contractor shall keep on the site, one (1) up-to-date copy of all contract documents, including specifications, drawings, addenda, shop drawings, change notices, schedule and any reports or bulletins pertaining to the work, in good order, available to the Departmental Representative and to his / her representatives at all times.
- .2 At least one (1) copy of specifications and drawings shall be marked by the Contractor to show all work "As Built" and shall be provided to the Departmental Representative with the Application for Payment and for the Final Certificate of Completion.

28. CO-OPERATION

- .1 Co-operate with NRC staff in order to keep disruption of normal research work to an absolute minimum.
- .2 Work out in advance, a schedule for all work which might disrupt normal work in the building.
- .3 Have schedule approved by the Departmental Representative.
- .4 Notify the Departmental Representative in writing, 72 hours prior to any intended interruption of facilities, areas, corridors, mechanical or electrical services and obtain requisite permission.

29. PROTECTION AND WARNING NOTICES

- .1 Provide all materials required to protect existing equipment.
- .2 Erect dust barriers to prevent dust and debris from spreading through the building.
- .3 Place dust protection in the form of cover sheets over equipment and furniture and tape these sheets to floors, to ensure no dust infiltration.
- .4 Repair or replace any and all damage to Owner's property caused during construction, at no cost to the Owner and to the satisfaction of the Departmental Representative.
- .5 Protect the buildings, roads, lawns, services, etc. from damage which might occur as a result of this work.
- .6 Plan and co-ordinate the work to protect the buildings from the leakage of water, dust, etc.

- .7 Ensure that all doors, windows, etc., that could allow transfer of dust, noise, fumes, etc., to other areas of the building are kept closed.
- .8 Be responsible for security of all areas affected by the work under the Contract until acceptance by NRC. Take all necessary precautions to prevent entry to the work area by unauthorized persons and guard against theft, fire and damage by any cause. Secure working area at the end of each day's work and be responsible for same.
- .9 Provide and maintain adequate safety barricades around the work sites to protect NRC personnel and the public from injury during the construction.
- .10 Post warnings, in all instances where possible injury could occur such as Work Overhead, Hard Hat Areas, etc. or as required by the Departmental Representative.
- .11 Provide temporary protective enclosures over building entrances and exits to protect pedestrians. All enclosures to be structurally sound against weather and falling debris.

30. BILINGUALISM

- .1 Ensure that all signs, notices, etc. are posted in both official languages.
- .2 Ensure that all identification of services called for by under this contract are bilingual.

31. LAYOUT OF WORK

- .1 Location of equipment, fixtures, outlets and openings indicated on drawings or specified are to be considered as approximate.
- .2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with the manufacturer's recommendations for safety, access and maintenance.
- .3 Employ competent person to lay out work in accordance with the contract documents.

32. DISCREPANCIES & INTERFERENCES

- .1 Prior to the start of the work, examine drawings and specifications. Report at once to the Departmental Representative, any defects, discrepancies, omissions or interferences affecting the work.
- .2 Contractor to immediately inform the Departmental Representative in writing, of any discrepancies between the plans and the physical conditions so the Departmental Representative may promptly verify same.
- .3 Any work done after such a discovery, until authorized, is at the Contractor's risk.
- .4 Where minor interferences as determined by the Departmental Representative are encountered on the job and they have not been pointed out on the original tender or on the plans and specifications, provide offsets, bends or reroute the services to suit job conditions at no extra cost.

- .5 Arrange all work so as not to interfere in any way with other work being carried out.

33. MANUFACTURER'S INSTRUCTIONS

- .1 Unless otherwise specified, comply with manufacturer's latest printed instructions for materials and installation methods.
- .2 Notify the Departmental Representative in writing of any conflict between these specifications and manufacturer's instruction. Departmental Representative will designate which document is to be followed.

34. TEMPORARY HEATING AND VENTILATING

- .1 Bear the costs of temporary heat and ventilation during construction including costs of installation, fuel, operation, maintenance, and removal of equipment.
- .2 Use of direct-fired heaters discharging waste products into the work areas will not be permitted unless prior approval is given by the Departmental Representative.
- .3 Furnish and install temporary heat and ventilation in enclosed areas as required to:
 - .1 Facilitate progress of work.
 - .2 Protect work and products against dampness and cold.
 - .3 Reduce moisture condensation on surfaces to an acceptable level.
 - .4 Provide ambient temperature and humidity levels for storage, installation and curing of materials.
 - .5 Provide adequate ventilation to meet health regulations for a safe working environment.
- .4 Maintain minimum temperature of 10oC (50oF) or higher where specified as soon as finishing work is commenced and maintain until acceptance by the Departmental Representative.
 - .1 Maintain ambient temperature and humidity levels as required for comfort of NRC personnel.
- .5 Prevent hazardous or unhealthy accumulations of dust, fumes, mists, vapours or gases in areas occupied during construction including also, storage areas and sanitary facilities.
 - .1 Dispose of exhaust materials in a manner that will not result in a harmful or unhealthy exposure to persons.
- .6 Maintain strict supervision of operation of temporary heating and ventilating equipment.
 - .1 Enforce conformance with applicable codes and standards.
 - .2 Comply with instructions of the Departmental Representative including provision of full-time watchman services when directed.
 - .3 Enforce safe practices.
 - .4 Vent direct-fired combustion units to outside.

- .7 Submit tenders assuming existing or new equipment and systems will not be used for temporary heating and ventilating.
- .8 After award of contract, Departmental Representative may permit use of the permanent system providing agreement can be reached on:
 - .1 Conditions of use, special equipment, protection, maintenance, and replacement of filters.
 - .2 Methods of ensuring that heating medium will not be wasted and in the case of steam, agreement on what is to be done with the condensate.
 - .3 Saving on contract price.
 - .4 Provisions relating to guarantees on equipment.

35. CONNECTIONS TO AND INTERRUPTIONS TO EXISTING SERVICES

- .1 Where work involves breaking into or connecting to existing services, carry out work at times and in the manner agreed to by the Departmental Representative and by authorities having jurisdiction, with minimum disruption to NRC Personnel and vehicular traffic and minimum service interruption. Do not operate any NRC equipment or plant.
- .2 Before commencing work, establish location and extent of service lines in area of work and notify Departmental Representative of findings.
- .3 Submit a schedule to and obtain approval from the Departmental Representative for any shut-down or closure of active service or facility; allow minimum 72 hours notice. Adhere to approved schedule and provide notice to the Departmental Representative.
- .4 Where unknown services are encountered, immediately advise Departmental Representative and confirm findings in writing.
- .5 Provide detours, bridges, alternate feeds, etc., as required to minimize disruptions.
- .6 Protect existing services as required and immediately make repairs if damage occurs.
- .7 Remove any abandoned service lines as indicated on the contract documents and as approved by the Departmental Representative; cap or otherwise seal lines at cut-off points. Record and provide a copy to the Departmental Representative of locations of maintained, re-routed and abandoned service lines.

36. CUTTING AND PATCHING

- .1 Cut existing surfaces as required to accommodate new work.
- .2 Remove all items as shown or specified.
- .3 Patch and make good with identical materials, the surfaces that have been disturbed, cut or damaged, to the satisfaction of the Departmental Representative.

- .4 Where new pipes pass through existing construction, core drill an opening. Size openings to leave 12mm (1/2") clearance around the pipes or pipe insulation. Do not drill or cut any surface without the approval of the Departmental Representative.
- .5 Obtain written approval of the Departmental Representative before cutting openings through existing or new structural members.
- .6 Seal all openings where cables, conduits or pipes pass through walls with an acoustic sealant conforming to CAN/CGSB-19.21-M87.
- .7 Where cables, conduits and pipes pass through fire rated walls and floors, pack space between with compressed glass fibres and seal with fire stop caulking in accordance with CAN/CGSB-19.13-M87 AND NBC 3.1.7.

37. FASTENING DEVICES

- .1 Do not use explosive actuated tools, without first obtaining permission from the Departmental Representative.
- .2 Comply with the requirements of CSA A-166 (Safety Code for Explosive Actuated Tools).
- .3 Do not use any kind of impact or percussion tool without first obtaining permission from the Departmental Representative.

38. OVERLOADING

- .1 Ensure that no part of the building or work is subjected to a load which will endanger safety or cause permanent deformation or structural damage.

39. DRAINAGE

- .1 Provide temporary drainage and pumping as required to keep excavations and site free of water.

40. ENCLOSURE OF STRUCTURES

- .1 Construct and maintain all temporary enclosures as required to protect foundations, sub-soil, concrete, masonry, etc., from frost penetration or damage.
- .2 Maintain in place until all chances of damage are over and proper curing has taken place.
- .3 Provide temporary weather tight enclosures for exterior openings until permanent sash and glazing and exterior doors are installed.
- .4 Provide lockable enclosures as required to maintain the security of NRC facilities and be responsible for the same.
- .5 Provide keys to NRC security personnel when required.

- .6 Lay out the work carefully and accurately and verify all dimensions and be responsible for them. Locate and preserve general reference points.
- .7 Throughout the course of construction, keep continuously acquainted with field conditions, and the work being developed by all trades involved in the project. Maintain an awareness of responsibility to avoid space conflict with other trades.
- .8 Conceal all services, piping, wiring, ductwork, etc., in floors, walls or ceilings except where indicated otherwise.

41. STORAGE

- .1 Provide storage as required to protect all tools, materials, etc., from damage or theft and be responsible for the same.
- .2 Do not store flammable or explosive materials on site without the authorization of the Departmental Representative.

42. GENERAL REVIEW

- .1 Periodic review of the Contractor's work by the Departmental Representative does not relieve the Contractor of the responsibility of making the work in accordance with contract documents. Contractor shall carry out his own quality control to ensure that the construction work is in accordance with contract documents.
- .2 Inform the Departmental Representative of any impediments to the installation and obtain his / her approval for actual location.

43. INSPECTION OF BURIED OR CONCEALED SERVICES

- .1 Prior to concealing any services that are installed, ensure that all inspection bodies concerned, including NRC, have inspected the work and have witnessed all tests. Failure to do so may result in exposing the services again at the Contractor's expense.

44. TESTING

- .1 On completion, or as required by local authority inspectors and/or Departmental Representative during progress of work and before any services are covered up and flushing is complete, test all installations in the presence of the Departmental Representative.
- .2 Obtain and hand to the Departmental Representative all acceptance certificates or test reports from authority having jurisdiction. The project will be considered incomplete without the same.

45. PARTIAL OCCUPANCY

- .1 NRC may request partial occupancy of the facility if the contract extends beyond the expected completion date.

- .2 Do not restrict access to the building, routes, and services.
- .3 Do not encumber the site with materials or equipment.

46. DISPOSAL OF WASTES

- .1 Dispose of waste materials including volatiles, safely off NRC property. Refer to the section entitled "General and Fire Safety Requirements" included as part of this specification.

47. CLEAN-UP DURING CONSTRUCTION

- .1 On a daily basis, maintain project site and adjacent area of campus including roofs, free from debris and waste materials.
- .2 Provide on-site dump containers for collection of waste materials and rubbish.

48. FINAL CLEAN-UP

- .1 Upon completion do a final clean-up to the satisfaction of the Departmental Representative.
- .2 Clean all new surfaces, lights, existing surfaces affected by this work, replace filters, etc.
- .3 Clean all resilient flooring and prepare to receive protective finish. Protective finish applied by NRC

49. WARRANTY AND RECTIFICATION OF DEFECTS IN WORK

- .1 Refer to General Conditions "C", section GC32.
- .2 Ensure that all manufacturers' guarantees and warranties are issued in the name of the **General Contractor** and the National Research Council.

50. MAINTENANCE MANUALS

- .1 Provide two (2) bilingual copies of maintenance manuals or two (2) English and two (2) French maintenance manuals and one electronic copy of same immediately upon completion of the work and prior to release of holdbacks.
- .2 Manuals to be neatly bound in hard cover loose leaf binders.
- .3 Manuals to include operating and maintenance instructions, all guarantees and warranties, shop drawings, technical data, etc., for the material and apparatus supplied under this contract.

END OF SECTION

1. GENERAL CONSTRUCTION SAFETY REQUIREMENTS

- .1 The Contractor shall take all necessary steps to protect personnel (workers, visitors general public, etc.) and property from any harm during the course of the contract.
- .2 The Contractor shall be solely responsible for the construction safety of both its employees and those of its sub-contractors at the work site, and for initiating, maintaining and supervising safety precautions, programs and procedures in connection with the performance of the work.
- .3 The Contractor shall comply with all Federal, Provincial and Municipal safety codes and regulations and all provincial OSH regulation. In the event of any conflict between any provisions in legislation or codes, the most stringent provisions shall apply.
- .4 Periodic review of the Contractor's work by the Departmental Representative, using the criteria of the contract documents, does not relieve the Contractor of his safety responsibilities in carrying out the work in accordance with the contract documents. The contractor shall consult with the Departmental Representative to ensure that this responsibility is carried out.
- .5 The Contractor shall ensure that only competent personnel are permitted to work on site. Throughout the term of the contract, any person will be removed from the site who is not observing or complying with the safety requirements.
- .6 All equipment shall be in safe operating condition and appropriate to the task.
- .7 Following a project and site hazard assessment, the Contractor shall develop a Site Specific Safety Plan based on the following minimum requirements. Site Specific Safety Plans must also be robust enough to address any abnormal occurrences, such as, but not limited to: pandemics (COVID-19 or a similar), fire, flooding, incimate weather or other environmental anomalies.
 - .1 Provide a safety board mounted in a visible location on the project site, with the following information included thereon:
 - .1 Notice of Project.
 - .2 Site specific Safety Policy.
 - .3 Copy of Provincial OSH regulation.
 - .4 Building Schematic showing emergency exits.
 - .5 Building emergency procedures.
 - .6 Contact list for NRC, Contractor and all involved sub-contractors.
 - .7 Any related MSDS sheets.
 - .8 Proper Emergency phone number.
- .8 The Contractor shall provide competent personnel to implement its safety program and those of any Health and Safety Act legislation applicable at this project location, and to ensure they are being complied with.

- .9 The Contractor shall provide safety orientation to all its employees as well as those of any sub-contractors under its jurisdiction.
- .10 The Departmental Representative will monitor to ensure that safety requirements are met and that safety records are properly kept and maintained. Continued disregard for safety standards can cause the contract to be cancelled and the Contractor or sub-contractors removed from the site.
- .11 The Contractor will report to the Departmental Representative and jurisdictional authorities, any accident or incident involving Contractor or NRC personnel or the public and/or property arising from the Contractor's execution of the work.
- .12 If entry to a laboratory is required as part of the work of the Contractor, a safety orientation shall be provided to all his employees as well as those of any sub-contractors regarding lab safety requirements and procedures, as provided by the Researcher or the Departmental Representative.

2. FIRE SAFETY REQUIREMENTS

.1 Authorities

1. The Fire Commissioner of Canada (FC) is the authority for fire safety at NRC.
2. For the purpose of this document, "Departmental Representative" will be deemed as the NRC person in charge of the project and who will enforce these Fire Safety Requirements.
3. Comply with the following standards as published by the Office of the Fire Commissioner of Canada:
 - a. Standard No. 301 - June 1982 "Standard for Construction Operations";
 - b. Standard No. 302 - June 1982 "Standard for Welding and Cutting".

.2 Smoking

- .1 Smoking is prohibited inside all NRC buildings, as well as roof areas.
- .2 Obey all "NO SMOKING" signs on NRC premises.

.3 Hot Work

- .1 Prior to commencement of any "Hot Work" involving welding, soldering, burning, heating, use of torches or salamanders or any open flame, obtain a Hot Work Permit from the Departmental Representative.
- .2 Prior to commencement of "Hot Work", review the area of hot work with the Departmental Representative to determine the level of fire safety precautions to be taken.

.4 Reporting Fires

- .1 Know the exact location of the nearest Fire Alarm Pull Station and telephone, including the emergency phone number.

- .2 REPORT immediately, all fire incidents as follows:
 - .1 Activate nearest fire alarm pull station and;
 - .2 Telephone the emergency phone numbers which will be provided at the project kick off meeting: 9-911 from any land line telephone.
 - .3 When reporting a fire by phone, give the location of fire, building number and be prepared to verify location.
 - .4 The person activating fire alarm pull station must remain at a safe distance from the scene of the fire but readily available to provide information and direction to the Fire Department personnel.

.5 Interior and Exterior Fire protection & Alarm Systems

- .1 DO NOT OBSTRUCT OR SHUT OFF FIRE PROTECTION EQUIPMENT OR SYSTEMS, INCLUDING BUT NOT LIMITED TO FIRE ALARM SYSTEMS, SMOKE/HEAT DETECTORS, SPRINKLER SYSTEM, PULL STATIONS, EMERGENCY CALL BUTTONS AND PA SYSTEMS, WITHOUT AUTHORIZATION FROM THE DEPARTMENTAL REPRESENTATIVE.
- .2 WHEN ANY FIRE PROTECTION EQUIPMENT IS TEMPORARILY SHUT DOWN, ALTERNATIVE MEASURES AS PRESCRIBED BY THE DEPARTMENTAL REPRESENTATIVE SHALL BE TAKEN TO ENSURE THAT FIRE PROTECTION IS MAINTAINED.
- .3 DO NOT LEAVE FIRE PROTECTION OR ALARM SYSTEMS INACTIVE AT THE END OF A WORKING DAY WITHOUT NOTIFICATION AND AUTHORISATION FROM THE DEPARTMENTAL REPRESENTATIVE. THE DEPARTMENTAL REPRESENTATIVE WILL ADVISE THE (FPO) OF THE DETAILS OF ANY SUCH EVENT.
- .4 DO NOT USE FIRE HYDRANTS, STANDPIPES AND HOSE SYSTEMS FOR OTHER THAN FIRE FIGHTING PURPOSES UNLESS AUTHORISED BY DEPARTMENTAL REPRESENTATIVE.

.6 Fire Extinguishers

- .1 Provide a minimum of 1-20 lb. ABC Dry Chemical Fire Extinguisher at each hot work or open flame location.
- .2 Provide fire extinguishers for hot asphalt and roofing operations as follows:
 - c. Kettle area - 1-20 lb. ABC Dry Chemical;
 - d. Roof - 1-20 lb. ABC Dry Chemical at each open flame location.
- .3 Provide fire extinguishers equipped as below:
 - e. Pinned and sealed;
 - f. With a pressure gauge; and
 - g. With an extinguisher tag signed by a fire extinguisher servicing company.
- .4 Carbon Dioxide (CO2) extinguishers will not be considered as substitutes for the above.

.7 Roofing Operations

.1 Kettles:

- .1 Arrange for the location of asphalt kettles and material storage with the Departmental Representative before moving on site. Do not locate kettles on any roof or structure and keep them at least 10m (30 feet) away from a building.
- .2 Equip kettles with 2 thermometers or gauges in good working order; a hand held and a kettle-mounted model.
- .3 Do not operate kettles at temperatures in excess of 232°C (450°F).
- .4 Maintain continuous supervision while kettles are in operation and provide metal covers for the kettles to smother any flames in case of fire. Provide fire extinguishers as required in article 2.6.
- .5 Demonstrate container capacities to Departmental Representative prior to start of work.
- .6 Store materials a minimum of 6m (20 feet) from the kettle.

.2 Mops:

- .1 Use only glass fibre roofing mops.
- .2 Remove used mops from the roof site at the end of each working day.

.3 Torch Applied Systems:

- .1 DO NOT USE TORCHES NEXT TO WALLS.
- .2 DO NOT TORCH MEMBRANES TO EXPOSED WOOD OR CAVITY
- .3 Provide a Fire Watch as required by article 2.9 of this section.

.4 Fire and Smoke Hazard Management:

- .1 Contractor shall identify “Designated Roofing Marshall” for duration of construction activities. “Designated Roofing Marshall” shall be responsible for the following:
 - .1 Perform NRC Daily Fire and Smoke Risk Hazard Assessment each day prior to commencement of roofing activities.
 - .2 Provide completed NRC Daily Fire and Smoke Risk Hazard Assessment to Departmental Representative every morning by email prior to commencement of roofing activities.
 - .3 Follow behind any torch activities with a thermal scanner periodically to identify any hot spots and rectify immediately. Interval for periodic thermal scanning to be approved on site with Departmental Representative.
- .2 Any proposed changes to “Designated Roofing Marshall” must be reviewed and approved by Departmental Representative.

- .5 Store all combustible roofing materials at least 3m (10 feet) away from any structure.

- .6 Keep compressed gas cylinders a minimum of 6m (20 feet) away from the kettle, protected from mechanical damage and secured in an upright position.

.8 Welding / Grinding Operations

- .1 Contractor to provide fire blankets, portable fume extraction devices, screens or similar equipment to prevent exposure to welding flash, or sparks from grinding.

.9 Fire Watch

- .1 Provide a fire watch for a minimum of one hour after the termination of any hot work operation.
- .2 For temporary heating, refer to General Instructions Section 00 010 00.
- .3 Equip fire watch personnel with fire extinguishers as required by article 2.6.

.10 Obstruction of access/egress routes-roadways, halls, doors, or elevators

- .1 Advise the Departmental Representative in advance of any work that would impede the response of Fire Department personnel and their apparatus. This includes violation of minimum overhead clearance, erection of barricades and the digging of trenches.
- .2 Building exit routes must not be obstructed in any way without special permission from the Departmental Representative, who will ensure that adequate alternative routes are maintained.
- .3 The Departmental Representative will advise the FPO of any obstruction that may warrant advanced planning and communication to ensure the safety of building occupants and the effectiveness of the Fire Department.

.11 Rubbish and Waste Materials

- .1 Keep rubbish and waste materials to a minimum and a minimum distance of 6m (20 feet) from any kettle or torches.
- .2 Do not burn rubbish on site.
- .3 Rubbish Containers:
 - .1 Consult with the Departmental Representative to determine an acceptable safe location for any containers and the arrangement of chutes etc. prior to bringing the containers on site.
 - .2 Do not overfill the containers and keep area around the perimeter free and clear of any debris.
- .4 Storage:
 - .1 Exercise extreme care when storing combustible waste materials in work areas. Ensure maximum possible cleanliness, ventilation and that all safety standards are adhered to when storing any combustible materials.

- .2 Deposit greasy or oily rags or materials subject to spontaneous combustion in CSA or ULC approved receptacles and remove at the end of the work day or shift, or as directed.

.12 Flammable Liquids

- .1 The handling, storage and use of flammable liquids is governed by the current National Fire Code of Canada.
- .2 Flammable Liquids such as gasoline, kerosene and naphtha may be kept for ready use in quantities not exceeding 45 litres (10 imp gal), provided they are stored in approved safety cans bearing the ULC seal of approval and kept away from buildings, stockpiled combustible materials etc. Storage of quantities of flammable liquids exceeding 45 litres (10 imp gal) for work purposes, require the permission of the Departmental Representative.
- .3 Flammable liquids are not to be left on any roof areas after normal working hours.
- .4 Transfer of flammable liquids is prohibited within buildings.
- .5 Do not transfer flammable liquids in the vicinity of open flames or any type of heat producing device.
- .6 Do not use flammable liquids having a flash point below 38°C (100°F) such as naphtha or gasoline as solvents or cleaning agents.
- .7 Store flammable waste liquids for disposal in approved container located in a safe, ventilated area. Waste flammable liquids are to be removed from the site on a regular basis.
- .8 Where flammable liquids, such as lacquers or urethane are used, ensure proper ventilation and eliminate all sources of ignition. Inform the Departmental Representative prior to, and at the cessation of such work.

3. Questions and/or clarifications

- .1 Direct any questions or clarification on Fire or General Safety, in addition to the above requirements, to the Departmental Representative.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section includes requirements for management of construction waste and disposal, which forms the Contractor's commitment to reduce and divert waste materials from landfill and includes the following:
 - .1 Preparation of a Draft Construction Waste Management Plan that will be used to track the success of the Construction Waste Management Plan against actual waste diversion from landfill.
 - .2 Preparation of monthly progress reports indicating cumulative totals representing progress towards achieving diversion and reduction goals of waste materials away from landfill and identifying any special programs, landfill options or alternatives to landfill used during construction.
 - .3 Preparation of a Construction Waste Management Report containing detailed information indicating total waste produced by the project, types of waste material and quantity of each material, and total waste diverted and diversion rates indicated as a percentage of the total waste produced.
- .2 Owner has established that this project shall generate the least amount of waste possible and that processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors be employed by the Contractor.

1.2 RELATED REQUIREMENTS

- .1 Section 00 10 00 – General Instructions.

1.3 REFERENCE STANDARDS

- .1 Recycling Certification Institute (RCI):
 - .1 RCI Certification Construction and Demolition Materials Recycling

1.4 DEFINITIONS

- .1 Clean Waste: Untreated and unpainted; not contaminated with oils, solvents, sealants or similar materials.
- .2 Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, re-modeling, repair and demolition operations.
- .3 Hazardous: Exhibiting the characteristics of hazardous substances including properties such as ignitability, corrosiveness, toxicity or reactivity.
- .4 Non-hazardous: Exhibiting none of the characteristics of hazardous substances, including properties such as ignitability, corrosiveness, toxicity, or reactivity.

- .5 Non-toxic: Not poisonous to humans either immediately or after a long period of exposure.
- .6 Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.
- .7 Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.
- .8 Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form; recycling does not include burning, incinerating, or thermally destroying waste.
- .9 Return: To give back reusable items or unused products to vendors for credit.
- .10 Reuse: To reuse a construction waste material in some manner on the project site.
- .11 Salvage: To remove a waste material from the project site to another site for resale or reuse by others.
- .12 Sediment: Soil and other debris that has been eroded and transported by storm or well production run off water.
- .13 Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.
- .14 Toxic: Poisonous to humans either immediately or after a long period of exposure.
- .15 Trash: Any product or material unable to be reused, returned, recycled, or salvaged.
- .16 Volatile Organic Compounds (VOC's): Chemical compounds common in and emitted by many building products over time through outgassing:
 - .1 Solvents in paints and other coatings;
 - .2 Wood preservatives; strippers and household cleaners;
 - .3 Adhesives in particleboard, fiberboard, and some plywood; and foam insulation.
 - .4 When released, VOC's can contribute to the formation of smog and can cause respiratory tract problems, headaches, eye irritations, nausea, damage to the liver, kidneys, and central nervous system, and possibly cancer.
- .17 Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.
- .18 Construction Waste Management Plan: A project related plan for the collection, transportation, and disposal of the waste generated at the construction site; the purpose of the plan is to ultimately reduce the amount of material being landfilled.

1.5 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination: Coordinate waste management requirements with all Divisions of the Work for the project, and ensure that requirements of the Construction Waste Management Plan are followed.
- .2 Preconstruction Meeting: Arrange a pre-construction meeting in accordance with Section 00 10 00 – General Instructions before starting any Work of the Contract attended by the Owner, Contractor, affected Subcontractor's and Departmental Representative to discuss the Contractor's Construction Waste Management Plan and to develop mutual understanding of the requirements for a consistent policy towards waste reduction and recycling.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide required information in accordance with Section 00 10 00 – General Instructions.
- .2 Action Submittals: Provide the following submittals before starting any work of this Section:
 - .1 Draft Construction Waste Management Plan (Draft CWM Plan): Submit to Departmental Representative a preliminary analysis of anticipated site generated waste by listing a minimum of five (5) construction or demolition waste streams that have potential to generate the most volume of material indicating methods that will be used to divert construction waste from landfill and source reduction strategies; Departmental Representative will provide commentary before development of Contractor's Construction Waste Management Plan.
 - .2 Construction Waste Management Plan (CWM Plan): Submit a CWM Plan for this project prior to any waste removal from site and that includes the following information:
 - .1 Material Streams: Analysis of the proposed jobsite waste being generated, including material types and quantities forming a part of identified material streams in the Draft CWM Plan; materials removed from site destined for alternative daily cover at landfill sites and land clearing debris cannot be considered as contributing to waste diversion and will be included as a component of the total waste generated for the site.
 - .2 Recycling Haulers and Markets: Investigate local haulers and markets for recyclable materials, and incorporate into CWM Plan.
 - .3 Alternative Waste Disposal: Prepare a listing of each material proposed to be salvaged, reused, recycled or composted during the course of the project, and the proposed local market for each material.
 - .4 Landfill Materials: Identify materials that cannot be recycled, reused or composted and provide explanation or justification; energy will be considered as a viable alternative diversion strategy for these materials where facilities exist.
 - .5 Landfill Options: The name of the landfill where trash will be disposed of; landfill materials will form a part of the total waste generated by the project.
 - .6 Materials Handling Procedures: A description of the means by which any recycled waste materials will be protected from contamination, and a description of the means to be employed in recycling the above materials consistent with requirements for acceptance by designated facilities.

- .7 Transportation: A description of the means of transportation of the recyclable materials, whether materials will be site separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler and removed from the site, and destination of materials.

1.7 PROJECT CLOSEOUT SUBMISSIONS

- .1 Record Documentation: Submit as constructed information in accordance with Section 00 10 00 – General Instructions as follows:
 - .1 Construction Waste Management Report (CWM Report): Submit a CWM Report for this project in a format that includes the following information:
 - .1 Accounting: Submit information indicating total waste produced by the project.
 - .2 Composition: Submit information indicating types of waste material and quantity of each material.
 - .3 Diversion Rate: Submit information indicating total waste diverted from landfill as a percentage of the total waste produced by the project.
 - .4 Transportation Documentation and Diversion Documentation: Submit copies of transportation documents or shipping manifests indicating weights of materials, and other evidence of disposal indicating final location of waste diverted from landfill and waste sent to landfill.
 - .5 Multiple Waste Hauling: Compile all information into a single CWM Report where multiple waste hauling and diversion strategies were used for the project.

1.8 QUALITY ASSURANCE

- .1 Resources for Development of Construction Waste Management Report (CWM Report): The following sources may be useful in developing the Draft Construction Waste Management Plan:
 - .1 Recycling Haulers and Markets: Investigate local haulers and markets for recyclable materials, and incorporate into CWM Plan.
 - .2 Waste-to-Energy Systems: Investigate local waste-to-energy incentives where systems for diverting materials from landfill for reuse or recycling are not available.
 - .3 Municipal Garbage & Recycling Waste Websites:
 - .1 West Region
 - .1 Edmonton
[Material Recovery Facility \(MRF\) | KBL Environmental](#)
 - .2 Penticton
<https://keremeos.civicweb.net/document/3069/>
 - .3 Saskatoon
[Construction/Demolition/Fencing — Loraas Disposal North](#)
 - .4 Victoria
[Reno & Demo Waste | CRD](#)
 - .5 Vancouver
[Construction and demolition waste disposal | City of Vancouver](#)
 - .6 Winnipeg

[What goes where? Use the Recyclepedia - MyUtility - Water and Waste Department - City of Winnipeg / MesServices – Service des eaux et des déchets – Ville de Winnipeg \]](#)

1.9 DELIVERY, STORAGE AND HANDLING

- .1 Storage Requirements: Implement a recycling/reuse program that includes separate collection of waste materials as appropriate to the project waste and the available recycling and reuse programs in the project area.
- .2 Handling Requirements: Clean materials that are contaminated before placing in collection containers and ensure that waste destined for landfill does not get mixed in with recycled materials:
 - .1 Deliver materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to recycling process.
 - .2 Arrange for collection by or delivery to the appropriate recycling or reuse facility.
- .3 Hazardous Waste and Hazardous Materials: Handle in accordance with applicable regulations.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 OBJECTIVE

- .1 The Federal Sustainable Development Strategy (FSDS) presents the Government of Canada's sustainable development goals and targets, as required by the *Federal Sustainable Development Act*. In keeping with the purpose of this Act – to provide the legal framework for developing and implementing a Federal Sustainable Development Strategy that will make environmental decision-making more transparent and accountable to Parliament – National Research Council (NRC) supports the goals laid out in the FSDS through the activities described in our Departmental Sustainable Development Strategy (DSDS). NRC's DSDS waste management target is as follows:
 - .1 Divert at least 90% (by weight) of all construction and demolition waste from landfills (striving to achieve 100% by 2030).
 - .2 Project Waste Diversion Target: 90%.

3.2 (CWM PLAN) IMPLEMENTATION

- .1 Manager: Contractor is responsible for designating an on-site party or parties responsible for instructing workers and overseeing and documenting results of the CWM Plan for the project.

- .2 Distribution: Distribute copies of the CWM Plan to the job site foreman, each Subcontractor, the Owner, the Departmental Representative and other site personnel as required to maintain CWM Plan.
- .3 Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, composting and return methods being used for the project to Subcontractor's at appropriate stages of the project.
- .4 Separation Facilities: Lay out and label a specific area to facilitate separation of materials for potential recycling, salvage, reuse, composting and return:
 - .1 Recycling and waste bin areas are to be kept neat and clean and clearly marked in order to avoid contamination of materials.
 - .2 Hazardous wastes shall be separated, stored, and disposed of in accordance with local regulations.
- .5 Progressive Documentation: Submit a monthly summary of waste generated by the project to ensure that waste diversion goals are on track with project requirements:
 - .1 Submission of waste summary can coincide with application for progress payment, or similar milestone event as agreed upon between the Contractor and Departmental Representative.
 - .2 Monthly waste summary shall contain the following information:
 - .1 The amount in tonnes or m3 and location of material landfilled;
 - .2 The amount in tonnes or m3 and location of materials diverted from landfill; and
 - .3 Indication of progress based on total waste generated by the project with materials diverted from landfill as a percentage.

3.3 SUBCONTRACTOR'S RESPONSIBILITY

- .1 Subcontractor's shall cooperate fully with the Contractor to implement the CWM Plan.
- .2 Failure to cooperate may result in the Owner not achieving their environmental goals, and may result in penalties being assessed by the Contractor to the responsible Subcontractor's.

3.4 CONSTRUCTION WASTE MANAGEMENT FORMS

- .1 Departmental Representative will provide Contractor will NRC Waste Management and Disposal Tracking Forms (sample provided below) for recording management of construction waste.
- .2 Contractor shall utilize these forms for all waste management and disposal tracking for the duration of the project, and is responsible for maintaining current up to date records at all times during construction.
- .3 Contractor is responsible to ensure all waste management tracking forms, weigh-bills, donation receipts, and summary information are incorporated into Operational and Maintenance Manuals upon construction completion in accordance with 00 10 00 – General Instructions.

NRC Construction, Renovation and Demolition WASTE MATERIAL TRACKING FORM
 (Entries required for every load leaving the site)

Project Name	#VALUE!
Project Type (Construction, Renovation or Demolition)	#VALUE!
Area (sq. m)	#VALUE!
Site Address	#VALUE!
Contact Person & Telephone	#VALUE!
Date	#VALUE!

Load #	Date	Time	Hauler	If Applicable:		Material Type(s)	Waybill # (if applicable)	Destination	Weight (metric Tonnes)			Comments
				Bin Size (yd ³)	Fill Level				Reuse	Recycling	Unspecified Diversion (Reuse or Recycling)	
1	Dec 17/08	3:00pm	Waste Co.	20	3/4	Commingled Recyclates (metals, wood, concrete)	12345	Waste Co.				Waste sent to commingled recycling facility. Total weight and % diversion to be reported by hauler
2	Dec 17/08	4:00pm	Waste Co.	30	Full	Untreated Wood	12346	Waste Co.				Total weight to be reported by hauler
3	Dec 18/08	12:00pm	Waste Co.	20	Over Flowing	Miscellaneous Waste	12347	Landfill				Total weight to be reported by hauler
4	Dec 19/08	12:00pm	Man and His Truck	N/A	N/A	Doors	N/A	Resale				Total weight estimated by hauler and PM
5												
6												
7												
8												
9												
10												

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 General requirements relating to commissioning of project's components and systems, specifying general requirements to PV of components, equipment, sub-systems, systems, and integrated systems.
- .2 Related Sections:
 - .1 Section 00 10 00 – General Instructions.
 - .2 Section 01 91 31 – Commissioning (Cx) Plan.
 - .3 Section 01 91 33 – Commissioning Forms.
 - .4 Section 01 91 41 - Commissioning Training.
- .3 Acronyms:
 - .1 Cx - Commissioning.
 - .2 EMCS - Energy Monitoring and Control Systems.
 - .3 O&M - Operation and Maintenance.
 - .4 PI - Product Information.
 - .5 PV - Performance Verification.
 - .6 TAB - Testing, Adjusting and Balancing.

1.2 GENERAL

- .1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:
 - .1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.
 - .2 Ensure appropriate documentation is compiled into the Operation and Maintenance (O&M) manual.
 - .3 Effectively train O&M staff.
- .2 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
 - .1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
 - .2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.
- .3 Design Criteria: as per Departmental Representative. To meet Project functional and operational requirements.

1.3 COMMISSIONING OVERVIEW

- .1 Section 01 91 31 - Commissioning (Cx) Plan.
- .2 For Cx responsibilities refer to Section 01 91 31 - Commissioning (Cx) Plan.
- .3 Cx to be a line item of Contractor's cost breakdown.
- .4 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .5 Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the CHORD Antenna Production Facility HVAC is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.
- .6 Departmental Representative will issue Interim Acceptance Certificate when:
 - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Departmental Representative's Consultant.
 - .2 Equipment, components and systems have been commissioned.
 - .3 O&M training has been completed.

1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the unfunctional system, including related systems as deemed required by Departmental Representative, to ensure effective performance.
- .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

1.5 PRE-CX REVIEW

- .1 Before Construction:
 - .1 Review contract documents, confirm by writing to Departmental Representative.
 - .1 Adequacy of provisions for Cx.
 - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
 - .1 Co-ordinate provision, location and installation of provisions for Cx.
- .3 Before start of Cx:
 - .1 Have completed Cx Plan up-to-date.

- .2 Ensure installation of related components, equipment, sub-systems, systems is complete.
 - .3 Fully understand Cx requirements and procedures.
 - .4 Have Cx documentation shelf-ready.
 - .5 Understand completely design criteria and intent and special features.
 - .6 Submit complete start-up documentation to Departmental Representative.
 - .7 Have Cx schedules up-to-date.
 - .8 Ensure systems have been cleaned thoroughly.
 - .9 Complete TAB procedures on systems, submit TAB reports to Departmental Representative for review and approval.
 - .10 Ensure "As-Built" system schematics are available.
- .4 Inform Departmental Representative's Consultant in writing of discrepancies and deficiencies on finished works.

1.6 CONFLICTS

- .1 Report conflicts between requirements of this section and other sections to Departmental Representative before start-up and obtain clarification.
- .2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

1.7 SUBMITTALS

- .1 Submittals: in accordance with Section 00 10 00 – General Instructions.
 - .1 Submit no later than 4 weeks after award of Contract:
 - .1 Draft Cx documentation.
 - .2 Preliminary Cx schedule.
 - .2 Request in writing to Departmental Representative for changes to submittals and obtain written approval at least 8 weeks prior to start of Cx.
 - .3 Submit proposed Cx procedures to Departmental Representative where not specified and obtain written approval at least 8 weeks prior to start of Cx.
 - .4 Provide additional documentation relating to Cx process required by Departmental Representative.

1.8 COMMISSIONING DOCUMENTATION

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms for requirements and instructions for use.
- .2 Departmental Representative to review and approve Cx documentation.
- .3 Provide completed and approved Cx documentation to Departmental Representative.
- .4 Provide all missing Cx forms and submit to Departmental Representative for approval.

- .5 Complete all Cx forms that are provided in Section 01 91 33 if information is missing.

1.9 COMMISSIONING SCHEDULE

- .1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 00 10 00 – General Instructions.
- .2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:
 - .1 Approval of Cx reports.
 - .2 Verification of reported results.
 - .3 Repairs, retesting, re-commissioning, re-verification.
 - .4 Training.

1.10 COMMISSIONING MEETINGS

- .1 Convene Cx meetings following project meetings and as required.
- .2 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to Cx.
- .3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.
- .4 At 60% construction completion stage: Instructions. Departmental Representative to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
 - .1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
 - .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
- .5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.
- .6 Meeting will be chaired by Departmental Representative, who will record and distribute minutes.
- .7 Ensure subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

1.11 STARTING AND TESTING

- .1 Contractor assumes liabilities and costs for inspections. Including disassembly and re-assembly after approval, starting, testing and adjusting, including supply of testing equipment.

1.12 WITNESSING OF STARTING AND TESTING

- .1 Provide 14 days notice prior to commencement.

- .2 Departmental Representative to witness of start-up and testing.
- .3 Contractor to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

1.13 MANUFACTURER'S INVOLVEMENT

- .1 Factory testing: manufacturer to:
 - .1 Coordinate time and location of testing.
 - .2 Provide testing documentation for approval by Departmental Representative.
 - .3 Arrange for Departmental Representative to witness tests.
 - .4 Obtain written approval of test results and documentation from Departmental Representative before delivery to site.
- .2 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Departmental Representative.
 - .1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
 - .2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.
- .3 Integrity of warranties:
 - .1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.
 - .2 Verify with manufacturer that testing as specified will not void warranties.
- .4 Qualifications of manufacturer's personnel:
 - .1 Experienced in design, installation and operation of equipment and systems.
 - .2 Ability to interpret test results accurately.
 - .3 To report results in clear, concise, logical manner.

1.14 PROCEDURES

- .1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.
- .2 Conduct start-up and testing in following distinct phases:
 - .1 Included in delivery and installation:
 - .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
 - .2 Visual inspection of quality of installation.
 - .2 Start-up: follow accepted start-up procedures.
 - .3 Operational testing: document equipment performance.
 - .4 System PV: include repetition of tests after correcting deficiencies.
 - .5 Post-substantial performance verification: to include fine-tuning.

- .3 Correct deficiencies and obtain approval from Departmental Representative after distinct phases have been completed and before commencing next phase.
- .4 Document require tests on approved PV forms.
- .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Departmental Representative. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:
 - .1 Minor equipment/systems: implement corrective measures approved by Departmental Representative.
 - .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Departmental Representative.
 - .3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.
 - .1 Rejected equipment to be remove from site and replace with new.
 - .2 Subject new equipment/systems to specified start-up procedures.

1.15 START-UP DOCUMENTATION

- .1 Assemble start-up documentation and submit to Departmental Representative for approval before commencement of commissioning.
- .2 Start-up documentation to include:
 - .1 Factory and on-site test certificates for specified equipment.
 - .2 Pre-start-up inspection reports.
 - .3 Signed installation/start-up check lists.
 - .4 Start-up reports,
 - .5 Step-by-step description of complete start-up procedures, to permit Departmental Representative to repeat start-up at any time.

1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.
- .2 With assistance of manufacturer develop written maintenance program and submit Departmental Representative for approval before implementation.
- .3 Operate and maintain systems for length of time required for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

1.17 TEST RESULTS

- .1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.

- .2 Provide manpower and materials, assume costs for re-commissioning.

1.18 START OF COMMISSIONING

- .1 Notify Departmental Representative at least 5 days prior to start of Cx.
- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

1.19 INSTRUMENTS / EQUIPMENT

- .1 Submit to Departmental Representative for review and approval:
 - .1 Complete list of instruments proposed to be used.
 - .2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.
- .2 Provide the following equipment as required:
 - .1 Ladders.
 - .2 Equipment as required to complete work.

1.20 COMMISSIONING PERFORMANCE VERIFICATION

- .1 Carry out Cx:
 - .1 Under accepted simulated operating conditions, over entire operating range, in all modes.
 - .2 On independent systems and interacting systems.
- .2 Cx procedures to be repeatable and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.
- .4 EMCS trending to be available as supporting documentation for performance verification.

1.21 WITNESSING COMMISSIONING

- .1 Departmental Representative to witness activities and verify results.

1.22 AUTHORITIES HAVING JURISDICTION

- .1 Where specified start-up, testing or commissioning procedures duplicate verification requirements of authority having jurisdiction, arrange for authority to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.
- .2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.
- .3 Provide copies to Departmental Representative within 5 days of test and with Cx report.

1.23 COMMISSIONING CONSTRAINTS

- .1 It is necessary to complete Cx of occupancy, weather, and seasonal sensitive equipment and systems before issuance of the Interim Certificate, using, if necessary, simulated thermal loads.

1.24 EXTRAPOLATION OF RESULTS

- .1 Where Cx of weather, occupancy, or seasonal-sensitive equipment or systems cannot be conducted under near-rated or near-design conditions, extrapolate part-load results to design conditions when approved by Departmental Representative in accordance with equipment manufacturer's instructions, using manufacturer's data, with manufacturer's assistance and using approved formulae.

1.25 EXTENT OF VERIFICATION

- .1 Laboratory areas:
 - .1 Provide manpower and instrumentation to verify 100 % of reported results.
- .2 Critical systems:
 - .1 Provide manpower and instrumentation to verify 100 % of reported results.
 - .2 Systems such as the following shall be deemed critical: roof top units.
- .3 Elsewhere:
 - .1 Provide manpower and instrumentation to verify 30 % of reported results, unless specified otherwise in other sections.
- .4 Number and location to be at discretion of Departmental Representative.
- .5 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.
- .6 Review and repeat commissioning of systems if inconsistencies found in more than 20 % of reported results. Repeat verifications shall be performed in accordance to the following unless otherwise specified.
 - .1 Laboratory areas:
 - .1 Second and subsequent verifications:
 - .1 Provide manpower and instrumentation to verify 100 % of reported results.
 - .2 Critical systems:
 - .1 Second and subsequent verifications:
 - .1 Provide manpower and instrumentation to verify 100 % of reported results.
 - .3 Elsewhere:
 - .1 Second verification:
 - .1 Provide manpower and instrumentation to verify 100 % of all failed tests results.

- .2 Provide manpower and instrumentation to verify an additional 20% of reported results, locations to be at the discretion of the Departmental Representative.
- .2 Third and subsequent verifications:
 - .1 Provide manpower and instrumentation to verify 100 % of reported results.
- .7 Perform additional commissioning until results are acceptable to Departmental Representative.

1.26 REPEAT VERIFICATIONS

- .1 Assume costs incurred by Departmental Representative for third and subsequent verifications where:
 - .1 Verification of reported results fail to receive Departmental Representative's approval.
 - .2 Repetition of second verification again fails to receive approval.
 - .3 Departmental Representative deems Contractor's request for second verification was premature.

1.27 SUNDRY CHECKS AND ADJUSTMENTS

- .1 Make adjustments and changes which become apparent as Cx proceeds.
- .2 Perform static and operational checks as applicable and as required.

1.28 DEFICIENCIES, FAULTS, DEFECTS

- .1 Correct deficiencies found during start-up and Cx to satisfaction of Departmental Representative.
- .2 Report problems, faults or defects affecting Cx to Departmental Representative in writing. Stop Cx until problems are rectified. Proceed with written approval from Departmental Representative.

1.29 COMPLETION OF COMMISSIONING

- .1 Upon completion of Cx leave systems in normal operating mode.
- .2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Interim Certificate of Completion.
- .3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Departmental Representative.

1.30 ACTIVITIES UPON COMPLETION OF COMMISSIONING

- .1 When changes are made to baseline components or system settings established during Cx process, provide updated Cx form for affected item.

1.31 TRAINING

- .1 In accordance with Section 01 91 41 - Commissioning (Cx) - Training.

1.32 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

- .1 Supply, deliver, and document maintenance materials, spare parts, and special tools as specified in contract.

1.33 OCCUPANCY

- .1 Cooperate fully with Departmental Representative during stages of acceptance and occupancy of facility.

1.34 INSTALLED INSTRUMENTATION

- .1 Use instruments installed under Contract for TAB and PV if:
 - .1 Accuracy complies with these specifications.
 - .2 Calibration certificates have been deposited with Departmental Representative.
- .2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

1.35 PERFORMANCE VERIFICATION TOLERANCES

- .1 Application tolerances:
 - .1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 10 % of specified values.
- .2 Instrument accuracy tolerances:
 - .1 To be of higher order of magnitude than equipment or system being tested.
- .3 Measurement tolerances during verification:
 - .1 Unless otherwise specified actual values to be within +/- 2 % of recorded values.

1.36 OWNER'S PERFORMANCE TESTING

- .1 Performance testing of equipment or system by Departmental Representative will not relieve Contractor from compliance with specified start-up and testing procedures.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 91 33 – Commissioning Forms.

1.2 REFERENCES

- .1 American Water Works Association (AWWA)
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA-13-2019, Installation of Sprinkler Systems Handbook.
 - .2 NFPA-14-2013, Automatic Sprinkler Systems Handbook.
 - .3 NFPA-20-2016, Standard for the Installation of Stationary Fire Pumps for Fire Protection.
- .3 Underwriters' Laboratories of Canada (ULC)

1.3 GENERAL

- .1 Provide a fully functional CHORD Antenna Production Facility HVAC system:
 - .1 Systems, equipment and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under normal loads.
 - .2 Facility user and O&M personnel have been fully trained in aspects of installed systems.
 - .3 Complete documentation relating to installed equipment and systems.
- .2 Term "Cx" in this section means "Commissioning".
- .3 Use this Cx Plan as master planning document for Cx:
 - .1 Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Cx.
 - .2 Communicates responsibilities of team members involved in Cx Scheduling, documentation requirements, and verification procedures.
 - .3 Sets out deliverables relating to O&M, process and administration of Cx.
 - .4 Describes process of verification of how built works meet design requirements.
 - .5 Produces a complete functional system prior to issuance of Certificate of Occupancy.
 - .6 Management tool that sets out scope, standards, roles and responsibilities, expectations, deliverables, and provides:
 - .1 Overview of Cx.
 - .2 General description of elements that make up Cx Plan.
 - .3 Process and methodology for successful Cx.
- .4 Acronyms:

- .1 Cx - Commissioning.
- .2 EMCS - Energy Monitoring and Control Systems.
- .3 MSDS - Material Safety Data Sheets.
- .4 PI - Product Information.
- .5 PV - Performance Verification.
- .6 TAB - Testing, Adjusting and Balancing.
- .7 WHMIS - Workplace Hazardous Materials Information System.
- .5 Commissioning terms used in this Section:
 - .1 Bumping: short term start-up to prove ability to start and prove correct rotation.
 - .2 Deferred Cx - Cx activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.

1.4 DEVELOPMENT OF 100% CX PLAN

- .1 Cx Plan to be 100% completed within 8 weeks of award of contract to take into account:
 - .1 Approved shop drawings and product data.
 - .2 Approved changes to contract.
 - .3 Contractor's project schedule.
 - .4 Cx schedule.
 - .5 Contractor's, sub-contractor's, suppliers' requirements.
 - .6 Project construction team's and Cx team's requirements.
- .2 Submit completed Cx Plan to Departmental Representative and obtain written approval.

1.5 REFINEMENT OF CX PLAN

- .1 During construction phase, revise, refine and update Cx Plan to include:
 - .1 Changes resulting from Client program modifications.
 - .2 Approved design and construction changes.
- .2 Revise, refine and update every 6 weeks during construction phase. At each revision, indicate revision number and date.
- .3 Submit each revised Cx Plan to Departmental Representative for review and obtain written approval.
- .4 Include testing parameters at full range of operating conditions and check responses of equipment and systems.

1.6 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM

- .1 Departmental Representative's to maintain overall responsibility for project and is sole point of contact between members of commissioning team.
- .2 NRC's Project Manager will select Cx Team consisting of following members:

- .1 Departmental Representative: during construction, will conduct periodic site reviews to observe general progress.
- .2 Departmental Representative: ensures Cx activities are carried out to ensure delivery of a fully operational project including:
 - .1 Review of Cx documentation from operational perspective.
 - .2 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.
 - .3 Protection of health, safety and comfort of occupants and O&M personnel.
 - .4 Monitoring of Cx activities, training, development of Cx documentation.
 - .5 Work closely with members of Cx Team.
- .3 Departmental Representative is responsible for:
 - .1 Organizing Cx.
 - .2 Monitoring operations Cx activities.
 - .3 Witnessing, certifying accuracy of reported results.
 - .4 Witnessing and certifying TAB and other tests.
 - .5 Ensuring implementation of final Cx Plan.
 - .6 Performing verification of performance of installed systems and equipment.
 - .7 Implementation of Training Plan.
- .4 Construction Team: contractor, sub-contractors, suppliers and support disciplines, is responsible for construction/installation in accordance with contract documents, including:
 - .1 Testing.
 - .2 TAB.
 - .3 Performance of Cx activities.
 - .4 Delivery of training and Cx documentation.
 - .5 Assigning one person as point of contact with Departmental Representative for administrative and coordination purposes.
- .5 Contractor implements specified Cx activities including:
 - .1 Demonstrations.
 - .2 Training.
 - .3 Testing.
 - .4 Preparation, submission of test reports.
- .6 End-user: represents lead role in Operation Phase and onwards and is responsible for:
 - .1 Receiving facility.
 - .2 Day-To-Day operation and maintenance of facility.

1.7 CX PARTICIPANTS

- .1 Employ the following Cx participants to verify performance of equipment and systems:
 - .1 Installation contractor/subcontractor:

- .1 Equipment and systems except as noted.
- .2 Equipment manufacturer: equipment specified to be installed and started by manufacturer.
 - .1 To include performance verification.
- .3 Specialist subcontractor: equipment and systems supplied and installed by specialist subcontractor.
- .4 Specialist Cx agency:
 - .1 Possessing specialist qualifications and installations providing environments essential to client's program but are outside scope or expertise of Cx specialists on this project.
- .5 Client: responsible for intrusion and access security systems.
- .6 Ensure that Cx participant:
 - .1 Could complete work within scheduled time frame.
 - .2 Available for emergency and troubleshooting service during first year of occupancy by user for adjustments and modifications outside responsibility of O&M personnel, including:
 - .1 Modify ventilation rates to meet changes in off-gassing.
 - .2 Changes to heating or cooling loads beyond scope of EMCS.
 - .3 Changes to EMCS control strategies beyond level of training provided to O&M personnel.
 - .4 Redistribution of electrical services.
 - .5 Modifications of fire alarm systems.
 - .6 Modifications to voice communications systems.
- .7 Provide names of participants to Departmental Representative and details of instruments and procedures to be followed for Cx 3 months prior to starting date of Cx for review and approval.

1.8 EXTENT OF CX

- .1 Commission mechanical systems and associated equipment:
 - .1 HVAC systems:
 - .1 HVAC systems:
 - .1 New rooftop units and associated systems.
 - .2 New ceiling mounted recirculation fans and associated systems.
 - .2 Fire and life safety systems:
 - .1 Fire extinguishers.
 - .3 Noise and vibration control systems for mechanical systems.
 - .4 Seismic restraint and control measures.
 - .5 EMCS:
- .2 Commission electrical systems and equipment:

- .1 Low voltage below 750 V:
 - .1 Low voltage equipment.
 - .2 Low voltage distribution systems.
 - .1 Systematically turn breakers/fused disconnects on starting at the new 600V breaker and then turn on the downstream devices one at a time until you reach the panels.
 - .2 Check phase rotation to ensure motors/fans are spinning in correct orientation.
 - .3 Voice communications systems.
 - .4 Electronic data and communications information systems.
- .2 Lighting systems:
 - .1 Lighting equipment.
 - .2 Distribution systems.
 - .3 Emergency lighting systems, including battery packs.
 - .4 Fire exit emergency signage.
- .3 Fire alarm systems, equipment – To be confirmed by fire safety consultant:
 - .1 Annunciators.
 - .2 Control panels.
 - .3 Fire alarm battery banks.

1.9 DELIVERABLES RELATING TO O&M PERSPECTIVES

- .1 General requirements:
 - .1 Compile English documentation.
 - .2 Documentation to be computer-compatible format ready for inputting for data management.
- .2 Provide deliverables:
 - .1 Warranties.
 - .2 Project record documentation.
 - .3 Inventory of spare parts, special tools and maintenance materials.
 - .4 Maintenance Management System (MMS) identification system used.
 - .5 WHMIS information.
 - .6 MSDS data sheets.
 - .7 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.

1.10 DELIVERABLES RELATING TO THE CX PROCESS

- .1 General:
 - .1 Start-up, testing and Cx requirements, conditions for acceptance and specifications form part of relevant technical sections of these specifications.
- .2 Definitions:
 - .1 Cx as used in this section includes:

- .1 Cx of components, equipment, systems, subsystems, and integrated systems.
- .2 Factory inspections and performance verification tests.
- .3 Deliverables: provide:
 - .1 Cx Specifications.
 - .2 Startup, pre-Cx activities and documentation for systems, and equipment.
 - .3 Completed installation checklists (ICL).
 - .4 Completed product information (PI) report forms.
 - .5 Completed performance verification (PV) report forms.
 - .6 Results of Performance Verification Tests and Inspections.
 - .7 Description of Cx activities and documentation.
 - .8 Description of Cx of integrated systems and documentation.
 - .9 Tests of following witnessed by Departmental Representative.
 - .10 Tests performed by User.
 - .11 Training Plans.
 - .12 Cx Reports.
 - .13 Prescribed activities during warranty period.
- .4 Departmental Representative to witness and certify tests and reports of results provided to Departmental Representative.
- .5 Departmental Representative to participate.

1.11 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION

- .1 Items listed in this Cx Plan include the following:
 - .1 Pre-Start-Up inspections: by Departmental Representative prior to permission to start up and rectification of deficiencies to Departmental Representative's satisfaction.
 - .2 Departmental Representative to use approved check lists.
 - .3 Departmental Representative will monitor all of these pre-start-up inspections.
 - .4 Include completed documentation with Cx report.
 - .5 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and "bumping" during construction as specified in technical sections. To be witnessed and certified by Departmental Representative and does not form part of Cx specifications.
 - .6 Departmental Representative will monitor all of these inspections and tests.
 - .7 Include completed documentation in Cx report.
- .2 Pre-Cx activities - MECHANICAL:
 - .1 Plumbing systems:
 - .1 "Bump" each item of equipment in its "stand-alone" mode.
 - .2 Complete pre-start-up checks and complete relevant documentation.

- .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
- .2 HVAC equipment and systems:
 - .1 "Bump" each item of equipment in its "stand-alone" mode.
 - .2 At this time, complete pre-start-up checks and complete relevant documentation.
 - .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
 - .4 Perform TAB on systems. TAB reports to be approved by Departmental Representative.
- .3 EMCS:
 - .1 EMCS trending to be available as supporting documentation for performance verification.
 - .2 Perform point-by-point testing in parallel with start-up.
 - .3 Carry out point-by-point verification.
 - .4 Demonstrate performance of systems, to be witnessed by Departmental Representative prior to start of 30 day Final Acceptance Test period.
 - .5 Perform final Cx and operational tests during demonstration period and 30 day test period.
 - .6 Only additional testing after foregoing have been successfully completed to be "Off-Season Tests".
- .3 Pre-Cx activities - ELECTRICAL:
 - .1 Low voltage below 750V:
 - .1 Visual inspection of equipment to ensure any metal shavings etc. are removed.
 - .2 Double check terminations are tightened.
 - .3 Megger the 600V 3c300MCM cable after pulling it and prior to termination.
 - .2 Lighting systems:
 - .1 Emergency lighting systems:
 - .1 Tests to include verification of lighting levels and coverage, initially by disrupting normal power.
 - .3 Fire alarm systems – To be confirmed by fire safety consultant:
 - .1 Test after other safety and security systems are completed.
 - .1 Testing to include a complete verification in accordance with ULC requirements. Departmental Representative has witnessed and certified report, demonstrate devices and zones to Departmental Representative's Consultant.

1.12 START-UP

- .1 Start up components, equipment and systems.
- .2 Equipment manufacturer, supplier, installing specialist sub-contractor, as appropriate, to start-up, under Contractor's direction, following equipment, systems:

- .3 Departmental Representative to monitor all of these start-up activities.
 - .1 Rectify start-up deficiencies to satisfaction of Departmental Representative.
- .4 Performance Verification (PV):
 - .1 Repeat when necessary until results are acceptable to Departmental Representative.
 - .2 Use procedures modified generic procedures to suit project requirements.
 - .3 Departmental Representative to witness and certify reported results using approved PI and PV forms.
 - .4 Departmental Representative to approve completed PV reports.
 - .5 Departmental Representative reserves right to verify up to 30% of reported results at random.
 - .6 Failure of randomly selected item shall result in rejection of PV report or report of system startup and testing.

1.13 CX ACTIVITIES AND RELATED DOCUMENTATION

- .1 Perform Cx using procedures developed by Departmental Representative and Contractor and approved by Departmental Representative.
- .2 Departmental Representative to monitor Cx activities.
- .3 Upon satisfactory completion, Contractor performing tests to prepare Cx Report using approved PV forms.
- .4 Departmental Representative to witness and certify reported results of Cx activities.
- .5 Departmental Representative reserves right to verify a percentage of reported results at no cost to contract.

1.14 CX OF INTEGRATED SYSTEMS AND RELATED DOCUMENTATION

- .1 Cx to be performed, using procedures developed by Departmental Representative and Contractor and approved by Departmental Representative.
- .2 Tests to be witnessed by Departmental Representative and documented on approved report forms.
- .3 Upon satisfactory completion, Cx specialist to prepare Cx Report, to be certified by Contractor and submitted to Departmental Representative for review.
- .4 Departmental Representative reserves right to verify percentage of reported results.
- .5 Integrated systems to include:
 - .1 HVAC and associated systems forming part of integrated HVAC systems.
- .6 Identification:
 - .1 In later stages of Cx, before hand-over and acceptance Departmental Representative and Contractor to co-operate to complete inventory data sheets

and provide assistance to NRC in full implementation of MMS identification system of components, equipment, sub-systems, systems.

1.15 INSTALLATION CHECK LISTS (ICL)

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.16 PRODUCT INFORMATION (PI) REPORT FORMS

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.17 PERFORMANCE VERIFICATION (PV) REPORT

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.18 CX SCHEDULES

- .1 Prepare detailed critical path Cx Schedule and submit to Departmental Representative for review and approval same time as project Construction Schedule. Include:
 - .1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:
 - .1 Design criteria, design intents.
 - .2 Pre-TAB review: 28 days after contract award, and before construction starts.
 - .3 Cx procedures: 3 months after award of contract.
 - .4 Cx Report format: 3 months after contract award.
 - .5 Discussion of heating/cooling loads for Cx: 3 months before start-up.
 - .6 Submission of list of instrumentation with relevant certificates: 21 days before start of Cx.
 - .7 Notification of intention to start TAB: 21 days before start of TAB.
 - .8 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.
 - .9 Notification of intention to start Cx: 14 days before start of Cx.
 - .10 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed 14 days before start of integrated system Cx.
 - .11 Identification of deferred Cx.
 - .12 Implementation of training plans.
 - .13 Cx reports: immediately upon successful completion of Cx.
 - .2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Departmental Representative.
 - .3 6 months in Cx schedule for verification of performance in all seasons and wear conditions.
- .2 After approval, incorporate Cx Schedule into Construction Schedule.

- .3 Contractor, and Departmental Representative will monitor progress of Cx against this schedule.

1.19 CX REPORTS

- .1 Submit reports of tests, witnessed and certified to Departmental Representative who will verify reported results.
- .2 Include completed and certified PV reports in properly formatted Cx Reports.
- .3 Before reports are accepted, reported results to be subject to verification by Departmental Representative.

1.20 ACTIVITIES DURING WARRANTY PERIOD

- .1 Cx activities must be completed before issuance of Interim Certificate, it is anticipated that certain Cx activities may be necessary during Warranty Period, including:
 - .1 Fine tuning of HVAC systems.
 - .2 Adjustment of ventilation rates to promote good indoor air quality and reduce deleterious effects of VOCs generated by off-gassing from construction materials and furnishings.
 - .3 Full-scale emergency evacuation exercises.

1.21 TESTS TO BE PERFORMED BY OWNER/USER

- .1 None is anticipated on this project.

1.22 TRAINING PLANS

- .1 Refer to Section 01 91 41 - Commissioning (Cx) - Training.

1.23 FINAL SETTINGS

- .1 Upon completion of Cx to satisfaction of Departmental Representative lock control devices in their final positions, indelibly mark settings marked and include in Cx Reports.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 INSTALLATION/START-UP CHECK LISTS

- .1 Include the following data:
 - .1 Product manufacturer's installation instructions and recommended checks.
 - .2 Special procedures as specified in relevant technical sections.
 - .3 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.
- .2 Equipment manufacturer's installation/start-up check lists are acceptable for use. As deemed necessary by Departmental Representative supplemental additional data lists will be required for specific project conditions.
- .3 Use check lists for equipment installation. Document check list verifying checks have been made, indicate deficiencies and corrective action taken.
- .4 Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Return completed check lists to Departmental Representative. Check lists will be required during Commissioning and will be included in Building's Operation and Maintenance (O&M) manual at completion of project.
- .5 Use of check lists will not be considered part of commissioning process but will be stringently used for equipment pre-start and start-up procedures.

1.2 PRODUCT INFORMATION (PI) REPORT FORMS

- .1 Product Information (PI) forms compiles gathered data on items of equipment produced by equipment manufacturer, includes nameplate information, parts list, operating instructions, maintenance guidelines and pertinent technical data and recommended checks that is necessary to prepare for start-up and functional testing and used during operation and maintenance of equipment. This documentation is included in the O&M at completion of work.
- .2 Prior to Performance Verification (PV) of systems complete items on PI forms related to systems and obtain Departmental Representative approval.

1.3 PERFORMANCE VERIFICATION (PV) FORMS

- .1 PV forms to be used for checks, running dynamic tests and adjustments carried out on equipment and systems to ensure correct operation, efficiently and function independently and interactively with other systems as intended with project requirements.
- .2 PV report forms include those developed by Contractor records measured data and readings taken during functional testing and Performance Verification procedures.
- .3 Prior to PV of integrated system, complete PV forms of related systems and obtain Departmental Representative's approval.

1.4 SAMPLES OF COMMISSIONING FORMS

- .1 Departmental Representative will develop and provide to Contractor required project-specific Commissioning forms in electronic format complete with specification data.
- .2 Revise items on Commissioning forms to suit project requirements.
- .3 Complete all forms missing information and provide all the required forms that are not attached but required for this project.
- .4 Samples of Commissioning forms and a complete index of produced to date will be attached to this section.

1.5 CHANGES AND DEVELOPMENT OF NEW REPORT FORMS

- .1 When additional forms are required, but are not available from Departmental Representative develop appropriate verification forms and submit to Departmental Representative for approval prior to use.
 - .1 Additional commissioning forms to be in same format as provided by Departmental Representative.

1.6 COMMISSIONING FORMS

- .1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.
- .2 Strategy for Use:
 - .1 Departmental Representative provides Contractor project-specific Commissioning forms with Specification data included.
 - .2 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.
 - .3 Confirm operation as per design criteria and intent.
 - .4 Identify variances between design and operation and reasons for variances.
 - .5 Verify operation in specified normal and emergency modes and under specified load conditions.
 - .6 Record analytical and substantiating data.
 - .7 Verify reported results.
 - .8 Form to bear signatures of recording technician and reviewed and signed off by Departmental Representative.
 - .9 Submit immediately after tests are performed.
 - .10 Reported results in true measured SI unit values.
 - .11 Provide Departmental Representative with originals of completed forms.
 - .12 Maintain copy on site during start-up, testing and commissioning period.
 - .13 Forms to be both hard copy and electronic format with typed written results in the building's Operations and Maintenance (O&M) manual.

1.7 LANGUAGE

- .1 To suit the language profile of the awarded contract.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 TRAINEES

- .1 Trainees: personnel selected for operating and maintaining this facility. Includes Departmental Representative, building operators, and technical specialists as required.
- .2 Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

1.2 INSTRUCTORS

- .1 Departmental Representative will provide:
 - .1 Descriptions of systems.
 - .2 Instruction on design philosophy, design criteria, and design intent.
- .2 Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:
 - .1 Start-Up, operation, shut-down of equipment, components and systems.
 - .2 Control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices.
 - .3 Instructions on servicing, maintenance and adjustment of systems, equipment and components.
- .3 Contractor and equipment manufacturer to provide instruction on:
 - .1 Start-up, operation, maintenance and shut-down of equipment they have certified installation, started up and carried out PV tests.

1.3 TRAINING OBJECTIVES

- .1 Training to be detailed and duration to ensure:
 - .1 Safe, reliable, cost-effective, energy-efficient operation of systems in normal and emergency modes under all conditions.
 - .2 Effective on-going inspection, measurements of system performance.
 - .3 Proper preventive maintenance, diagnosis and trouble-shooting.
 - .4 Ability to update documentation.
 - .5 Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.

1.4 TRAINING MATERIALS

- .1 Instructors to be responsible for content and quality.
- .2 Training materials to include:
 - .1 "As-Built" Contract Documents.
 - .2 Operating Manual.

- .3 Maintenance Manual.
- .4 Management Manual.
- .5 TAB and PV Reports.
- .3 Departmental Representative will review training manuals.
- .4 Training materials to be in a format that permits future training procedures to same degree of detail.
- .5 Supplement training materials:
 - .1 Transparencies for overhead projectors.
 - .2 Multimedia presentations.
 - .3 Manufacturer's training videos.
 - .4 Equipment models.

1.5 SCHEDULING

- .1 Include in Commissioning Schedule time for training.
- .2 Deliver training during regular working hours, training sessions to be 3 hours in length.
- .3 Training to be completed prior to acceptance of facility.

1.6 RESPONSIBILITIES

- .1 Be responsible for:
 - .1 Implementation of training activities,
 - .2 Coordination among instructors,
 - .3 Quality of training, training materials,
- .2 Departmental Representative will evaluate training and materials.
- .3 Upon completion of training, provide written report, signed by Instructors, witnessed by Departmental Representative.

1.7 TRAINING CONTENT

- .1 Training to include demonstrations by Instructors using the installed equipment and systems.
- .2 Content includes:
 - .1 Review of facility and occupancy profile.
 - .2 Functional requirements.
 - .3 System philosophy, limitations of systems and emergency procedures.
 - .4 Review of system layout, equipment, components and controls.
 - .5 Equipment and system start-up, operation, monitoring, servicing, maintenance and shut-down procedures.

- .6 System operating sequences, including step-by-step directions for starting up, shut-down, operation of valves, dampers, switches, adjustment of control settings and emergency procedures.
 - .7 Maintenance and servicing.
 - .8 Trouble-shooting diagnosis.
 - .9 Inter-Action among systems during integrated operation.
 - .10 Review of O&M documentation.
- .3 Provide specialized training as specified in relevant Technical Sections of the construction specifications.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

AHU (BUILT-UP) CX CHECKLIST

EQUIPMENT INFORMATION

SAP Equipment ID:		
Project No:	Project Number	
Drawing No:		
Manufacturer:		
Model No.:		
Serial No.:		
Area Served:		
Installed Location (Room #):		
	Supply Fan HP:	
	Return/Exhaust Fan HP:	
	Energy Recovery Wheel Motor HP:	
	Unit description:	
Cooling Coil:	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> Water <input type="checkbox"/> DX
For DX Coils Only:		
	Refrigerant Type:	
	Refrigerant Volume:	
	Subcooling adjustment (°F - °C) - Refrigerant liquid pressure converted to temperature minus the liquid line temperature	
	Suction superheat adjustment via TXV (°F - °C) - Suction temperature minus the suction pressure converted to temperature	
Heating Coil:	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> Glycol <input type="checkbox"/> Electric
Humidifier:	<input type="checkbox"/> Y <input type="checkbox"/> N	<input type="checkbox"/> Direct Steam <input type="checkbox"/> Electric

PREREQUISITE (check to confirm that the following prerequisites are documented)

<input type="checkbox"/> Shop Drawing Received	<input type="checkbox"/> Installation Complete
<input type="checkbox"/> Start-up Process per Manufacturer's Instructions Complete	<input type="checkbox"/> Connected to BAS
<input type="checkbox"/> Sequence Complete	<input type="checkbox"/> System Balanced
<input type="checkbox"/> Seismic Review Letter Received	Control Valve(s) <input type="checkbox"/> Yes (specification(s) attached) <input type="checkbox"/> No

Comments:

EQUIPMENT ITEMS TO BE VERIFIED

This checklist does not take the place of the manufacturer's recommended checkout and start-up procedures or report.

Equipment Items	Yes / No	Comments
Cabinet and General Installation		
Casing condition good: no dents, leaks, door gaskets installed, no missing screws.		
Access doors close tightly and open easily - no leaks		
Vibration isolation equipment installed and released from shipping locks		
Abnormal noise and vibration		
Maintenance access acceptable for unit and components		
Thermal insulation properly installed		
Instrumentation installed according to specification (thermometers, pressure gauges, flow meters, etc.)		
Filters installed and replacement type and efficiency permanently affixed to housing - construction filters removed		
Equipment identification label has been applied and adheres to NRC naming convention		
Viewing windows installed in sizes and location as specified. Maintenance lights inside unit installed as specified.		
No leakage between unit's outlet and ductwork connection. Flexible connection properly installed		
Unit installed on baserail as specified to ensure proper condensate drainage		
Valves, Piping and Coils		
	Yes / No	
Pipe fittings complete and pipes properly supported		
Pipes properly labeled		
Pipes properly insulated		
Strainers in place and clean		
Piping system properly installed and flushed		
No leaking apparent around fittings		
All coils are clean and fins are in good condition		
All condensate drain pans clean and slope to drain		
Valves properly labeled		
Valves installed in proper direction		
BAS sensors properly located and secure		
P/T plugs and isolation valves installed per drawings		
Control, balancing and isolation valves verified and are accessible for maintenance		
Enough clearance for coil removal		
Energy Recovery Wheel		
	Yes / No	
Unit on separate power circuit		
Power circuit labelled		
No visible damage on face or housing		

The wheel's purge side is correctly facing the building side supply air stream		
Ductwork correctly matched direction and locations of airflow		
Access doors installed immediately adjacent to the unit on all four ducts as specified		
All access doors are large enough to allow a person easy access to all seals and bearings		
Ductwork is self-supporting and does NOT use the unit as structural support		
Ductwork is attached to the unit's frame only and NOT to the unit's sheet metal		
Filters are incorporated into the outside and return air streams		
Filters have restraints to keep them from blowing out should they become wet		
Any indication of leakage (pay particular attention to the partition seal)		
Fans and Dampers	Yes / No	
Supply/exhaust/return fans and motor alignment correct		
Supply/exhaust/return fans belt tension & condition good		
Supply/exhaust/return fans protective shrouds for belts in place and secure		
Supply/exhaust/return fans area clean		
Supply/exhaust/return fans and motor properly lubricated		
Fan motor base vibration isolators type and quantity as per specifications		
Supply/exhaust/return accessible for replacement		
Interlocks installed as per specifications		
Filters clean and tight fitting		
Filter pressure differential measuring device installed and functional, per specification		
Smoke and fire dampers installed properly per contract documents (proper location, access doors,		
All dampers close tightly		
All damper linkages have minimum play		
Low limit freeze stat sensor located to deal with stratification & bypass		
Blade orientation as specified - Opposed/Paralle		
Verify loss of power position (N.O., N.C.) as specified		
Humidifer	Yes / No	
Casing condition good: no dents, leaks, door gaskets installed. No missing screws		
Unit's nameplate permanently affixed to the humidifer		
Humidifier is leveled and properly secured (floor stand or wall supports bolted to ther fllow/walls)		

Piping system properly installed and water isolation valve is provided at the supply piping		
Condensate piping properly sloped and trapped as per manufacturer's instructions		
Manifold is clean and has no damage		
Internal drain cooler is provided to maintain discharge temperature as per city's by-law requirements		
Humidity sensor located as per manufacturer's instructions		
High-humidity cut-out sensor located as per manufacturer's instructions and tested. Must be hard-wired		
DX Coil (if applicable)	Yes / No	
Equipment and refrigerant piping components installed as per drawings		
Refrigerent line sizes, slope, trapping, support, insulation as per manufacturer's instructions		
TXV bulb and equalizer line positioned and installed as per manufacturer's instructions		
Refrigerent pipeing leaked checked and evacuated down to 500 microns or in accordance with manufacturer's instructions		
System charged with total system refrigerant charge (including condensing unit, DX Coil and piping)		
Minimum face velocity of 350fpm		
Ducts	Yes / No	
Balancing report submitted		
Sound attenuation installed		
Duct joint sealant properly installed		
No apparent severe duct restrictions		
Turning vanes in square elbows as per drawings		
Fresh air intakes located away from pollutant sources & exhaust outlets		
Pressure leakage tests completed		
Branch duct control dampers operable		
Ducts cleaned as per specifications		
Balancing dampers installed as per drawings and TAB's site visit		
Electrical and Controls	Yes / No	
Pilot lights are functioning		
Power disconnects in place and labeled		
All electric connections tight		
Proper grounding installed for components and unit		
Safeties in place and operable		
Starter overload breakers installed and correct size		
Control system interlocks hooked up and functional		
Smoke detectors in place		
All control devices and wiring complete		

Controls, interlocks and sequence are functional		
VFD	Yes / No	
VFD powered (wired to controlled equipment)		
VFD interlocked to control system		
Static pressure sensor or other controlling sensor properly located and per drawings and calibrated		
Drive location not subject to excessive moisture or dirt		
Drive location not subject to excessive temperatures		
Drive size matches motor size		
Internal settings designating the model is correct		
Input of FLA represents 100% to 105% of motor FLA rating		
Appropriate Volts and Hz curve is being used		
Accel and decel times are around 10-50 seconds, except for special applications		
Actual decel = _____ Actual accel = _____		
Lower frequency limit at 0 for VAV fans and around 10-30% for chilled water pumps Actual = _____		
Upper frequency set at 100%, unless explained otherwise		
Unit is programmed with full written programming record on site		
Final	Yes / No	
Smoke and fire dampers and unpowered TUs are open		
Startup report completed with this checklist attached		
Safeties installed and safe operating ranges for this equipment provided to the commissioning agent		
Alarms and local protection are functional		
If unit is started and will be running during construction: have quality filters on RA grills, etc. to minimize dirt in the ductwork and coils in any finished areas. Verify moisture migration is not a problem, due to improper pressures between spaces		
Comments:		

ELEMENTS TO BE MEASURED FOR DESIGN VALIDATION

This checklist does not take the place of the manufacturer's recommended checkout and start-up procedures or report.

Measured Element	Instrument (portable/BAS/local)	Design	Measured 1	Measured 2
Supply Fan CFM				
Return/Exhaust Fan CFM				
Supply Fan Amperage				
Return/Exhaust Fan Amperage				
Fuse/Breaker rating				
Supply Fan RPM from balancing report				
Supply motor RPM from balancing report				
Return/Exhaust Fan RPM from balancing report				
Return/Exhaust Motor RPM from balancing report				
Supply/Return/Exhaust Fan External static pressure (ESP) from balancing report				
Supply/Return/Exhaust Fan Total Static Pressure (TSP) from balancing report				
Heating Coil (Airside)				
Airflow (l/s - CFM)				
Entering Air Temp (°C - °F)				
Leaving Air Temp (°C - °F)				
Temperature Difference (°C - °F)				
Airside Pressure Drop (Pa - "H ₂ O)				
Airflow Velocity (m/s - fps)				
Capacity (kW - BTU/h)				

Heating Coil (Fluidside)				
Fluid Flow (l/s - GPM)				
Entering Fluid Temp (°C - °F)				
Leaving Fluid Temp (°C - °F)				
Fluid Temperature Drop (°C - °F)				
Fluid Pressure Drop (Pa - "H ₂ O)				
Number of rows in coil				
Fins Per Inch (FPI)				
Capacity (kW - BTU/h)				
Heating Coil (Electric)				
Amperage				
Voltage				
Capacity (kW - BTU/h)				
Cooling Coil (chilled water)				
Airflow (l/s - CFM)				
Entering Air Temperature (°C - °F)				
Leaving Air Temp (°C - °F)				
Temperature Difference (°C - °F)				
Airside Pressure Drop (Pa - "H ₂ O)				
Airflow Velocity (m/s - fps)				
Capacity (kW - BTU/h)				
Fluid Flow (l/s - GPM)				
Entering Fluid Temp (°C - °F)				
Leaving Fluid Temp (°C - °F)				
Fluid Temperature Drop (°C - °F)				
Fluid Pressure Drop (Pa - "H ₂ O)				

Capacity (kW - BTU/h)				
Number of rows in coil				
Fins Per Inch (FPI)				
Cooling Coil (DX)				
Airflow (l/s - CFM)				
Entering Air Temp (°C - °F)				
Leaving Air Temp (°C - °F)				
Temperature Difference (°C - °F)				
Pressure Drop (Pa - "H ₂ O)				
Capacity (kW - BTU/h)				
Refrigerant suction line pressure (kPa)				
Refrigerant liquid line pressure (kPa)				
Humidifier				
Entering Dry Bulb Temp (°C - °F)				
Entering Wet Bulb Temp (°C - °F)				
Entering Relative Humidity %				
Leaving Dry Bulb Temp (°C - °F)				
Leaving Wet Bulb Temp (°C - °F)				
Leaving Relative Humidity %				
Filters				
Static Pressure Drop				
Type				
Efficiency				
Size				
Quantity				
Energy Recovery Wheel				
Wheel size (nominal CFM)				
Total effectiveness				

Exhaust air transfer ratio (EATR)				
Outside air correction factor (OACF)				
Pressure drop (supply to exhaust air)				
Comments:				

CONTROL SYSTEM ITEMS TO BE BE VERIFIED

Control System Items	Yes / No	Comments
NRC Graphics Standard Checklist Completed		
NRC BAS Field Equipment Checklist Completed		
NRC Sequence Standard Checklist Completed		
Have scheduled points been added to the All Points Log (APL)		
Controller online		
Has AHU been programmed for GTA		
Graphics created		
Link to written sequence on system graphic		
Equipment shown on BAS floor plan		
Network layout shown on BAS floor plan		
SAP Equipment ID used in BAS		
Nametags for AHU and BAS control points installed		
Wiring inside BAS panel labelled to identify BAS point names		
Input/output points sheet for controller updated to include new equipment		
BAS Controller labelled		
Power source labelled on controller		
Comments:		

CONTROL SYSTEM PRE-FUNCTIONAL CHECKS - TBC

<i>Observations, Notes & Comments</i>	
Initial Conditions:	
As-Found Outside Temp/Hum	
As-Found Supply Set Point - Temp/Hum	
As-Found Supply Temp/Hum	
As-Found Return Temp/Hum	

As-Found Position HV/CV/Damper	
As-Found HumVlv	
Total Pressure drop across fan	
Mixed air chamber pressure	
Pressure drop across OAD and MAD	
Manually override the dampers to obtain:	
0% (Fully Closed on OA)	
10% (Min)	
50%	
100% (Fully Open on OA)	
50%	
Back to Automatic	
Note travel time	
Manually override the HV to obtain:	
0% (Fully Closed)	
50%	
100% (Fully Open)	
Back to Automatic	
Note travel time. Verify if temperature is coherent with valve setting	
Manually override the CV to obtain:	
0% (Fully Closed)	
50%	
100% (Fully Open)	
Back to Automatic	
Note travel time. Verify if temperature is coherent with valve setting	
Manually override the HumVlv to obtain:	
0% (Fully Closed)	
50%	
100% (Fully Open)	
Back to Automatic	
Note travel time. Verify that steam is injected when valve is open	
Calculate Energy Recovery Wheel effectiveness:	
Supply airflow (CFM)	
Return airflow (CFM)	
Calculate the energy recovery wheel effectiveness according to ASHRAE Standard 84-2020 and note if different from design	
Modify schedule for the system to go in unoccupied mode:	
Verify that fan stops	
Verify damper positions	
Verify HV setting	
Back to normal schedule	
Return all changed control parameters and conditions to their pre-functional check values	

Comments:

TBC - To be completed by Cx Agent and Contractor based on the control sequence.

CONTROL SEQUENCE FUNCTIONAL PERFORMANCE TEST - TBC

Functional Performance Test Procedure	Expected, Actual Response & Comments	Pass (Y / N)
System stopped:		
System start-up:		
Normal mode:		
Control points:		
Local protection:		
Alarms:		

Return all changed control parameters and conditions to their pre-functional performance test values.

Comments:

TBC - To be completed by Cx Agent and Contractor based on the control sequence.

NRC BAS Field Equipment Checklist

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To be completed by BAS Contractor and submitted to NRC team for review prior to start of commissioning.			
Item	Qty	Yes/No	Deficiencies
Nameplates for panel/cabinets - Standard is black on white melamine - 1" x 2-3/4"			
Nameplates for controllers - Standard is black on white stick-on label			
Field controllers - Controllers located in finished ceiling space must have an orange circle on t-bar below the controller identifying its location			
Nameplate for Field Devices - Standard is plastic encased card			
Nameplates for room sensors - Standard is black on white stick-on label			
Warning signs - Starters under remote automatic control			
Wiring:			
Tape markings on wiring inside panels to identify BAS point name			
Power wiring - identify circuit breaker panel/circuit breaker number inside each EMCS panel			
Conduit:			
New conduit to be in pre-painted orange conduit			
Existing conduit to use florescent orange paint to identify control wiring			
Prepaint box covers and fittings in florescent orange			

NRC BAS Graphics Standard Checklist

To be completed by BAS Contractor and submitted NRC for review prior to start of commissioning.						
Item	Building Name					
	System Name	i.e 19AHU01	System Name	i.e 19AHU01	System Name	i.e 19AHU01
Building name, system name and system description to be identified on each i.e. M24 - 24AHU01 – Environmental Lab						
Location of system to be identified on each graphic (directly under the system name). (i.e. Basement Mechanical Room 02)						
NRC equipment names used to identify mechanical equipment. Format to be black on white consistent with NRCs equipment tags. (except bacnet points- black on blue background)						
Network point path to display when mouse is over BAS point. Applicable for all points						
Provide unique sequence of operation graphic or pop-up window in plain English for each graphic that is depicted on OWS. Provide access to plain English sequence of operation graphic by link button on each system graphic. Sequences operation to be stored on the RPPM BAS server						
Written sequences to use the same naming convention as on the graphics						
Each system to have a link to the appropriate floor plan						
Floor plan graphics (complete with roof plans) are required showing the following:						
Equipment locations						
Controllers and their wiring runs. (location specifics must be included on graphics such as ceiling, closet, etc.						
Sensor locations						
Separate floor plans for temperature locations, controller locations and equipment locations to be the template to accommodate larger buildings						
Floor plan graphics to be colour coded to identify the areas served by each air handling unit						
Each building to have a heating, cooling and ventilation summary table						
Each converted building to have a lighting page						
Items grouped under miscellaneous alarms must also have equipment locations identified						
Each system to have identified schedules						

NRC BAS Sequence Standard Checklist

To be completed by BAS Contractor and submitted NRC for review prior to start of commissioning.																		
Item	Building Name																	
	System Name	i.e 19AHU01	System Name	i.e 19AHU01	System Name	i.e 19AHU01												
<p>Enthalpy for all applicable systems. The economizer flag is used to signal the damper economizer so that the outdoor air is not to be used as a cooling source.</p> <p>Calculate the value of the Outdoor Enthalpy using the current Outdoor Air Temperature and relative humidity. Calculate the Enthalpy for the Indoor condition of 72F and 45%RH.</p> <p>This is the Indoor Enthalpy Setpoint.</p> <p>Set the economizer flag to OFF when the outdoor enthalpy is greater than the Indoor Enthalpy Setpoint.</p> <p>Set the Economizer flag to ON when the outdoor enthalpy is less than the (Indoor Setpoint * 0.9)</p> $OAE_{nth} = 9 + 0.27 * (\text{Site_Oat} - 35) + 0.5 * (\text{Site_Oat} - 35) * (\text{Site_Oah} / 100) \text{ Btu/lb}$ $OAE_{nthSp} = \text{based on a space setpoint of 72F and RH of 45\%} = 8 + 0.27 * (72 - 35) + 0.5 * (72 - 35) * 45 / 100 = 26.3 \text{ Btu/lb}$ $\text{Enthalpy} = ((Oa_{nth} \geq Oa_{nthSp}) \text{ or } (\text{Enthalpy and } (Oa_{nth} \geq (Oa_{nthSp} * 0.9))))$																		
<p>SSTO - Start Stop Time Optimization. Identify occupancy time and use BAS to calculate the required system start time. Systems to operate in full recirculation until occupancy time unless free cooling is available. During the heating season, when system is heated solely via perimeter radiation/reheats, system occupancy will be the system start time</p>																		
<p>Occupied/Unoccupied Set Points -</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Occupied</th> <th>Summer</th> <th>Winter</th> </tr> </thead> <tbody> <tr> <td>Temperature (Occupied)</td> <td>24 +/-1C</td> <td>22 +/-1C</td> </tr> <tr> <td>Temperature (Unoccupied)</td> <td>28C</td> <td>18C</td> </tr> <tr> <td>Humidity</td> <td colspan="2">60% - 25%</td> </tr> </tbody> </table> <p>Essentially we would have a winter set-point (22C) and a summer set-point (24C) that are toggled when we move from cooling to heating season and vice versa. The individual room controls would allow local control up or down 1C. During unoccupied hours, system to operate in full recirculation to maintain the unoccupied setpoints unless free cooling is available</p>	Occupied	Summer	Winter	Temperature (Occupied)	24 +/-1C	22 +/-1C	Temperature (Unoccupied)	28C	18C	Humidity	60% - 25%							
Occupied	Summer	Winter																
Temperature (Occupied)	24 +/-1C	22 +/-1C																
Temperature (Unoccupied)	28C	18C																
Humidity	60% - 25%																	
<p>GTA - Global Temperature Adjustment. Systems to be programmed to allow for GTA that can be used on a call for curtailment</p>																		
<p>SAT Reset - Implement a supply air temperature reset based on the return or outside air temperature</p>																		
<p>MAD - Mixing air dampers to be controlled by SAT. Mixed air dampers to modulate to maintain supply air temperature at set point. If the unit goes into enthalpy mode, MAD will go to minimum position</p>																		

Item	Building Name											
	System Name	i.e 19AHU01	System Name	i.e 19AHU01	System Name	i.e 19AHU01						
<p>PHC - Preheat coil reset based on outside air temperature</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%; text-align: center;">OAT °F</th> <th style="width: 50%; text-align: center;">PHC %</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">30</td> <td style="text-align: center;">100</td> </tr> <tr> <td style="text-align: center;">53</td> <td style="text-align: center;">0</td> </tr> </tbody> </table>	OAT °F	PHC %	30	100	53	0						
OAT °F	PHC %											
30	100											
53	0											
<p>CO₂ - The MAD minimum will be overridden if the return or floor CO₂ sensor is above the setpoint. If there is more than one floor CO₂ sensor, the MAD will be overridden by the maximum CO₂ sensed on the floors</p>												
<p>RAH - Return air humidity - The humidifier valve will modulate to maintain the return air humidity RAH at setpoint</p>												
<p>APL - All Points Log - Scheduled BAS points to be added to the APL in order to capture equipment left on that should be off</p>												



Commissioning (Cx) Project Control Sheet

Project Number **MXX PROJECT NAME / MXX NOM DU PROJET**

Project Designers:	Name - Architectural Designer	RPPM-Engineering	cell number	email
	Name - Electrical Engineer	RPPM-Engineering	cell number	email
	Name - Mechanical Engineer	RPPM-Engineering	cell number	email
	Structural Engineer	Consulting Firm Name	cell number	email
	Other A&E Support Names	Consulting Firm Name	cell number	email
Project Manager:	Name	RPPM-Project Delivery	cell number	email
Project Coordinator:	Name	RPPM-Project Delivery	cell number	email
BAS Control Specialist:	Name	O&M BAS Team	cell number	email
Building Coordinator:	Name	O&M Client Services	cell number	email
Client Contact:	Name	CBI	cell number	email
PMO:	9100XXXX	WBS Element:	A1-XXXXXX-XX-XX	
General Contractor:	Company Name			
	Primary Contact Name	Title	cell number	email
Commissioning Authority (Agent):	Company Name			
	Primary Contact Name	Title	cell number	email
Controls (Ainsworth) Contact:	Ainsworth Canada			
	Primary Contact Name	Title	cell number	email



Commissioning (Cx) List of Participants Execution (E), Verification (V), and Approval (A)

Systems for Cx	Company	Participant Name	Activity	Signature and Date
Plumbing	Company Name	Participant(s) Name	Execution <input type="checkbox"/> Verification <input type="checkbox"/> Approval <input type="checkbox"/>	
Ventilation	Company Name	Participant(s) Name	Execution <input type="checkbox"/> Verification <input type="checkbox"/> Approval <input type="checkbox"/>	
BAS	Company Name	Participant(s) Name	Execution <input type="checkbox"/> Verification <input type="checkbox"/> Approval <input type="checkbox"/>	
Electrical	Company Name	Participant(s) Name	Execution <input type="checkbox"/> Verification <input type="checkbox"/> Approval <input type="checkbox"/>	
Balancing	Company Name	Participant(s) Name	Execution <input type="checkbox"/> Verification <input type="checkbox"/> Approval <input type="checkbox"/>	
Witness - General Contractor	Company Name	Participant(s) Name	Execution <input type="checkbox"/> Verification <input type="checkbox"/> Approval <input type="checkbox"/>	
Witness - RPPM Departmental Rep(s)	Company Name	Participant(s) Name	Execution <input type="checkbox"/> Verification <input type="checkbox"/> Approval <input type="checkbox"/>	
Commissioning Authority (Agent)	Company Name	Participant(s) Name	Execution <input type="checkbox"/> Verification <input type="checkbox"/> Approval <input type="checkbox"/>	



Commissioning (Cx) Sign-Off

EQUIPMENT INFORMATION			
SAP Equipment ID	Tasks Complete (select Yes, No or N/A)	Supervised By	Date
PREREQUISITES			
SAP Equipment ID	Tasks Complete (select Yes, No or N/A)	Supervised By	Date
EQUIPMENT ITEMS TO BE VERIFIED			
SAP Equipment ID	Tasks Complete (select Yes, No or N/A)	Supervised By	Date



ELEMENTS TO BE MEASURED FOR DESIGN VALIDATION

<i>SAP Equipment ID</i>	<i>Tasks Complete (select Yes, No or N/A)</i>	<i>Supervised By</i>	<i>Date</i>

CONTROL SYSTEM ITEMS TO BE VERIFIED

<i>SAP Equipment ID</i>	<i>Tasks Complete (select Yes, No or N/A)</i>	<i>Supervised By</i>	<i>Date</i>

CONTROL SYSTEM PRE-FUNCTIONAL CHECKS

<i>SAP Equipment ID</i>	<i>Tasks Complete (select Yes, No or N/A)</i>	<i>Supervised By</i>	<i>Date</i>



CONTROL SYSTEM FUNCTIONAL PERFORMANCE TESTS			
SAP Equipment ID	Tasks Complete (select Yes, No or N/A)	Supervised By	Date
FINAL SIGNATURES			
Project Manager:	_____	O&M Project Acceptance Representative:	_____
Design Engineer:	_____		
BAS Control Specialist:	_____	E&C Handover Representative:	_____
O&M Supervisor:	_____		



Fan Cx Checklist

EQUIPMENT INFORMATION

SAP Equipment ID:	
Project No:	Project Number
Drawing No:	
Manufacturer:	
Model No.:	
Serial No.:	
Area Served:	
Location:	
Supply/Exhaust:	
Type:	
Constant/Variable Volume:	
Vibration Isolators	
Motor HP	
Electrical: V/ ϕ / Hz	
Filter Type and Quantity:	
Filter Size:	
SAP Equipment IDs of all systems linked to fan (i.e. 50SAF01 is linked with 50XAF01, 50RAF01):	

PREREQUISITE (check to confirm that the following prerequisites are documented)

<input type="checkbox"/> Shop Drawing Received	<input type="checkbox"/> Installation Complete
<input type="checkbox"/> Start-up Process per Manufacturer's Instructions Complete	<input type="checkbox"/> Connected to BAS
<input type="checkbox"/> Sequence Complete	<input type="checkbox"/> System Balanced
<input type="checkbox"/> Seismic Review Letter Received	
Comments:	

EQUIPMENT ITEMS TO BE VERIFIED

This checklist does not take the place of the manufacturer's recommended checkout and start-up procedures or report.

Equipment Items	Yes / No	Comments
Equipment identification label has been applied and follows NRC naming convention		
Fan installation & start-up completed and form/report attached		
Local protection/interlocks/alarms are functional		
Verification of abnormal noise and vibration		
Verification of isolation/spring deflection on start-up & shutdown		

Comments:

ELEMENTS TO BE MEASURED FOR DESIGN VALIDATION

This checklist does not take the place of the manufacturer's recommended checkout and start-up procedures or report.

Measured Element	Instrument (portable/BAS/local)	Design	Measured 1	Measured 2
Airflow (l/s - CFM)				
Differential Pressure (kPa - "H ₂ O)				
Voltage (T ₁ -T ₂ , T ₂ -T ₃ , T ₃ -T ₁)				
Amperage (I ₁ , I ₂ , I ₃)				
Fuse/Breaker Rating				
O/L Protection - Adjustment				

Comments:

CONTROL SYSTEM ITEMS TO BE BE VERIFIED

Control System Items	Yes / No	Comments
NRC Graphics Standard Checklist Completed		
NRC BAS Field Equipment Checklist Completed		
NRC Sequence Standard Checklist Completed		
Have scheduled points been added to the All Points Log (APL)		
Controller online		
Has fan been programmed for GTA		
Graphics created		
Link to written sequence on system graphic		
Equipment shown on BAS floor plan		
Network layout shown on BAS floor plan		
SAP Equipment ID used in BAS		
Nametags for fan and BAS control points installed		
BAS Controller labelled		
Power source labelled on controller		

Comments:

CONTROL SYSTEM PRE-FUNCTIONAL CHECKS - TBC
Observations, Notes & Comments
Initial Conditions:
Manually override the fan to obtain:

From BAS, command fan ON

Record (mA):

Physically check fan is ON:

 Y N

From BAS, command fan OFF

Record (mA):

Physically check fan is OFF:

 Y N

Return to automatic

Return all changed control parameters and conditions to their pre-functional check values.

Comments:

TBC - To be completed by Cx Agent and Contractor based on the control sequence.

CONTROL SEQUENCE FUNCTIONAL PERFORMANCE TEST - TBC

Functional Performance Test Procedure	Expected, Actual Response & Comments	Pass (Y / N)
System stopped:		
System start-up:		
Normal mode:		
Control points:		
Local protection:		
Alarms:		

Return all changed control parameters and conditions to their pre-functional performance test values.

Comments:

TBC - To be completed by Cx Agent and Contractor based on the control sequence.



TP1 Amount Payable – General

1.1 Subject to any other provisions of the contract, Her Majesty shall pay the Contractor, at the times and in the manner hereinafter set out, the amount by which

1.1.1 the aggregate of the amounts described in TP2 exceeds

1.1.2 the aggregate of the amounts described in TP3

and the Contractor shall accept that amount as payment in full satisfaction for everything furnished and done by him in respect of the work to which the payment relates.

TP2 Amounts Payable to the Contractor

2.1 The amounts referred to in TP1.1.1 are the aggregate of

2.1.1 the amounts referred to in the Articles of Agreement, and

2.1.2 the amounts, if any, that are payable to the Contractor pursuant to the General Conditions.

TP3 Amounts Payable to Her Majesty

3.1 The amounts referred to in TP1.1.2 are the aggregate of the amounts, in any, that the Contractor is liable to pay Her Majesty pursuant to the contract.

3.2 When making any payments to the Contractor, the failure of Her Majesty to deduct an amount referred to in TP3.1 from an amount referred to in TP2 shall not constitute a waiver of the right to do so, or an admission of lack of entitlement to do so in any subsequent payment to the Contractor.

TP4 Time of Payment

4.1 In these Terms of Payment

4.1.1 The “payment period” means a period of 30 consecutive days or such other longer period as is agreed between the Contractor and the Departmental Representative.

4.1.2 An amount is “due and payable” when it is due and payable by Her Majesty to the Contractor according to TP4.4, TP4.7 or TP4.10.

4.1.3 An amount is overdue when it is unpaid on the first day following the day upon which it is due and payable.

4.1.4 The “date of payment” means the date of the negotiable instrument of an amount due and payable by the Receiver General for Canada and given for payment.

4.1.5 The “Bank Rate” means the discount rate of interest set by the Bank of Canada in effect at the opening of business on the date of payment.



- 4.2 The Contractor shall, on the expiration of a payment period, deliver to the Departmental Representative in respect of that payment period a written progress claim that fully describes any part of the work that has been completed, and any material that was delivered to the work site but not incorporated into the work during that payment period.
- 4.3 The Departmental Representative shall, not later than ten days after receipt by him of a progress claim referred to in TP4.2,
- 4.3.1 inspect the part of the work and the material described in the progress claim; and
- 4.3.2 issue a progress report, a copy of which the Departmental Representative will give to the Contractor, that indicates the value of the part of the work and the material described in the progress claim that, in the opinion of the Departmental Representative,
- 4.3.2.1 is in accordance with the contract, and
- 4.3.2.2 was not included in any other progress report relating to the contract.
- 4.4 Subject to TP1 and TP4.5 Her Majesty shall, not later than 30 days after receipt by the Departmental Representative of a progress claim referred to in TP4.2, pay the Contractor
- 4.4.1 an amount that is equal to 95% of the value that is indicated in the progress report referred to in TP4.3.2 if a labour and material payment bond has been furnished by the Contractor, or
- 4.4.2 an amount that is equal to 90% of the value that is indicated in the progress report referred to in TP4.3.2 if a labour and material payment bond has not been furnished by the Contractor.
- 4.5 It is a condition precedent to Her Majesty's obligation under TP4.4 that the Contractor has made and delivered to the Departmental Representative,
- 4.5.1 a statutory declaration described in TP4.6 in respect of a progress claim referred to in TP4.2,
- 4.5.2 in the case of the Contractor's first progress claim, a construction schedule in accordance with the relevant sections of the Specifications, and
- 4.5.3 if the requirement for a schedule is specified, an update of the said schedule at the times identified in the relevant sections of the Specifications.
- 4.6 A statutory declaration referred to in TP4.5 shall contain a deposition by the Contractor that
- 4.6.1 up to the date of the Contractor's progress claim, the Contractor has complied with all his lawful obligations with respect to the Labour Conditions; and
- 4.6.2 up to the date of the Contractor's immediately preceding progress claim, all lawful obligations of the Contractor to subcontractors and suppliers of material in respect of the



work under the contract have been fully discharged.

- 4.7 Subject to TP1 and TP4.8, Her Majesty shall, not later than 30 days after the date of issue of an Interim Certificate of Completion referred to in GC44.2, pay the Contractor the amount referred to in TP1 less the aggregate of
- 4.7.1 the sum of all payments that were made pursuant to TP4.4;
 - 4.7.2 an amount that is equal to the Departmental Representative's estimate of the cost to Her Majesty or rectifying defects described in the Interim Certificate of Completion; and
 - 4.7.3 an amount that is equal to the Departmental Representative's estimate of the cost to Her Majesty of completing the parts of the work described in the Interim Certificate of Completion other than the defects referred to in TP4.7.2.
- 4.8 It is a condition precedent to Her Majesty's obligation under TP4.7 that the Contractor has made and delivered to the Departmental Representative,
- 4.8.1 a statutory declaration described in TP4.9 in respect of an Interim Certificate of Completion referred to in GC44.2, and
 - 4.8.2 if so specified in the relevant sections of the Specifications, and update of the construction schedule referred to in TP4.5.2 and the updated schedule shall, in addition to the specified requirements, clearly show a detailed timetable that is acceptable to the Departmental Representative for the completion of any unfinished work and the correction of all defects.
- 4.9 A statutory declaration referred to in TP4.8 shall contain a deposition by the contractor that up to the date of the Interim Certificate of Completion the Contractor has
- 4.9.1 complied with all of the Contractor's lawful obligations with respect to the Labour Conditions;
 - 4.9.2 discharged all of the Contractor's lawful obligations to the subcontractors and suppliers of material in respect of the work under the contract; and
 - 4.9.3 discharged the Contractor's lawful obligations referred to in GC14.6.
- 4.10 Subject to TP1 and TP4.11, Her Majesty shall, not later than 60 days after the date of issue of a Final Certificate of Completion referred to in GC44.1, pay the Contractor the amount referred to in TP1 less the aggregate of
- 4.10.1 the sum of all payments that were made pursuant to TP4.4; and
 - 4.10.2 the sum of all payments that were made pursuant to TP4.7.
- 4.11 It is a condition precedent to Her Majesty's obligation under TP4.10 that the Contractor has made and delivered a statutory declaration described in TP4.12 to the Departmental Representative.



- 4.12 A statutory declaration referred to in TP4.11 shall, in addition to the depositions described in TP4.9, contain a deposition by the Contractor that all of the Contractor's lawful obligations and any lawful claims against the Contractor that arose out of the performance of the contract have been discharged and satisfied.

TP5 Progress Report and Payment Thereunder Not Binding on Her Majesty

- 5.1 Neither a progress report referred to in TP4.3 nor any payment made by Her Majesty pursuant to these Terms of Payment shall be construed as an admission by Her Majesty that the work, material or any part thereof is complete, is satisfactory or is in accordance with the contract.

TP6 Delay in Making Payment

- 6.1 Notwithstanding GC7 any delay by Her Majesty in making any payment when it is due pursuant to these Terms of Payment shall not be a breach of the contract by Her Majesty.

- 6.2 Her Majesty shall pay, without demand from the Contractor, simple interest at the Bank Rate plus 1 -1/4 per centum on any amount which is overdue pursuant to TP4.1.3, and the interest shall apply from and include the day such amount became overdue until the day prior to the date of payment except that

- 6.2.1 interest shall not be payable or paid unless the amount referred to in TP6.2 has been overdue for more than 15 days following

6.2.1.1 the date the said amount became due and payable, or

6.2.1.2 the receipt by the Departmental Representative of the Statutory Declaration referred to in TP4.5, TP4.8 or TP4.11,

whichever is the later, and

- 6.6.2 interest shall not be payable or paid on overdue advance payments if any.

TP7 Right of Set-off

- 7.1 Without limiting any right of set-off or deduction given or implied by law or elsewhere in the contract, Her Majesty may set off any amount payable to Her Majesty by the Contractor under this contract or under any current contract against any amount payable to the Contractor under this contract.

- 7.2 For the purposes of TP7.1, "current contract" means a contract between Her Majesty and the Contractor

7.2.1 under which the Contractor has an undischarged obligation to perform or supply work, labour or material, or

7.2.2 in respect of which Her Majesty has, since the date of which the Articles of Agreement were made, exercised any right to take the work that is the subject of the contract out of the Contractor's hands.



TP8 Payment in Event of Termination

- 8.1 If the contract is terminated pursuant to GC41, Her Majesty shall pay the Contractor any amount that is lawfully due and payable to the Contractor as soon as is practicable under the circumstances.

TP9 Interest on Settled Claims

- 9.1 Her Majesty shall pay to the Contractor simple interest on the amount of a settled claim at an average Bank Rate plus 1 ¼ per centum from the date the settled claim was outstanding until the day prior to the date of payment.
- 9.2 For the purposes of TP9.1,
- 9.2.1 a claim is deemed to have been settled when an agreement in writing is signed by the Departmental Representative and the Contractor setting out the amount of the claim to be paid by Her Majesty and the items or work for which the said amount is to be paid.
- 9.2.2 an "average Bank Rate" means the discount rate of interest set by the Bank of Canada in effect at the end of each calendar month averaged over the period the settled claim was outstanding.
- 9.2.3 a settled claim is deemed to be outstanding from the day immediately following the date the said claim would have been due and payable under the contract had it not been disputed.
- 9.3 For the purposes of TP9 a claim means a disputed amount subject to negotiation between Her Majesty and the Contractor under the contract.



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GC5	2	Amendments
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GC48	24	Determination of Cost – Unit Price Table
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GC50	25	Determination of Cost – Failing Negotiation
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GC53	27	Contractor Status



GC1 Interpretation

1.1 In the contract

- 1.1.1 where reference is made to a part of the contract by means of numbers preceded by letters, the reference shall be construed to be a reference to the particular part of the contract that is identified by that combination of letters and numbers and to any other part of the contract referred to therein;
- 1.1.2 “contract” means the contract document referred to in the Articles of Agreement;
- 1.1.3 “contract security” means any security given by the Contractor to Her Majesty in accordance with the contract;
- 1.1.4 “Departmental Representative” means the officer or employee of Her Majesty who is designated pursuant to the Articles of Agreement and includes a person specially authorized by him to perform, on his behalf, any of his functions under the contract and is so designated in writing to the Contractor;
- 1.1.5 “material” includes all commodities, articles and things required to be furnished by or for the Contractor under the contract for incorporation into the work;
- 1.1.6 “Minister” includes a person acting for, or if the office is vacant, in place of the Minister and his successors in the office, and his or their lawful deputy and any of his or their representatives appointed for the purposes of the contract;
- 1.1.7 “person” includes, unless the context otherwise requires, a partnership, proprietorship, firm, joint venture, consortium and a corporation;
- 1.1.8 “plant” includes all animals, tools, implements, machinery, vehicles, buildings, structures, equipment and commodities, articles and things other than material, that are necessary for the due performance of the contract;
- 1.1.9 “subcontractor” means a person to whom the Contractor has, subject to GC4, subcontracted the whole or any part of the work;
- 1.1.10 “superintendent” means the employee of the Contractor who is designated by the Contractor to act pursuant to GC19;
- 1.1.11 “work includes, subject only to any express stipulation in the contract to the contrary, everything that is necessary to be done, furnished or delivered by the Contractor to perform the contract.

1.2 The headings in the contract documents, other than in the Plans and Specifications, form no part of the contract but are inserted for convenience of reference only.

1.3 In interpreting the contract, in the event of discrepancies or conflicts between anything in the Plans and Specifications and the General Conditions, the General Conditions govern.



- 1.4 In interpreting the Plans and Specifications, in the event of discrepancies or conflicts between
- 1.4.1 the Plans and Specifications, the Specifications govern;
 - 1.4.2 the Plans, the Plans drawn with the largest scale govern; and
 - 1.4.3 figured dimensions and scaled dimensions, the figured dimensions govern.

GC2 Successors and Assigns

- 2.1 The contract shall inure to the benefit of and be binding upon the parties hereto and their lawful heirs, executors, administrators, successors and assigns.

GC3 Assignment of Contract

- 3.1 The contract may not be assigned by the Contractor, either in whole or in part, without the written consent of the Minister.

GC4 Subcontracting by Contractor

- 4.1 Subject to this General Condition, the Contractor may subcontract any part of the work.
- 4.2 The Contractor shall notify the Departmental Representative in writing of his intention to subcontract.
- 4.3 A notification referred to in GC4.2 shall identify the part of the work, and the subcontractor with whom it is intended to subcontract.
- 4.4 The Departmental Representative may object to the intended subcontracting by notifying the Contractor in writing within six days of receipt by the Departmental Representative of a notification referred to in GC4.2.
- 4.5 If the Departmental Representative objects to a subcontracting pursuant to GC4.4, the Contractor shall not enter into the intended subcontract.
- 4.6 The contractor shall not, without the written consent of the Departmental Representative, change a subcontractor who has been engaged by him in accordance with this General Condition.
- 4.7 Every subcontract entered into by the Contractor shall adopt all of the terms and conditions of this contract that are of general application.
- 4.8 Neither a subcontracting nor the Departmental Representative's consent to a subcontracting by the Contractor shall be construed to relieve the Contractor from any obligation under the contract or to impose any liability upon Her Majesty.

GC5 Amendments



- 5.1 No amendment or change in any of the provisions of the contract shall have any force or effect until it is reduced to writing.

GC6 No Implied Obligations

- 6.1 No implied terms or obligations of any kind by or on behalf of Her Majesty shall arise from anything in the contract and the express covenants and agreements therein contained and made by Her Majesty are the only covenants and agreements upon which any rights against Her Majesty are to be founded.
- 6.2 The contract supersedes all communications, negotiations and agreements, either written or oral, relating to the work that were made prior to the date of the contract.

GC7 Time of Essence

- 7.1 Time is of the essence of the contract.

GC8 Indemnification by Contractor

- 8.1 The Contractor shall indemnify and save Her Majesty harmless from and against all claims, demand, losses, costs, damages, actions, suits, or proceedings by whomever made, brought or prosecuted and in any manner based upon, arising out of, related to, occasioned by or attributable to the activities of the Contractor, his servants, agents, subcontractors and sub-subcontractors in performing the work including an infringement or an alleged infringement of a patent of invention or any other kind of intellectual property.
- 8.2 For the purpose of GC8.1, "activities" includes any act improperly carried out, any omission to carry out an act and any delay in carrying out an act.

GC9 Indemnification by Her Majesty

- 9.1 Her Majesty shall, subject to the Crown Liability Act, the Patent Act, and any other law that affects Her Majesty's rights, powers, privileges or obligations, indemnify and save the Contractor harmless from and against all claims, demands, losses, costs, damage, actions, suits or proceedings arising out of his activities under the contract that are directly attributable to
- 9.1.1 lack of or a defect in Her Majesty's title to the work site whether real or alleged; or
- 9.1.2 an infringement or an alleged infringement by the Contractor of any patent of invention or any other kind of intellectual property occurring while the Contractor was performing any act for the purposes of the contract employing a model, plan or design or any other thing related to the work that was supplied by Her Majesty to the Contractor.

GC10 Members of House of Commons Not to Benefit



- 10.1 As required by the Parliament of Canada Act, it is an express condition of the contract that no member of the House of Commons shall be admitted to any share of part of the contract or to any benefit arising therefrom.

GC11 Notices

- 11.1 Any notice, consent, order, decision, direction or other communication, other than a notice referred to in GC11.4, that may be given to the Contractor pursuant to the contract may be given in any manner.
- 11.2 Any notice, consent, order, decision, direction or other communication required to be given in writing, to any party pursuant to the contract shall, subject to GC11.4, be deemed to have been effectively given
- 11.2.1 to the Contractor, if delivered personally to the Contractor or the Contractor's superintendent, or forwarded by mail, telex or facsimile to the Contractor at the address set out in A4.1, or
- 11.2.2 to Her Majesty, if delivered personally to the Departmental Representative, or forwarded by mail, telex or facsimile to the Departmental Representative at the address set out in A1.2.1.
- 11.3 Any such notice, consent, order, decision, direction or other communication given in accordance with GC11.2 shall be deemed to have been received by either party
- 11.3.1 if delivered personally, on the day that it was delivered,
- 11.3.2 if forwarded by mail, on the earlier of the day it was received and the sixth day after it was mailed, and
- 11.3.3 if forwarded by telex or facsimile, 24 hours after it was transmitted.
- 11.4 A notice given under GC38.1.1, GC40 and GC41, if delivered personally, shall be delivered to the Contractor if the Contractor is doing business as sole proprietor or, if the Contractor is a partnership or corporation, to an officer thereof.

GC12 Material, Plant and Real Property Supplied by Her Majesty

- 12.1 Subject to GC12.2, the Contractor is liable to Her Majesty for any loss of or damage to material, plant or real property that is supplied or placed in the care, custody and control of the Contractor by Her Majesty for use in connection with the contract, whether or not that loss or damage is attributable to causes beyond the Contractor's control.
- 12.2 The Contractor is not liable to Her Majesty for any loss or damage to material, plant or real property referred to in GC12.1 if that loss or damage results from and is directly attributable to reasonable wear and tear.
- 12.3 The Contractor shall not use any material, plant or real property referred to in GC12.1 except for



the purpose of performing this contract.

- 12.4 When the Contractor fails to make good any loss or damage for which he is liable under GC12.1 within a reasonable time after being required to do so by the Departmental Representative, the Departmental Representative may cause the loss or damage to be made good at the Contractor's expense, and the Contractor shall thereupon be liable to Her Majesty for the cost thereof and shall, on demand, pay to Her Majesty an amount equal to that cost.
- 12.5 The Contractor shall keep such records of all material, plant and real property referred to in GC12.1 as the Departmental Representative from time to time requires and shall satisfy the Departmental Representative, when requested, that such material, plant and real property are at the place and in the condition which they ought to be.

GC13 Material, Plant and Real Property Become Property of Her Majesty

- 13.1 Subject to GC14.7 all material and plant and the interest of the Contractor in all real property, licenses, powers and privileges purchased, used or consumed by the Contractor for the contract shall, after the time of their purchase, use or consumption be the property of Her Majesty for the purposes of the work and they shall continue to be the property of Her Majesty.
- 13.1.1 in the case of material, until the Departmental Representative indicates that he is satisfied that it will not be required for the work, and
- 13.1.2 in the case of plant, real property, licenses, powers and privileges, until the Departmental Representative indicates that he is satisfied that the interest vested in Her Majesty therein is no longer required for the purposes of the work.
- 13.2 Material or plant that is the property of Her Majesty by virtue of GC13.1 shall not be taken away from the work site or used or disposed of except for the purposes of the work without the written consent of the Departmental Representative.
- 13.3 Her Majesty is not liable for loss of or damage from any cause to the material or plant referred to in GC13.1 and the Contractor is liable for such loss or damage notwithstanding that the material or plant is the property of Her Majesty.

GC14 Permits and Taxes Payable

- 14.1 The Contractor shall, within 30 days after the date of the contract, tender to a municipal authority an amount equal to all fees and charges that would be lawfully payable to that municipal authority in respect of building permits as if the work were being performed for a person other than Her Majesty.
- 14.2 Within 10 days of making a tender pursuant to GC14.1, the Contractor shall notify the Departmental Representative of his action and of the amount tendered and whether or not the municipal authority has accepted that amount.
- 14.3 If the municipal authority does not accept the amount tendered pursuant to GC14.1 the Contractor shall pay that amount to Her Majesty within 6 days after the time stipulated in GC14.2.



- 14.4 For the purposes of GC14.1 to GC14.3 “municipal authority” means any authority that would have jurisdiction respecting permission to perform the work if the owner were not Her Majesty.
- 14.5 Notwithstanding the residency of the Contractor, the Contractor shall pay any applicable tax arising from or related to the performance of the work under the contract.
- 14.6 In accordance with the Statutory Declaration referred to in TP4.9, a Contractor who has neither residence nor place of business in the province in which work under the contract is being performed shall provide Her Majesty with proof of registration with the provincial sales tax authorities in the said province.
- 14.7 For the purpose of the payment of any applicable tax or the furnishing of security for the payment of any applicable tax arising from or related to the performance of the work under the contract, the Contractor shall, notwithstanding the fact that all material, plant and interest of the Contractor in all real property, licenses, powers and privileges, have become the property of Her Majesty after the time of purchase, be liable, as a user or consumer, for the payment or for the furnishing of security for the payment of any applicable tax payable, at the time of the use or consumption of that material, plant or interest of the Contractor in accordance with the relevant legislation.

GC15 Performance of Work under Direction of Departmental Representative

- 15.1 The Contractor shall
- 15.1.1 permit the Departmental Representative to have access to the work and its site at all times during the performance of the contract;
 - 15.1.2 furnish the Departmental Representative with such information respecting the performance of the contract as he may require; and
 - 15.1.3 give the Departmental Representative every possible assistance to enable the Departmental Representative to carry out his duty to see that the work is performed in accordance with the contract and to carry out any other duties and exercise any powers specially imposed or conferred on the Departmental Representative under the contract.

CG16 Cooperation with Other Contractors

- 16.1 Where, in the opinion of the Departmental Representative, it is necessary that other contractors or workers with or without plant and material, be sent onto the work or its site, the Contractor shall, to the satisfaction of the Departmental Representative, allow them access and cooperate with them in the carrying out of their duties and obligation.
- 16.2 If
- 16.2.1 the sending onto the work or its site of other contractors or workers pursuant to GC16.1 could not have been reasonably foreseen or anticipated by the Contractor when entering into the contract, and



16.2.2 the Contractor incurs, in the opinion of the Departmental Representative, extra expense in complying with GC16.1, and

16.2.3 The Contractor has given the Departmental Representative written notice of his claim for the extra expense referred to in GC16.2.2 within 30 days of the date that the other contractors or workers were sent onto the work or its site,

Her Majesty shall pay the Contractor the cost, calculated in accordance with GC48 to GC50, of the extra labour, plant and material that was necessarily incurred.

GC17 Examination of Work

17.1 If, at any time after the commencement of the work but prior to the expiry of the warranty or guarantee period, the Departmental Representative has reason to believe that the work or any part thereof has not been performed in accordance with the contract, the Departmental Representative may have that work examined by an expert of his choice.

17.2 If, as a result of an examination of the work referred to in GC17.1, it is established that the work was not performed in accordance with the contract, then, in addition to and without limiting or otherwise affecting any of Her Majesty's rights and remedies under the contract either at law or in equity, the Contractor shall pay Her Majesty, on demand, all reasonable costs and expenses that were incurred by Her Majesty in having that examination performed.

GC18 Clearing of Site

18.1 The Contractor shall maintain the work and its site in a tidy condition and free from the accumulation of waste material and debris, in accordance with any directions of the Departmental Representative.

18.2 Before the issue of an interim certificate referred to in GC44.2, the Contractor shall remove all the plant and material not required for the performance of the remaining work, and all waste material and other debris, and shall cause the work and its site to be clean and suitable for occupancy by Her Majesty's servants, unless otherwise stipulated in the contract.

18.3 Before the issue of a final certificate referred to in GC44.1, the Contractor, shall remove from the work and its site all of the surplus plant and material and any waste material and other debris.

18.4 The Contractor's obligations described in GC18.1 to GC18.3 do not extend to waste material and other debris caused by Her Majesty's servants or contractors and workers referred to in GC16.1.

GC19 Contractor's Superintendent

19.1 The Contractor shall, forthwith upon the award of the contract, designate a superintendent.

19.2 The Contractor shall forthwith notify the Departmental Representative of the name, address and telephone number of a superintendent designate pursuant to GC19.1.



- 19.3 A superintendent designated pursuant to GC19.1 shall be in full charge of the operations of the Contractor in the performance of the work and is authorized to accept any notice, consent, order, direction, decision or other communication on behalf of the Contractor that may be given to the superintendent under the contract.
- 19.4 The Contractor shall, until the work has been completed, keep a competent superintendent at the work site during working hours.
- 19.5 The Contractor shall, upon the request of the Departmental Representative, remove any superintendent who, in the opinion of the Departmental Representative, is incompetent or has been conducting himself improperly and shall forthwith designate another superintendent who is acceptable to the Departmental Representative.
- 19.6 Subject to GC19.5, the Contractor shall not substitute a superintendent without the written consent of the Departmental Representative.
- 19.7 A breach by the Contractor of GC19.6 entitles the Departmental Representative to refuse to issue any certificate referred to in GC44 until the superintendent has returned to the work site or another superintendent who is acceptable to the Departmental Representative has been substituted.

GC20 National Security

- 20.1 If the Minister is of the opinion that the work is of a class or kind that involves the national security, he may order the Contractor
- 20.1.1 to provide him with any information concerning persons employed or to be employed by him for purposes of the contract; and
 - 20.1.2 to remove any person from the work and its site if, in the opinion of the Minister, that person may be a risk to the national security.
- 20.2 The Contractor shall, in all contracts with persons who are to be employed in the performance of the contract, make provision for his performance of any obligation that may be imposed upon him under GC19 to GC21.
- 20.3 The Contractor shall comply with an order of the Minister under GC20.1

GC21 Unsuitable Workers

- 21.1 The Contractor shall, upon the request of the Departmental Representative, remove any person employed by him for purposes of the contract who, in the opinion of the Departmental Representative, is incompetent or has conducted himself improperly, and the Contractor shall not permit a person who has been removed to return to the work site.

GC22 Increased or Decreased Costs



- 22.1 The amount set out in the Articles of Agreement shall not be increased or decreased by reason of any increase or decrease in the cost of the work that is brought about by an increase or decrease in the cost of labour, plant or material or any wage adjustment arising pursuant to the Labour Conditions.
- 22.2 Notwithstanding GC22.1 and GC35, an amount set out in the Articles of Agreement shall be adjusted in the manner provided in GC22.3, if any change in a tax imposed under the Excise Act, the Excise Tax Act, the Old Age Security Act, the Customs Act, the Customs Tariff or any provincial sales tax legislation imposing a retail sales tax on the purchase of tangible personal property incorporated into Real Property
- 22.2.1 occurs after the date of the submission by the Contractor of his tender for the contract,
- 22.2.2 applies to material, and
- 22.2.3 affects the cost to the Contractor of that material.
- 22.3 If a change referred to in GC22.2 occurs, the appropriate amount set out in the Articles of Agreement shall be increased or decreased by an amount equal to the amount that is established by an examination of the relevant records of the Contractor referred to in GC51 to be the increase or decrease in the cost incurred that is directly attributable to that change.
- 22.4 For the purpose of GC22.2, where a tax is changed after the date of submission of the tender but public notice of the change has been given by the Minister of Finance before that date, the change shall be deemed to have occurred before the date of submission of the tender.

GC23 Canadian Labour and Material

- 23.1 The Contractor shall use Canadian labour and material in the performance of the work to the full extent to which they are procurable, consistent with proper economy and expeditious carrying out of the work.
- 23.2 Subject to GC23.1, the Contractor shall, in the performance of the work, employ labour from the locality where the work is being performed to the extent to which it is available, and shall use the offices of the Canada Employment Centres for the recruitment of workers wherever practicable.
- 23.3 Subject to GC23.1 and GC23.2, the Contractor shall, in the performance of the work, employ a reasonable proportion of persons who have been on active service with the armed forces of Canada and have been honourably discharged therefrom.

GC24 Protection of Work and Documents

- 24.1 The Contractor shall guard or otherwise protect the work and its site, and protect the contract, specifications, plans, drawings, information, material, plant and real property, whether or not they are supplied by Her Majesty to the Contractor, against loss or damage from any cause, and he shall not use, issue, disclose or dispose of them without the written consent of the Minister, except as may be essential for the performance of the work.



- 24.2 If any document or information given or disclosed to the Contractor is assigned a security rating by the person who gave or disclosed it, the Contractor shall take all measures directed by the Departmental Representative to be taken to ensure the maintenance of the degree of security that is ascribed to that rating.
- 24.3 The Contractor shall provide all facilities necessary for the purpose of maintaining security, and shall assist any person authorized by the Minister to inspect or to take security measures in respect of the work and its site.
- 24.4 The Departmental Representative may direct the Contractor to do such things and to perform such additional work as the Departmental Representative considers reasonable and necessary to ensure compliance with or to remedy a breach of GC24.1 to GC24.3.

GC25 Public Ceremonies and Signs

- 25.1 The Contractor shall not permit any public ceremony in connection with the work without the prior consent of the Minister.
- 25.2 The Contractor shall not erect or permit the erection of any sign or advertising on the work or its site without the prior consent of the Departmental Representative.

GC26 Precautions against Damage, Infringement of Rights, Fire, and Other Hazards

- 26.1 The Contractor shall, at his own expense, do whatever is necessary to ensure that
- 26.1.1 no person, property, right, easement or privilege is injured, damaged or infringed by reasons of the Contractor's activities in performing the contract;
 - 26.1.2 pedestrian and other traffic on any public or private road or waterway is not unduly impeded, interrupted or endangered by the performance or existence of the work or plant;
 - 26.1.3 fire hazards in or about the work or its site are eliminated and, subject to any direction that may be given by the Departmental Representative, any fire is promptly extinguished;
 - 26.1.4 the health and safety of all persons employed in the performance of the work is not endangered by the method or means of its performance;
 - 26.1.5 adequate medical services are available to all persons employed on the work or its site at all times during the performance of the work;
 - 26.1.6 adequate sanitation measures are taken in respect of the work and its site; and
 - 26.1.7 all stakes, buoys and marks placed on the work or its site by or under the authority of the Departmental Representative are protected and are not removed, defaced, altered or destroyed.
- 26.2 The Departmental Representative may direct the Contractor to do such things and to perform such additional work as the Departmental Representative considers reasonable and necessary to ensure



compliance with or to remedy a breach of GC26.1.

- 26.3 The Contractor shall, at his own expense, comply with a direction of the Departmental Representative made under GC26.2.

GC27 Insurance

- 27.1 The Contractor shall, at his own expense, obtain and maintain insurance contracts in respect of the work and shall provide evidence thereof to the Departmental Representative in accordance with the requirements of the Insurance Conditions "E".

- 27.2 The insurance contracts referred to in GC27.1 shall

27.2.1 be in a form, of the nature, in the amounts, for the periods and containing the terms and conditions specified in Insurance Conditions "E", and

27.2.2 provide for the payment of claims under such insurance contracts in accordance with GC28.

GC28 Insurance Proceeds

- 28.1 In the case of a claim payable under a Builders Risk/Installation (All Risks) insurance contract maintained by the Contractor pursuant to GC27, the proceeds of the claim shall be paid directly to Her Majesty, and

28.1.1 the monies so paid shall be held by Her Majesty for the purposes of the contract, or

28.1.2 if Her Majesty elects, shall be retained by Her Majesty, in which event they vest in Her Majesty absolutely.

- 28.2 In the case of a claim payable under a General Liability insurance contract maintained by the Contractor pursuant to GC27, the proceeds of the claim shall be paid by the insurer directly to the claimant.

- 28.3 If an election is made pursuant to GC28.1, the Minister may cause an audit to be made of the accounts of the Contractor and of Her Majesty in respect of the part of the work that was lost, damaged or destroyed for the purpose of establishing the difference, if any, between

28.3.1 the aggregate of the amount of the loss or damage suffered or sustained by Her Majesty, including any cost incurred in respect of the clearing and cleaning of the work and its site and any other amount that is payable by the Contractor to Her Majesty under the contract, minus any monies retained pursuant to GC28.12, and

28.3.2 the aggregate of the amounts payable by Her Majesty to the Contractor pursuant to the contract up to the date of the loss or damage.

- 28.4 A difference that is established pursuant to GC28.3 shall be paid forthwith by the party who is determined by the audit to be the debtor to the party who is determined by the audit to be the



creditor.

- 28.5 When payment of a deficiency has been made pursuant to GC28.4, all rights and obligations of Her Majesty and the Contractor under the contract shall, with respect only to the part of the work that was the subject of the audit referred to in GC28.3, be deemed to have been expended and discharged.
- 28.6 If an election is not made pursuant to GC28.1.2 the Contractor shall, subject to GC28.7, clear and clean the work and its site and restore and replace the part of the work that was lost, damaged or destroyed at his own expense as if that part of the work had not yet been performed.
- 28.7 When the Contractor clears and cleans the work and its site and restores and replaces the work referred to in GC 28.6, Her Majesty shall pay him out of the monies referred to in GC28.1 so far as they will thereunto extend.
- 28.8 Subject to GC28.7, payment by Her Majesty pursuant to GC28.7 shall be made in accordance with the contract but the amount of each payment shall be 100% of the amount claimed notwithstanding TP4.4.1 and TP4.4.2.

GC29 Contract Security

- 29.1 The Contractor shall obtain and deliver contract security to the Departmental Representative in accordance with the provisions of the Contract Security Conditions.
- 29.2 If the whole or a part of the contract security referred to in GC29.1 is in the form of a security deposit, it shall be held and disposed of in accordance with GC43 and GC45.
- 29.3 If a part of the contract security referred to in GC29.1 is in the form of a labour and material payment bond, the Contractor shall post a copy of that bond on the work site.

GC30 Changes in the Work

- 30.1 Subject to GC5, the Departmental Representative may, at any time before he issues his Final Certificate of Completion,
- 30.1.1 order work or material in addition to that provided for in the Plans and Specifications;
and
- 30.1.2 delete or change the dimensions, character, quantity, quality, description, location or position of the whole or any part of the work or material provided for in the Plans and Specifications or in any order made pursuant to GC30.1.1,
- if that additional work or material, deletion, or change is, in his opinion, consistent with the general intent of the original contract.
- 30.2 The Contractor shall perform the work in accordance with such orders, deletions and changes that are made by the Departmental Representative pursuant to GC30.1 from time to time as if they had appeared in and been part of the Plans and Specifications.



- 30.3 The Departmental Representative shall determine whether or not anything done or omitted by the Contractor pursuant to an order, deletion or change referred to in GC30.1 increased or decreased the cost of the work to the Contractor.
- 30.4 If the Departmental Representative determines pursuant to GC30.3 that the cost of the work to the Contractor has been increased, Her Majesty shall pay the Contractor the increased cost that the Contractor necessarily incurred for the additional work calculated in accordance with GC49 or GC50.
- 30.5 If the Departmental Representative determines pursuant to GC30.3 that the cost of the work to the Contractor has been decreased, Her Majesty shall reduce the amount payable to the Contractor under the contract by an amount equal to the decrease in the cost caused by the deletion or change referred to in GC30.1.2 and calculated in accordance with GC49.
- 30.6 GC30.3 to GC30.5 are applicable only to a contract or a portion of a contract for which a Fixed Price Arrangement is stipulated in the contract.
- 30.7 An order, deletion or change referred to in GC30.1 shall be in writing, signed by the Departmental Representative and given to the Contractor in accordance with GC11.

GC31 Interpretation of Contract by Departmental Representative

- 31.1 If, at any time before the Departmental Representative has issued a Final Certificate of Completion referred to in GC44.1, any question arises between the parties about whether anything has been done as required by the contract or about what the Contractor is required by the contract to do, and, in particular but without limiting the generality of the foregoing, about
- 31.1.1 the meaning of anything in the Plans and Specification,
 - 31.1.2 the meaning to be given to the Plans and Specifications in case of any error therein, omission therefrom, or obscurity or discrepancy in their working or intention,
 - 31.1.3 whether or not the quality or quantity of any material or workmanship supplied or proposed to be supplied by the Contractor meets the requirements of the contract,
 - 31.1.4 whether or not the labour, plant or material provided by the Contractor for performing the work and carrying out the contract are adequate to ensure that the work will be performed in accordance with the contract and that the contract will be carried out in accordance with its terms,
 - 31.1.5 what quantity of any kind of work has been completed by the Contractor, or
 - 31.1.6 the timing and scheduling of the various phases of the performance of the work,
- the question shall be decided by the Departmental Representative whose decision shall be final and conclusive in respect of the work.
- 31.2 The Contractor shall perform the work in accordance with any decisions of the Departmental



Representative that are made under GC31.1 and in accordance with any consequential directions given by the Departmental Representative.

GC32 Warranty and Rectification of Defects in Work

- 32.1 Without restricting any warranty or guarantee implied or imposed by law or contained in the contract documents, the Contractor shall, at his own expense,
- 32.1.1 rectify and make good any defect or fault that appears in the work or comes to the attention of the Minister with respect to those parts of the work accepted in connection with the Interim Certificate of Completion referred to GC44.2 within 12 months from the date of the Interim Certificate of Completion;
- 32.1.2 rectify and make good any defect or fault that appears in or comes to the attention of the Minister in connection with those parts of the work described in the Interim Certificate of Completion referred to in GC44.2 within 12 months from the date of the Final Certificate of Completion referred to in GC44.1.
- 32.2 The Departmental Representative may direct the Contractor to rectify and make good any defect or fault referred to in GC32.1 or covered by any other expressed or implied warranty or guarantee.
- 32.3 A direction referred to in GC32.2 shall be in writing, may include a stipulation in respect of the time within which a defect or fault is required to be rectified and made good by the Contractor, and shall be given to the Contractor in accordance with GC11.
- 32.4 The Contractor shall rectify and make good any defect or fault described in a direction given pursuant to GC32.2 within the time stipulated therein.

GC33 Non-Compliance by Contractor

- 33.1 If the Contractor fails to comply with any decision or direction given by the Departmental Representative pursuant to GC18, GC24, GC26, GC31 or GC32, the Departmental Representative may employ such methods as he deems advisable to do that which the Contractor failed to do.
- 33.2 The Contractor shall, on demand, pay Her Majesty an amount that is equal to the aggregate of all cost, expenses and damage incurred or sustained by Her Majesty by reason of the Contractor's failure to comply with any decision or direction referred to in GC33.1, including the cost of any methods employed by the Departmental Representative pursuant to GC33.1.

GC34 Protesting Departmental Representative's Decisions

- 34.1 The Contractor may, within ten days after the communication to him of any decision or direction referred to in GC30.3 or GC33.1, protest that decision or direction.
- 34.2 A protest referred to in GC34.1 shall be in writing, contain full reasons for the protest, be signed



by the Contractor and be given to Her Majesty by delivery to the Departmental Representative.

- 34.3 If the Contractor gives a protest pursuant to GC34.2, any compliance by the Contractor with the decision or direction that was protested shall not be construed as an admission by the Contractor of the correctness of that decision or direction, or prevent the Contractor from taking whatever action he considers appropriate in the circumstances.
- 34.4 The giving of a protest by the Contractor pursuant to GC34.2 shall not relieve him from complying with the decision or direction that is the subject of the protest.
- 34.5 Subject to GC34.6, the Contractor shall take any action referred to in GC34.3 within three months after the date that a Final Certificate of Completion is issued under GC44.1 and not afterwards.
- 34.6 The Contractor shall take any action referred to in GC34.3 resulting from a direction under GC32 within three months after the expiry of a warranty or guarantee period and not afterwards.
- 34.7 Subject to GC34.8, if Her Majesty determines that the Contractor's protest is justified, Her Majesty shall pay the Contractor the cost of the additional labour, plant and material necessarily incurred by the Contractor in carrying out the protested decision or direction.
- 34.8 Costs referred to in GC34.7 shall be calculated in accordance with GC48 to GC50.

GC35 Changes in Soil Conditions and Neglect or Delay by Her Majesty

- 35.1 Subject to GC35.2 no payment, other than a payment that is expressly stipulated in the contract, shall be made by Her Majesty to the Contractor for any extra expense or any loss or damage incurred or sustained by the Contractor.
- 35.2 If the Contractor incurs or sustains any extra expense or any loss or damage that is directly attributable to
- 35.2.1 a substantial difference between the information relating to soil conditions at the work site that is contained in the Plans and Specifications or other documents supplied to the Contractor for his use in preparing his tender or a reasonable assumption of fact based thereon made by the Contractor, and the actual soil conditions encountered by the Contractor at the work site during the performance of the contract, or
- 35.2.2 any neglect or delay that occurs after the date of the contract on the part of Her Majesty in providing any information or in doing any act that the contract either expressly requires Her Majesty to do or that would ordinarily be done by an owner in accordance with the usage of the trade,

he shall, within ten days of the date the actual soil conditions described in GC35.2.1 were encountered or the neglect or delay described in GC35.2.2 occurred, give the Departmental Representative written notice of his intention to claim for that extra expense or that loss or damage.

- 35.3 When the Contractor has given a notice referred to in GC35.2, he shall give the Departmental Representative a written claim for extra expense or loss or damage within 30 days of the date that



a Final Certificate of Completion referred to in GC44.1 is issued and not afterwards.

- 35.4 A written claim referred to in GC35.3 shall contain a sufficient description of the facts and circumstances of the occurrence that is the subject of the claim to enable the Departmental Representative to determine whether or not the claim is justified and the Contractor shall supply such further and other information for that purpose as the Departmental Representative requires from time to time.
- 35.5 If the Departmental Representative determines that a claim referred to in GC35.3 is justified, Her Majesty shall make an extra payment to the Contractor in an amount that is calculated in accordance with GC47 to GC50.
- 35.6 If, in the opinion of the Departmental Representative, an occurrence described in GC35.2.1 results in a savings of expenditure by the Contractor in performing the contract, the amount set out in the Articles of Agreement shall, subject to GC35.7, be reduced by an amount that is equal to the saving.
- 35.7 The amount of the saving referred to in GC35.6 shall be determined in accordance with GC47 to GC49.
- 35.8 If the Contractor fails to give a notice referred to in GC35.2 and a claim referred to in GC35.3 within the times stipulated, an extra payment shall not be made to him in respect of the occurrence.

GC36 Extension of Time

- 36.1 Subject to GC36.2, the Departmental Representative may, on the application of the Contractor made before the day fixed by the Articles of Agreement for completion of the work or before any other date previously fixed under this General Condition, extend the time for its completion by fixing a new date if, in the opinion of the Departmental Representative, causes beyond the control of the Contractor have delayed its completion.
- 36.2 An application referred to in GC36.1 shall be accompanied by the written consent of the bonding company whose bond forms part of the contract security.

GC37 Assessments and Damages for Late Completion

- 37.1 For the purposes of this General Condition
- 37.1.1 the work shall be deemed to be completed on the date that an Interim Certificate of Completion referred to in GC44.2 is issued, and
- 37.1.2 "period of delay" means the number of days commencing on the day fixed by the Articles of Agreement for completion of the work and ending on the day immediately preceding the day on which the work is completed but does not include any day within a period of extension granted pursuant to GC36.1, and any other day on which, in the opinion of the Departmental Representative, completion of the work was delayed for reasons beyond the control of the Contractor.



- 37.2 If the Contractor does not complete the work by the day fixed for its completion by the Articles of Agreement but completes it thereafter, the Contractor shall pay Her Majesty an amount equal to the aggregate of
- 37.2.1 all salaries, wages and travelling expenses incurred by Her Majesty in respect of persons overseeing the performance of the work during the period of delay;
 - 37.2.2 the cost incurred by Her Majesty as a result of the inability to use the completed work for the period of delay; and
 - 37.2.3 all other expenses and damages incurred or sustained by Her Majesty during the period of delay as a result of the work not being completed by the day fixed for its completion.
- 37.3 The Minister may waive the right of Her Majesty to the whole or any part of the amount payable by the Contractor pursuant to GC37.2 I, in the opinion of the Minister, it is in the public interest to do so.

GC38 Taking the Work Out of the Contractor's Hands

- 38.1 The Minister may, at his sole discretion, by giving a notice in writing to the Contractor in accordance with GC11, take all or any part of the work out of the Contractor's hands, and may employ such means as he sees fit to have the work completed if the Contractor
- 38.1.1 Has not, within six days of the Minister or the Departmental Representative giving notice to the Contractor in writing in accordance with GC11, remedied any delay in the commencement or any default in the diligent performance of the work to the satisfaction of the Departmental Representative;
 - 38.1.2 has defaulted in the completion of any part of the work within the time fixed for its completion by the contract;
 - 38.1.3 has become insolvent;
 - 38.1.4 has committed an act of bankruptcy;
 - 38.1.5 has abandoned the work;
 - 38.1.6 has made an assignment of the contract without the consent required by GC3.1; or
 - 38.1.7 has otherwise failed to observe or perform any of the provisions of the contract.
- 38.2 If the whole or any part of the work is taken out of the Contractor's hands pursuant to GC38.1,
- 38.2.1 the Contractor's right to any further payment that is due or accruing due under the contract is, subject only to GC38.4, extinguished, and
 - 38.2.2 the Contractor is liable to pay Her Majesty, upon demand, an amount that is equal to the amount of all loss and damage incurred or sustained by Her Majesty in respect of the



Contractor's failure to complete the work.

- 38.3 If the whole or any part of the work that is taken out of the Contractor's hands pursuant to GC38.1 is completed by Her Majesty, the Departmental Representative shall determine the amount, if any, of the holdback or a progress claim that had accrued and was due prior to the date on which the work was taken out of the Contractor's hands and that is not required for the purposes of having the work performed or of compensating Her Majesty for any other loss or damage incurred or sustained by reason of the Contractor's default.
- 38.4 Her Majesty may pay the Contractor the amount determined not to be required pursuant to GC38.3.

GC39 Effect of Taking the Work Out of the Contractor's Hands

- 39.1 The taking of the work or any part thereof out of the Contractor's hands pursuant to GC38 does not operate so as to relieve or discharge him from any obligation under the contract or imposed upon him by law except the obligation to complete the performance of that part of the work that was taken out of his hands.
- 39.2 If the work or any part thereof is taken out of the Contractor's hands pursuant to GC38, all plant and material and the interest of the Contractor is all real property, licenses, powers and privileges acquired, used or provided by the Contractor under the contract shall continue to be the property of Her Majesty without compensation to the Contractor.
- 39.3 When the Departmental Representative certifies that any plant, material, or any interest of the Contractor referred to in GC39.2 is no longer required for the purposes of the work, or that it is not in the interest of Her Majesty to retain that plant, material or interest, it shall revert to the Contractor.

G40 Suspension of Work by Minister

- 40.1 The Minister may, when in his opinion it is in the public interest to do so, require the Contractor to suspend performance of the work either for a specified or an unspecified period by giving a notice of suspension in writing to the Contractor in accordance with GC11.
- 40.2 When a notice referred to in GC40.1 is received by the Contractor in accordance with GC11, he shall suspend all operations in respect of the work except those that, in the opinion of the Departmental Representative, are necessary for the care and preservation of the work, plant and material.
- 40.3 The Contractor shall not, during a period of suspension, remove any part of the work, plant or material from its site without the consent of the Departmental Representative.
- 40.4 If a period of suspension is 30 days or less, the Contractor shall, upon the expiration of that period, resume the performance of the work and he is entitled to be paid the extra cost, calculated in accordance with GC48 to GC50, of any labour, plant and material necessarily incurred by him as a result of the suspension.



- 40.5 If, upon the expiration of a period of suspension of more than 30 days, the Minister and the Contractor agree that the performance of the work will be continued by the Contractor, the Contractor shall resume performance of the work subject to any terms and conditions agreed upon by the Minister and the Contractor.
- 40.6 If, upon the expiration of a period of suspension of more than 30 days, the Minister and the Contractor do not agree that performance of the work will be continued by the Contractor or upon the terms and conditions under which the Contractor will continue the work, the notice of suspension shall be deemed to be a notice of termination pursuant to GC41.

GC41 Termination of Contract

- 41.1 The Minister may terminate the contract at any time by giving a notice of termination in writing to the Contractor in accordance with GC11.
- 41.2 When a notice referred to in GC41.1 is received by the Contractor in accordance with GC11, he shall, subject to any conditions stipulated in the notice, forthwith cease all operations in performance of the contract.
- 41.3 If the contract is terminated pursuant to GC41.1, Her Majesty shall pay the Contractor, subject to GC41.4, an amount equal to
- 41.3.1 the cost to the contractor of all labour, plant and material supplied by him under the contract up to the date of termination in respect of a contract or part thereof for which a Unit Price Arrangement is stipulated in the contract, or
 - 41.3.2 the lesser of
 - 41.3.2.1 an amount, calculated in accordance with the Terms and Payment, that would have been payable to the Contractor had he completed the work, and
 - 41.3.2.2 an amount that is determined to be due to the Contractor pursuant to GC49 in respect of a contract or part thereof for which a Fixed Price Arrangement is stipulated in the contract
- less the aggregate of all amounts that were paid to the Contractor by Her Majesty and all amounts that are due to Her Majesty from the Contractor pursuant to the contract.
- 41.4 If Her Majesty and the Contractor are unable to agree about an amount referred to in GC41.3 that amount shall be determined by the method referred to in GC50.

GC42 Claims Against and Obligations of the Contractor or Subcontractor

- 42.1 Her Majesty may, in order to discharge lawful obligations of and satisfy claims against the Contractor or a subcontractor arising out of the performance of the contract, pay any amount that is due and payable to the Contractor pursuant to the contract directly to the obligees of and the claimants against the Contractor or the subcontractor but such amount if any, as is paid by Her Majesty, shall not exceed that amount which the Contractor would have been obliged to pay to



such claimant had the provisions of the Provincial or Territorial lien legislation, or, in the Province of Quebec, the law relating to privileges, been applicable to the work. Any such claimant need not comply with the provisions of such legislation setting out the steps by way of notice, registration or otherwise as might have been necessary to preserve or perfect any claim for lien or privilege which claimant might have had;

- 42.2 Her Majesty will not make any payment as described in GC42.1 unless and until that claimant shall have delivered to Her Majesty:
- 42.2.1 a binding and enforceable Judgment or Order of a court of competent jurisdiction setting forth such amount as would have been payable by the Contractor to the claimant pursuant to the provisions of the applicable Provincial or Territorial lien legislation, or, in the Province of Quebec, the law relating to privileges, had such legislation been applicable to the work; or
 - 42.2.2 a final and enforceable award of an arbitrator setting forth such amount as would have been payable by the Contractor to the claimant pursuant to the provisions of the applicable Provincial or Territorial lien legislation, or, in the Province of Quebec, the law relating to privileges, had such legislation been applicable to the work; or
 - 42.2.3 the consent of the Contractor authorizing a payment.
- For the purposes of determining the entitlement of a claimant pursuant to GC42.2.1 and GC42.2.2, the notice required by GC42.8 shall be deemed to replace the registration or provision of notice after the performance of work as required by any applicable legislation and no claim shall be deemed to have expired, become void or unenforceable by reason of the claimant not commencing any action within the time prescribed by any applicable legislation.
- 42.3 The Contractor shall, by the execution of his contract, be deemed to have consented to submit to binding arbitration at the request of any claimant those questions that need be answered to establish the entitlement of the claimant to payment pursuant to the provisions of GC42.1 and such arbitration shall have as parties to it any subcontractor to whom the claimant supplied material, performed work or rented equipment should such subcontractor wish to be adjoined and the Crown shall not be a party to such arbitration and, subject to any agreement between the Contractor and the claimant to the contrary, the arbitration shall be conducted in accordance with the Provincial or Territorial legislation governing arbitration applicable in the Province or Territory in which the work is located.
- 42.4 A payment made pursuant to GC42.1 is, to the extent of the payment, a discharge of Her Majesty's liability to the Contractor under the contract and may be deducted from any amount payable to the Contractor under the contract.
- 42.5 To the extent that the circumstances of the work being performed for Her Majesty permit, the Contractor shall comply with all laws in force in the Province or Territory where the work is being performed relating to payment period, mandatory holdbacks, and creation and enforcement of mechanics' liens, builders' liens or similar legislation or in the Province of Quebec, the law relating to privileges.
- 42.6 The Contractor shall discharge all his lawful obligations and shall satisfy all lawful claims against him arising out of the performance of the work at least as often as the contract requires Her



Majesty to pay the Contractor.

- 42.7 The Contractor shall, whenever requested to do so by the Departmental Representative, make a statutory declaration deposing to the existence and condition of any obligations and claims referred to in GC42.6.
- 42.8 GC42.1 shall only apply to claims and obligations
- 42.8.1 the notification of which has been received by the Departmental Representative in writing before payment is made to the Contractor pursuant to TP4.10 and within 120 days of the date on which the claimant
- 42.8.1.1 should have been paid in full under the claimant's contract with the Contractor or subcontractor where the claim is for money that was lawfully required to be held back from the claimant; or
- 42.8.1.2 performed the last of the services, work or labour, or furnished the last of the material pursuant to the claimant's contract with the Contractor or subcontractor where the claim is not for money referred to in GC42.8.1.1, and
- 42.8.2 the proceedings to determine the right to payment of which, pursuant to GC42.2. shall have commenced within one year from the date that the notice referred to in GC42.8.1 was received by the Departmental Representative, and
- the notification required by GC42.8.1 shall set forth the amount claimed to be owing and the person who by contract is primarily liable.
- 42.9 Her Majesty may, upon receipt of a notice of claim under GC42.8.1, withhold from any amount that is due and payable to the Contractor pursuant to the contract the full amount of the claim or any portion thereof.
- 42.10 The Departmental Representative shall notify the Contractor in writing of receipt of any claim referred to in GC42.8.1 and of the intention of Her Majesty to withhold funds pursuant to GC42.9 and the Contractor may, at any time thereafter and until payment is made to the claimant, be entitled to post, with Her Majesty, security in a form acceptable to Her Majesty in an amount equal to the value of the claim, the notice of which is received by the Departmental Representative and upon receipt of such security Her Majesty shall release to the Contractor any funds which would be otherwise payable to the Contractor, that were withheld pursuant to the provisions of GC42.9 in respect of the claim of any claimant for whom the security stands.

GC43 Security Deposit – Forfeiture or Return

- 43.1 If
- 43.1.1 the work is taken out of the Contractor's hands pursuant to GC38,
- 43.1.2 the contract is terminated pursuant to GC41, or
- 43.1.3 the Contractor is in breach of or in default under the contract,



Her Majesty may convert the security deposit, if any, to Her own use.

- 43.2 If Her Majesty converts the contract security pursuant to GC43.1, the amount realized shall be deemed to be an amount due from Her Majesty to the Contractor under the contract.
- 43.3 Any balance of an amount referred to in GC43.2 that remains after payment of all losses, damage and claims of Her Majesty and others shall be paid by Her Majesty to the Contractor if, in the opinion of the Departmental Representative, it is not required for the purposes of the contract.

GC44 Departmental Representative's Certificates

44.1 On the date that

44.1.1 the work has been completed, and

44.1.2 the Contractor has complied with the contract and all orders and directions made pursuant thereto,

both to the satisfaction of the Departmental Representative, the Departmental Representative shall issue a Final Certificate of Completion to the Contractor.

44.2 If the Departmental Representative is satisfied that the work is substantially complete he shall, at any time before he issues a certificate referred to in GC44.1, issue an Interim Certificate of Completion to the Contractor, and

44.2.1 for the purposes of GC44.2 the work will be considered to be substantially complete,

44.2.1.1 when the work under the contract or a substantial part thereof is, in the opinion of the Departmental Representative, ready for use by Her Majesty or is being used for the purpose intended; and

44.2.1.2 when the work remaining to be done under the contract is, in the opinion of the Departmental Representative, capable of completion or correction at accost of not more than

44.2.1.2.1 -3% of the first \$500,000, and

44.2.1.2.2 -2% of the next \$500,000, and

44.2.1.2.3 -1% of the balance

of the value of the contract at the time this cost is calculated.

44.3 For the sole purpose of GC44.2.1.2, where the work or a substantial part thereof is ready for use or is being used for the purposes intended and the remainder of the work or a part thereof cannot be completed by the time specified in A2.1, or as amended pursuant to GC36, for reasons beyond the control of the Contractor or where the Departmental Representative and the Contractor agree not to complete a part of the work within the specified time, the cost of that part of the work



which was either beyond the control of the Contractor to complete or the Departmental Representative and the Contractor have agreed not to complete by the time specified shall be deducted from the value of the contract referred to GC44.2.1.2 and the said cost shall not form part of the cost of the work remaining to be done in determining substantial completion.

44.4 An Interim Certificate of Completion referred to in GC44.2 shall describe the parts of the work not completed to the satisfaction of the Departmental Representative and all things that must be done by the Contractor

44.4.1 before a Final Certificate of Completion referred to in GC44.1 will be issued, and

44.4.2 before the 12-month period referred to in GC32.1.2 shall commence for the said parts and all the said things.

44.5 The Departmental Representative may, in addition to the parts of the work described in an Interim Certificate of Completion referred to in GC44.2, require the Contractor to rectify any other parts of the work not completed to his satisfaction and to do any other things that are necessary for the satisfactory completion of the work.

44.6 If the contract or a part thereof is subject to a Unit Price Arrangement, the Departmental Representative shall measure and record the quantities of labour, plant and material, performed, used and supplied by the Contractor in performing the work and shall, at the request of the Contractor, inform him of those measurements.

44.7 The Contractor shall assist and co-operate with the Departmental Representative in the performance of his duties referred to in GC44.6 and shall be entitled to inspect any record made by the Departmental Representative pursuant to GC44.6.

44.8 After the Departmental Representative has issued a Final Certificate of Completion referred to in GC44.1, he shall, if GC44.6 applies, issue a Final Certificate of Measurement.

44.9 A Final Certificate of Measurement referred to in GC44.8 shall

44.9.1 contain the aggregate of all measurements of quantities referred to in GC44.6, and

44.9.2 be binding upon and conclusive between Her Majesty and the Contractor as to the quantities referred to therein.

GC45 Return of Security Deposit

45.1 After an Interim Certificate of Completion referred to in GC44.2 has been issued, Her Majesty shall, if the Contractor is not in breach of or in default under the contract, return to the Contractor all or any part of the security deposit that, in the opinion of the Departmental Representative, is not required for the purposes of the contract.

45.2 After a Final Certificate of Completion referred to in GC44.1 has been issued, Her Majesty shall return to the Contractor the remainder of any security deposit unless the contract stipulates otherwise.



- 45.3 If the security deposit was paid into the Consolidated Revenue Fund of Canada, Her Majesty shall pay interest thereon to the Contractor at a rate established from time to time pursuant to section 21(2) of the Financial Administration Act.

GC46 Clarification of Terms in GC47 to GC50

- 46.1 For the purposes of GC47 to GC50,
- 46.1.1 "Unit Price Table" means the table set out in the Articles of Agreement, and
- 46.1.2 "plant" does not include tools customarily provided by a tradesman in practicing his trade.

GC47 Additions or Amendments to Unit Price Table

- 47.1 Where a Unit Price Arrangement applies to the contract or a part thereof the Departmental Representative and the Contractor may, by an agreement in writing,
- 47.1.1 add classes of labour or material, and units of measurement, prices per unit and estimated quantities to the Unit Price Table if any labour, plant or material that is to be included in the Final Certificate of Measurement referred to in GC44.8 is not included in any class of labour, plant or material set out in the Unit Price Table; or
- 47.1.2 subject to GC47.2 and GC47.3, amend a price set out in the Unit Price Table for any class of labour, plant or material included therein if the Final Certificate of Measurement referred to in GC44.8 shows or is expected to show that the total quantity of that class of labour, plant or material actually performed, used or supplied by the Contractor in performing the work is
- 47.1.2.1 less than 85% of that estimated total quantity, or
- 47.1.2.2 in excess of 115% of that estimated total quantity.
- 47.2 In no event shall the total cost of an item set out in the Unit Price Table that has been amended pursuant to GC47.1.2.1 exceed the amount that would have been payable to the Contractor had the estimated total quantity actually been performed, used or supplied.
- 47.3 An amendment that is made necessary by GC47.1.2.2 shall apply only to the quantities that are in excess of 115%.
- 47.4 If the Departmental Representative and the Contractor do not agree as contemplated in GC47.1, the Departmental Representative shall determine the class and the unit of measurement of the labour, plant or material and, subject to GC47.2 and GC47.3, the price per unit therefore shall be determined in accordance with GC50.

GC48 Determination of Cost – Unit Price Table



- 48.1 Whenever, for the purposes of the contract, it is necessary to determine the cost of labour, plant or material, it shall be determined by multiplying the quantity of that labour, plant or material expressed in the unit set out in column 3 of the Unit Price Table by the price of that unit set out in column 5 of the Unit Price Table.

GC49 Determination of Cost – Negotiation

- 49.1 If the method described in GC48 cannot be used because the labour, plant or material is of a kind or class that is not set out in the Unit Price Table, the cost of that labour, plant or material for the purposes of the contract shall be the amount agreed upon from time to time by the Contractor and the Departmental Representative.
- 49.2 For the purposes of GC49.1, the Contractor shall submit to the Departmental Representative any necessary cost information requested by the Departmental Representative in respect of the labour, plant and material referred to in GC49.1

GC50 Determination of Cost – Failing Negotiation

- 50.1 If the methods described in GC47, GC48 or GC49 fail for any reason to achieve a determination of the cost of labour, plant and material for the purposes referred to therein, that cost shall be equal to the aggregate of
- 50.1.1 all reasonable and proper amounts actually expended or legally payable by the Contractor in respect of the labour, plant and material that falls within one of the classes of expenditure described in GC50.2 that are directly attributable to the performance of the contract,
 - 50.1.2 an allowance for profit and all other expenditures or costs, including overhead, general administration cost, financing and interest charges, and every other cost, charge and expenses, but not including those referred to in GC50.1.1 or GC50.1.3 or a class referred to in GC50.2, in an amount that is equal to 10% of the sum of the expenses referred to in GC50.1.1, and
 - 50.1.3 interest on the cost determined under GC50.1.1 and GC50.1.2, which interest shall be calculated in accordance with TP9,

provide that the total cost of an item set out in the Unit Price Table that is subject to the provisions of GC47.1.2.1 does not exceed the amount that would have been payable to the Contractor had the estimated total quantity of the said item actually be performed, used or supplied.

- 50.2 For purposes of GC50.1.1 the classes of expenditure that may be taken into account in determining the cost of labour, plant and material are,
- 50.2.1 payments to subcontractors;
 - 50.2.2 wages, salaries and travelling expenses of employees of the Contractor while they are actually and properly engaged on the work, other than wages, salaries, bonuses, living



and travelling expenses of personnel of the Contractor generally employed at the head office or at a general office of the Contractor unless they are engaged at the work site with the approval of the Departmental Representative,

- 50.2.3 assessments payable under any statutory authority relating to workmen's compensation, unemployment insurance, pension plan or holidays with pay;
- 50.2.4 rent that is paid for plant or an amount equivalent of the said rent if the plant is owned by the Contractor that is necessary for and used in the performance of the work, if the rent of the equivalent amount is reasonable and use of that plant has been approved by the Departmental Representative;
- 50.2.5 payments for maintaining and operating plant necessary for and used in the performance of the work, and payments for effecting such repairs thereto as, in the opinion of the Departmental Representative, are necessary to the proper performance of the contract other than payments for any repairs to the plant arising out of defects existing before its allocation to the work;
- 50.2.6 payments for material that is necessary for and incorporated in the work, or that is necessary for and consumed in the performance of the contract;
- 50.2.7 payments for preparation, delivery, handling, erection, installation, inspection protection and removal of the plant and material necessary for and used in the performance of the contract; and
- 50.2.8 any other payments made by the Contractor with the approval of the Departmental Representative that are necessary for the performance of the contract.

GC51 Records to be kept by Contractor

51.1 The Contractor shall

- 51.1.1 maintain full records of his estimated and actual cost of the work together with all tender calls, quotations, contracts, correspondence, invoices, receipts and vouchers relating thereto.
- 51.1.2 make all records and material referred to in GC5.1.1 available to audit and inspection by the Minister and the Deputy Receiver General for Canada or by persons acting on behalf of either of both of them, when requested;
- 51.1.3 allow any of the person referred to in GC51.1.2 to make copies of and to take extracts from any of the records and material referred to in GC51.1.1; and
- 51.1.4 furnish any person referred to in GC51.1.2 with any information he may require from time to time in connection with such records and material.

- 51.2 The records maintained by the Contractor pursuant to GC51.1.1 shall be kept intact by the Contractor until the expiration of two years after the date that a Final Certificate of Completion referred to in GC44.1 was issued or until the expiration of such other period of time as the



Minister may direct.

- 51.3 The Contractor shall cause all subcontractors and all other persons directly or indirectly controlled by or affiliated with the Contractor and all persons directly or indirectly having control of the Contractor to comply with GC51.1 and GC51.2 as if they were the Contractor.

GC52 Conflict of Interest

- 52.1 It is a term of this contract that no former public office holder who is not in compliance with the Conflict of Interest and Post-Employment Code for Public Office Holders shall derive a direct benefit from this contract.

GC53 Contractor Status

- 53.1 The Contractor shall be engaged under the contract as an independent contractor.
- 53.2 The Contractor and any employee of the said Contractor is not engaged by the contract as an employee, servant or agent of Her Majesty.
- 53.3 For the purposes of GC53.1 and GC53.2 the Contractor shall be solely responsible for any and all payments and deductions required to be made by law including those required for Canada or Quebec Pension Plans, Unemployment Insurance, Worker's Compensation or Income Tax.



GENERAL CONDITONS

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- IC 2 Risk Management**
- IC 3 Payment of Deductible**
- IC 4 Insurance Coverage**

GENERAL INSUANCE COVERAGES

- GCI 1 Insured**
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- GIC 3 Proof of Insurance**
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COMMERCIAL GENERAL LIABILITY

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BUILDER'S RISK – INSTALLATION FLOATER – ALL RISKS

- BR 1 Scope of Policy**
- BR 2 Property Insured**
- BR 3 Insurance Proceeds**
- BR 4 Amount of Insurance**
- BR 5 Deductible**
- BR 6 Subrogation**
- BR 7 Exclusion Qualifications**

INSURER'S CERTIFICATE OF INSURANCE



General Conditions

IC 1 Proof of Insurance (02/12/03)

Within thirty (30) days after acceptance of the Contractor's tender, the Contractor shall, unless otherwise directed in writing by the Contracting Officer, deposit with the Contracting Officer an Insurer's Certificate of Insurance in the form displayed in this document and, if requested by the Contracting Officer, the originals or certified true copies of all contracts of insurance maintained by the Contractor pursuant to the Insurance Coverage Requirements shown hereunder.

IC 2 Risk Management (01/10/94)

The provisions of the Insurance Coverage Requirements contained hereunder are not intended to cover all of the Contractor's obligations under GC8 of the General Conditions "C" of the contract. Any additional risk management measures or additional insurance coverages the Contractor may deem necessary to fulfill its obligations under GC8 shall be at its own discretion and expense.

IC 3 Payment of Deductible (01/10/94)

The payment of monies up to the deductible amount made in satisfaction of a claim shall be borne by the Contractor.

IC 4 Insurance Coverage (02/12/03)

The Contractor has represented that it has in place and effect the appropriate and usual liability insurance coverage as required by these Insurance Conditions and the Contractor has warranted that it shall obtain, in a timely manner and prior to commencement of the Work, the appropriate and usual property insurance coverage as required by these Insurance Conditions and, further, that it shall maintain all required insurance policies in place and effect as required by these Insurance Conditions.



INSURANCE COVERAGE REQUIREMENTS

PART I GENERAL INSURANCE COVERAGES (GIC)

GCI 1 Insured (02/12/03)

Each insurance policy shall insure the Contractor, and shall include, as an Additional Named Insured, Her Majesty the Queen in right of Canada, represented by the National Research Council Canada.

GIC 2 Period of Insurance (02/12/03)

Unless otherwise directed in writing by the Contracting Officer or otherwise stipulated elsewhere in these Insurance Conditions, the policies required hereunder shall be in force and be maintained from the date of the contract award until the day of issue of the Departmental Representative's Final Certificate of Completion.

GIC 3 Proof of Insurance (01/10/94)

Within twenty five (25) days after acceptance of the Contractor's tender, the Insurer shall, unless otherwise directed by the Contractor, deposit with the Contractor an Insurer's Certificate of Insurance in the form displayed in the document and, if requested, the originals or certified true copies of all contracts of insurance maintained by the Contractor pursuant to the requirements of these Insurance Coverages.

GIC 4 Notification (01/10/94)

Each Insurance policy shall contain a provision that (30) days prior written notice shall be given by the Insurer to Her Majesty in the event of any material change in or cancellation of coverage. Any such notice received by the Contractor shall be transmitted forthwith to Her Majesty.

PART II COMMERCIAL GENERAL LIABILITY

CGL 1 Scope of Policy (01/10/94)

The policy shall be written on a form similar to that known and referred to in the insurance industry as IBC 2100 – Commercial General Liability policy (Occurrence form) and shall provide for limit of liability of not less than \$2,000,000 inclusive for Bodily Injury and Property Damage for any one occurrence or series of occurrences arising out of one cause. Legal or defence cost incurred in respect of a claim or claims shall not operate to decrease the limit of liability.

CGL 2 Coverages/Provisions (01/10/94)



The policy shall include but not necessarily be limited to the following coverages/provisions.

- 2.1 Liability arising out of or resulting from the ownership, existence, maintenance or use of premises by the Contractor and operations necessary or incidental to the performance of this contract.
- 2.2 "Broad Form" Property Damage including the loss of use of property.
- 2.3 Removal or weakening of support of any building or land whether such support be natural or otherwise.
- 2.4 Elevator liability (including escalators, hoists and similar devices).
- 2.5 Contractor's Protective Liability
- 2.6 Contractual and Assumed Liabilities un this contact.
- 2.7 Completed Operations Liability – The insurance, including all aspects of this Part II of these Insurance Conditions shall continue for a period of at least one (1) year beyond the date of the Departmental Representative's Final Certificate of Completion for the Completed Operations.
- 2.8 Cross Liability – The Clause shall be written as follows:

Cross Liability – The insurance as is afforded by this policy shall apply in respect to any claim or action brought against any one Insured by any other Insured. The coverage shall apply in the same manner and to the same extent as though a separate policy had been issued to each Insured. The inclusion herein of more than one Insured shall not increase the limit of the Insurer's liability.

- 2.9 Severability of Interests – The Clause shall be written as follows:

Severability of Interests – This policy, subject to the limits of liability stated herein, shall apply separately to each Insured in the same manner and to the same extent as if a separate policy had been issued to each. The inclusion herein of more than one insured shall not increase the limit of the Insurer's liability.

CGL 3 Additional Exposures (02/12/03)

The policy shall either include or be endorsed to include the following exposures of hazards if the Work is subject thereto:

- 3.1 Blasting
- 3.2 Pile driving and calsson work
- 3.3 Underpinning
- 3.4 Risks associated with the activities of the Contractor on an active airport



- 3.5 Radioactive contamination resulting from the use of commercial isotopes
- 3.6 Damage to the portion of an existing building beyond that directly associated with an addition, renovation or installation contract.
- 3.7 Marine risks associated with the contraction of piers, wharves and docks.

**CGL 4 Insurance Proceeds
(01/10/94)**

Insurance Proceeds from this policy are usually payable directly to a Claimant/Third Party.

**CGL 5 Deductible
(02/12/03)**

This policy shall be issued with a deductible amount of not more than \$10,000 per occurrence applying to Property Damage claims only.

**PART III
BUILDER'S RISK - INSTALLATION FLOATER - ALL RISKS**

**BR 1 Scope of Policy
(01/10/94)**

The policy shall be written on an "All Risks" basis granting coverages similar to those provided by the forms known and referred to in the insurance industry as "Builder's Risk Comprehensive Form" or "Installation Floater - All Risks".

**BR 2 Property Insured
(01/10/94)**

The property insured shall include:

- 2.1 The Work and all property, equipment and materials intended to become part of the finished Work at the site of the project while awaiting, during and after installation, erection or construction including testing.
- 2.2 Expenses incurred in the removal from the construction site of debris of the property insured, including demolition of damaged property, de-icing and dewatering, occasioned by loss, destruction or damage to such property and in respect of which insurance is provided by this policy.

**BR 3 Insurance Proceeds
(01/10/94)**

- 3.1 Insurance proceeds from this policy are payable in accordance with GC28 of the General Conditions "C" of the contract.
- 3.2 This policy shall provide that the proceeds thereof are payable to Her Majesty or as the Minister may direct.



3.3 The Contractor shall do such things and execute such documents as are necessary to effect payment of the proceeds.

BR 4 Amount of Insurance
(01/10/94)

The amount of insurance shall not be less than the sum of the contract value plus the declared value (if any) set forth in the contract documents of all material and equipment supplied by Her Majesty at the site of the project to be incorporated into and form part of the finished Work.

BR 5 Deductible
(02/12/03)

The Policy shall be issued with a deductible amount of not more than \$10,000.

BR 6 Subrogation
(01/10/94)

The following Clause shall be included in the policy:

"All rights of subrogation or transfer of rights are hereby waived against any corporation, firm, individual or other interest, with respect to which, insurance is provided by this policy".

BR 7 Exclusion Qualifications
(01/10/94)

The policy may be subject to the standard exclusions but the following qualifications shall apply:

- 7.1 Faulty materials, workmanship or design may be excluded only to the extent of the cost of making good thereof and shall not apply to loss or damage resulting therefrom.
- 7.2 Loss or damage caused by contamination by radioactive material may be excluded except for loss or damage resulting from commercial isotopes used for industrial measurements, inspection, quality control radiographic or photographic use.
- 7.3 Use and occupancy of the project or any part of section thereof shall be permitted where such use and occupancy is for the purpose for which the project is intended upon completion.



INSURER'S CERTIFICATE OF INSURANCE

(TO BE COMPLETED BY INSURER (NOT BOKER) AND DELIVERD TO NATIONAL RESEARCH COUNCIL CANADA WITH 30 DAYS FOLLOWING ACCEPTANCE OF TENDER)

CONTRACT

DESCRIPTION OF WORK	CONTRACT NUMBER	AWARD DATE
LOCATION		

INSURER

NAME
ADDRESS

BROKER

NAME
ADDRESS

INSURED

NAME OF CONTRACTOR
ADDRESS

ADDITIONAL INSURED

HER MAJESTY THE QUEEN IN RIGHT OF CANADA AS REPRESENTED BY THE NATIONAL RESEARCH COUNCIL CANADA

THIS DOCUENT CERTIFIES THAT THE FOLLOWING POLICES OF INSURANCE ARE AT PRESENT IN FORCE COVERING ALL OPERATIONS OF THE INSURE IN CONNECTION WITH THE CONTRACT MADE BETWEEN THE NAMED INSURED AND THE NATIONAL RESEARCH COUNCIL CANADA AND IN ACCORDANCE WITH THE INSURANCE CONDITIONS "E"

POLICY					
TYPE	NUMBER	INCEPTION DATE	EXPIRY DATE	LIMITS OF LIABILITY	DEDUCTIBLE
COMMERCIAL GENERAL LIABILITY					
BUILDERS RISK "AL RISKS"					
INSTALLATION FLOATER "ALL RISKS"					

THE INSURER AGREES TO NOTIFY THE NATIONAL RESEARCH COUNCIL CANADA IN WRITING 30 DAYS PRIOR TO ANY MATERIAL CHANGE IN OR CANCELLATION OF ANY POLICY OR COVERAGE SPECIFICALLY RELATED TO THE CONTRACT

NAME OF INSURER'S OFFICER OR AUTHORIZED EMPLOYEE	SIGNATURE	DATE:
		TELEPHONE NUMBER:

ISSUANCE OF THIS CERTIFIATE SHALL NOT LIMIT OR RESTRICT THE RIGHT OF THE NATIONAL RESEARCH COUNCIL CANADA TO REQUEST AT ANY TIME DUPLICATE COPIES OF SAID INSURANCE POLICIES



CS1 Obligation to provide Contract Security

- 1.1 The Contractor shall, at the Contractor's own expense, provide one or more of the forms of contract security prescribed in CS2.
- 1.2 The Contractor shall deliver to the Departmental Representative the contract security referred to in CS1.1 within 14 days after the date that the Contractor receives notice that the Contractor's tender or offer was accepted by Her Majesty.

CS2 Prescribed Types and Amounts of Contract Security

- 2.1 The Contractor shall deliver to the Departmental Representative pursuant to CS1
 - 2.1.1 a performance bond and a labour and material payment bond each in an amount that is equal to not less than 50% of the contract amount referred to in the Articles of Agreement, or
 - 2.1.2 a labour and material payment bond in an amount that is equal to not less than 50% of the contract amount referred to in the Articles of Agreement, and a security deposit in an amount that is equal to
 - 2.1.2.1 not less than 10% of the contract amount referred to in the Articles of Agreement where that amount does not exceed \$250,000, or
 - 2.1.2.2 \$25,000 plus 5% of the part of the contract amount referred to in the Articles of Agreement that exceeds \$250,000, or
 - 2.1.3 a security deposit in an amount prescribed by CS2.12 plus an additional amount that is equal to 10% of the contract amount referred to in the Articles of Agreement.
- 2.2 A performance bond and a labour and material payment bond referred to in CS2.1 shall be in a form and be issued by a bonding or surety company that is approved by Her Majesty.
- 2.3 The amount of a security deposit referred to in CS2.1.2 shall not exceed \$250,000 regardless of the contract amount referred to in the Articles of Agreement.
- 2.4 A security deposit referred to in CS2.1.2 and CS2.1.3 shall be in the form of
 - 2.4.1 a bill of exchange made payable to the Receiver General of Canada and certified by an approved financial institution or drawn by an approved financial institution on itself, or
 - 2.4.2 bonds of or unconditionally guaranteed as to principal and interest by the Government of Canada.
- 2.5 For the purposes of CS2.4
 - 2.5.1 a bill of exchange is an unconditional order in writing signed by the Contractor and addressed to an approved financial institution, requiring the said institution to pay, on demand, at a fixed or determinable future time a sum certain of money to, or to the order



of, the Receiver General for Canada, and

- 2.5.2 If a bill of exchange is certified by a financial institution other than a chartered bank then it must be accompanied by a letter or stamped certification confirming that the financial institution is in at least one of the categories referred to in CS2.5.3
- 2.5.3 an approved financial institution is
 - 2.5.3.1 any corporation or institution that is a member of the Canadian Payments Association,
 - 2.5.3.2 a corporation that accepts deposits that are insured by the Canada Deposit Insurance Corporation or the Régie de l'assurance-dépôts du Québec to the maximum permitted by law,
 - 2.5.3.3 a credit union as defined in paragraph 137(6)(b) of the *Income Tax Act*,
 - 2.5.3.4 a corporation that accepts deposits from the public, if repayment of the deposit is guaranteed by Her Majesty in right of a province, or
 - 2.5.3.5 The Canada Post Corporation.
- 2.5.4 the bonds referred to in CS2.4.2 shall be
 - 2.5.4.1 made payable to bearer, or
 - 2.5.4.2 accompanied by a duly executed instrument of transfer of the bonds to the Receiver General for Canada in the form prescribed by the Domestic Bonds of Canada Regulations, or
 - 2.5.4.3 registered, as to principal or as to principal and interest in the name of the Receiver General for Canada pursuant to the Domestic Bonds of Canada Regulations, and
 - 2.5.4.4 provided on the basis of their market value current at the date of the contract.



Contract Number / Numéro du contrat
Security Classification / Classification de sécurité

**SECURITY REQUIREMENTS CHECK LIST (SRCL)
LISTE DE VÉRIFICATION DES EXIGENCES RELATIVES À LA SÉCURITÉ (LVERS)**

PART A - CONTRACT INFORMATION / PARTIE A - INFORMATION CONTRACTUELLE

1. Originating Government Department or Organization / Ministère ou organisme gouvernemental d'origine	2. Branch or Directorate / Direction générale ou Direction	
3. a) Subcontract Number / Numéro du contrat de sous-traitance	3. b) Name and Address of Subcontractor / Nom et adresse du sous-traitant	
4. Brief Description of Work / Brève description du travail		
5. a) Will the supplier require access to Controlled Goods? Le fournisseur aura-t-il accès à des marchandises contrôlées? <input type="checkbox"/> No / Non <input type="checkbox"/> Yes / Oui		
5. b) Will the supplier require access to unclassified military technical data subject to the provisions of the Technical Data Control Regulations? Le fournisseur aura-t-il accès à des données techniques militaires non classifiées qui sont assujetties aux dispositions du Règlement sur le contrôle des données techniques? <input type="checkbox"/> No / Non <input type="checkbox"/> Yes / Oui		
6. Indicate the type of access required / Indiquer le type d'accès requis		
6. a) Will the supplier and its employees require access to PROTECTED and/or CLASSIFIED information or assets? Le fournisseur ainsi que les employés auront-ils accès à des renseignements ou à des biens PROTÉGÉS et/ou CLASSIFIÉS? (Specify the level of access using the chart in Question 7. c) (Préciser le niveau d'accès en utilisant le tableau qui se trouve à la question 7. c) <input type="checkbox"/> No / Non <input type="checkbox"/> Yes / Oui		
6. b) Will the supplier and its employees (e.g. cleaners, maintenance personnel) require access to restricted access areas? No access to PROTECTED and/or CLASSIFIED information or assets is permitted. Le fournisseur et ses employés (p. ex. nettoyeurs, personnel d'entretien) auront-ils accès à des zones d'accès restreintes? L'accès à des renseignements ou à des biens PROTÉGÉS et/ou CLASSIFIÉS n'est pas autorisé. <input type="checkbox"/> No / Non <input type="checkbox"/> Yes / Oui		
6. c) Is this a commercial courier or delivery requirement with no overnight storage? S'agit-il d'un contrat de messagerie ou de livraison commerciale sans entreposage de nuit? <input type="checkbox"/> No / Non <input type="checkbox"/> Yes / Oui		
7. a) Indicate the type of information that the supplier will be required to access / Indiquer le type d'information auquel le fournisseur devra avoir accès		
Canada <input type="checkbox"/>	NATO / OTAN <input type="checkbox"/>	Foreign / Étranger <input type="checkbox"/>
7. b) Release restrictions / Restrictions relatives à la diffusion		
No release restrictions Aucune restriction relative à la diffusion <input type="checkbox"/>	All NATO countries Tous les pays de l'OTAN <input type="checkbox"/>	No release restrictions Aucune restriction relative à la diffusion <input type="checkbox"/>
Not releasable À ne pas diffuser <input type="checkbox"/>		
Restricted to: / Limité à : <input type="checkbox"/> Specify country(ies): / Préciser le(s) pays :	Restricted to: / Limité à : <input type="checkbox"/> Specify country(ies): / Préciser le(s) pays :	Restricted to: / Limité à : <input type="checkbox"/> Specify country(ies): / Préciser le(s) pays :
7. c) Level of information / Niveau d'information		
PROTECTED A PROTÉGÉ A <input type="checkbox"/>	NATO UNCLASSIFIED NATO NON CLASSIFIÉ <input type="checkbox"/>	PROTECTED A PROTÉGÉ A <input type="checkbox"/>
PROTECTED B PROTÉGÉ B <input type="checkbox"/>	NATO RESTRICTED NATO DIFFUSION RESTREINTE <input type="checkbox"/>	PROTECTED B PROTÉGÉ B <input type="checkbox"/>
PROTECTED C PROTÉGÉ C <input type="checkbox"/>	NATO CONFIDENTIAL NATO CONFIDENTIEL <input type="checkbox"/>	PROTECTED C PROTÉGÉ C <input type="checkbox"/>
CONFIDENTIAL CONFIDENTIEL <input type="checkbox"/>	NATO SECRET NATO SECRET <input type="checkbox"/>	CONFIDENTIAL CONFIDENTIEL <input type="checkbox"/>
SECRET SECRET <input type="checkbox"/>	COSMIC TOP SECRET COSMIC TRÈS SECRET <input type="checkbox"/>	SECRET SECRET <input type="checkbox"/>
TOP SECRET TRÈS SECRET <input type="checkbox"/>		TOP SECRET TRÈS SECRET <input type="checkbox"/>
TOP SECRET (SIGINT) TRÈS SECRET (SIGINT) <input type="checkbox"/>		TOP SECRET (SIGINT) TRÈS SECRET (SIGINT) <input type="checkbox"/>

Security Classification / Classification de sécurité
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Contract Number / Numéro du contrat
Security Classification / Classification de sécurité

PART A (continued) / PARTIE A (suite)

8. Will the supplier require access to PROTECTED and/or CLASSIFIED COMSEC information or assets?
 Le fournisseur aura-t-il accès à des renseignements ou à des biens COMSEC désignés PROTÉGÉS et/ou CLASSIFIÉS? No / Non Yes / Oui
 If Yes, indicate the level of sensitivity:
 Dans l'affirmative, indiquer le niveau de sensibilité :

9. Will the supplier require access to extremely sensitive INFOSEC information or assets?
 Le fournisseur aura-t-il accès à des renseignements ou à des biens INFOSEC de nature extrêmement délicate? No / Non Yes / Oui
 Short Title(s) of material / Titre(s) abrégé(s) du matériel :
 Document Number / Numéro du document :

PART B - PERSONNEL (SUPPLIER) / PARTIE B - PERSONNEL (FOURNISSEUR)

10. a) Personnel security screening level required / Niveau de contrôle de la sécurité du personnel requis

<input type="checkbox"/> RELIABILITY STATUS COTE DE FIABILITÉ	<input type="checkbox"/> CONFIDENTIAL CONFIDENTIEL	<input type="checkbox"/> SECRET SECRET	<input type="checkbox"/> TOP SECRET TRÈS SECRET
<input type="checkbox"/> TOP SECRET-SIGINT TRÈS SECRET - SIGINT	<input type="checkbox"/> NATO CONFIDENTIAL NATO CONFIDENTIEL	<input type="checkbox"/> NATO SECRET NATO SECRET	<input type="checkbox"/> COSMIC TOP SECRET COSMIC TRÈS SECRET
<input type="checkbox"/> SITE ACCESS ACCÈS AUX EMBLEMES			

Special comments:
 Commentaires spéciaux : _____

NOTE: If multiple levels of screening are identified, a Security Classification Guide must be provided.
 REMARQUE : Si plusieurs niveaux de contrôle de sécurité sont requis, un guide de classification de la sécurité doit être fourni.

10. b) May unscreened personnel be used for portions of the work?
 Du personnel sans autorisation sécuritaire peut-il se voir confier des parties du travail? No / Non Yes / Oui
 If Yes, will unscreened personnel be escorted?
 Dans l'affirmative, le personnel en question sera-t-il escorté? No / Non Yes / Oui

PART C - SAFEGUARDS (SUPPLIER) / PARTIE C - MESURES DE PROTECTION (FOURNISSEUR)

INFORMATION / ASSETS / RENSEIGNEMENTS / BIENS

11. a) Will the supplier be required to receive and store PROTECTED and/or CLASSIFIED information or assets on its site or premises?
 Le fournisseur sera-t-il tenu de recevoir et d'entreposer sur place des renseignements ou des biens PROTÉGÉS et/ou CLASSIFIÉS? No / Non Yes / Oui

11. b) Will the supplier be required to safeguard COMSEC information or assets?
 Le fournisseur sera-t-il tenu de protéger des renseignements ou des biens COMSEC? No / Non Yes / Oui

PRODUCTION

11. c) Will the production (manufacture, and/or repair and/or modification) of PROTECTED and/or CLASSIFIED material or equipment occur at the supplier's site or premises?
 Les installations du fournisseur serviront-elles à la production (fabrication et/ou réparation et/ou modification) de matériel PROTÉGÉ et/ou CLASSIFIÉ? No / Non Yes / Oui

INFORMATION TECHNOLOGY (IT) MEDIA / SUPPORT RELATIF À LA TECHNOLOGIE DE L'INFORMATION (TI)

11. d) Will the supplier be required to use its IT systems to electronically process, produce or store PROTECTED and/or CLASSIFIED information or data?
 Le fournisseur sera-t-il tenu d'utiliser ses propres systèmes informatiques pour traiter, produire ou stocker électroniquement des renseignements ou des données PROTÉGÉS et/ou CLASSIFIÉS? No / Non Yes / Oui

11. e) Will there be an electronic link between the supplier's IT systems and the government department or agency?
 Disposera-t-on d'un lien électronique entre le système informatique du fournisseur et celui du ministère ou de l'agence gouvernementale? No / Non Yes / Oui



PART C - (continued) / PARTIE C - (suite)

For users completing the form **manually** use the summary chart below to indicate the category(ies) and level(s) of safeguarding required at the supplier's site(s) or premises.

Les utilisateurs qui remplissent le formulaire **manuellement** doivent utiliser le tableau récapitulatif ci-dessous pour indiquer, pour chaque catégorie, les niveaux de sauvegarde requis aux installations du fournisseur.

For users completing the form **online** (via the Internet), the summary chart is automatically populated by your responses to previous questions.

Dans le cas des utilisateurs qui remplissent le formulaire **en ligne** (par Internet), les réponses aux questions précédentes sont automatiquement saisies dans le tableau récapitulatif.

SUMMARY CHART / TABLEAU RÉCAPITULATIF

Category Catégorie	PROTECTED PROTÉGÉ			CLASSIFIED CLASSIFIÉ			NATO				COMSEC					
	A	B	C	CONFIDENTIAL CONFIDENTIEL	SECRET	TOP SECRET TRÈS SECRET	NATO RESTRICTED NATO DIFFUSION RESTREINTE	NATO CONFIDENTIAL NATO CONFIDENTIEL	NATO SECRET	COSMIC TOP SECRET COSMIC TRÈS SECRET	PROTECTED PROTÉGÉ			CONFIDENTIAL CONFIDENTIEL	SECRET	TOP SECRET TRÈS SECRET
											A	B	C			
Information / Assets Renseignements / Biens Production																
IT Media / Support TI																
IT Link / Lien électronique																

12. a) Is the description of the work contained within this SRCL PROTECTED and/or CLASSIFIED? No Yes
 La description du travail visé par la présente LVERS est-elle de nature PROTÉGÉE et/ou CLASSIFIÉE? Non Oui

If Yes, classify this form by annotating the top and bottom in the area entitled "Security Classification".
Dans l'affirmative, classifiez le présent formulaire en indiquant le niveau de sécurité dans la case intitulée « Classification de sécurité » au haut et au bas du formulaire.

12. b) Will the documentation attached to this SRCL be PROTECTED and/or CLASSIFIED? No Yes
 La documentation associée à la présente LVERS sera-t-elle PROTÉGÉE et/ou CLASSIFIÉE? Non Oui

If Yes, classify this form by annotating the top and bottom in the area entitled "Security Classification" and indicate with attachments (e.g. SECRET with Attachments).
Dans l'affirmative, classifiez le présent formulaire en indiquant le niveau de sécurité dans la case intitulée « Classification de sécurité » au haut et au bas du formulaire et indiquez qu'il y a des pièces jointes (p. ex. SECRET avec des pièces jointes).



Contract Number / Numéro du contrat
Security Classification / Classification de sécurité

PART D - AUTHORIZATION / PARTIE D - AUTORISATION

13. Organization Project Authority / Chargé de projet de l'organisme			
Name (print) - Nom (en lettres moulées)		Title - Titre	Signature
Telephone No. - N° de téléphone	Facsimile No. - N° de télécopieur	E-mail address - Adresse courriel	Date
14. Organization Security Authority / Responsable de la sécurité de l'organisme			
Name (print) - Nom (en lettres moulées)		Title - Titre	Signature
Telephone No. - N° de téléphone	Facsimile No. - N° de télécopieur	E-mail address - Adresse courriel	Date
15. Are there additional instructions (e.g. Security Guide, Security Classification Guide) attached? Des instructions supplémentaires (p. ex. Guide de sécurité, Guide de classification de la sécurité) sont-elles jointes?			<input type="checkbox"/> No / Non <input type="checkbox"/> Yes / Oui
16. Procurement Officer / Agent d'approvisionnement			
Name (print) - Nom (en lettres moulées) Collin Long		Title - Titre Senior Contracting Officer	Signature
Telephone No. - N° de téléphone	Facsimile No. - N° de télécopieur	E-mail address - Adresse courriel Collin.Long@nrc-cnrc.gc.ca	Date
17. Contracting Security Authority / Autorité contractante en matière de sécurité			
Name (print) - Nom (en lettres moulées)		Title - Titre	Signature
Telephone No. - N° de téléphone	Facsimile No. - N° de télécopieur	E-mail address - Adresse courriel	Date

Security Classification / Classification de sécurité
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