NRC·CNRC Administrative Services and Property Management

SPECIFICATIONS

SOLICITATION #: 20-58034

BUILDING: NRC-Mississauga
2620 Speakman Drive
Mississauga, Ontario

PROJECT: NRC-MISSISSAUGA Fit-Up Project

PROJECT #: IMC0248

Date: June 2020

National Research Council Canada | Conseil national de recherches Canada

Canada

SPECIFICATION

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National Research Council Canada	Conseil national de recherches Canada
Administrative Services & Property management Branch (ASPM)	Direction des services administratif et gestion de l'immobilier (SAGI)

Construction Tender Form

Project Identification **Mississauga- Fit-Up Project**

Tender No.: **20-58034**

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 Her Majesty the Queen in Right of Canada (hereinafter referred to as "Her 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.

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 servives 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 Her Majesty to forfeit the security deposit.

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

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)

1.10 Execution of Tender

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

The cost breakdown must be included with your bid at closing date. Failure to include this may result in your bid being disqualified.

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

National Research Council Canada | Conseil national de recherches Canada

COST BREAKDOWN FOR FIXED PRICE CONTRACT

Project Title	Tender no.	Page ___ of ___

Item No.	Description	Value of Item

Breakdown shown above is subject to review/revision and approval by NRC after contract award for the purposes of establishing monthly invoicing.

Contractor	Date	Authorized Signature	Date

Canada

APPENDIX 5 - QUALIFICATIONS FORM

MANDATORY QUALIFICATIONS AND SUBMISSIONS
"Attachment no. ONE - QUALIFICATIONS"

Any Bid that fails to submit the required information as listed below or fails to meet any of the mandatory qualifications herein shall be declared non-compliant and shall receive no further consideration. In the event that a bid is non-compliant with all mandatory qualifications and submissions, Attachment no. Two – PRICE, will be returned unopened.

Evaluation of Requirements;
A summary of the evaluation SCALES are in the following table.
To be considered further, Bidders must achieve a pass rating of the indicated criterion, or criterion sub-element;

Criterion	Evaluation SCALE
Bidder's Qualifications	Scale 1
Bidder's Experience in Explosion Rated Environment	Scale 2
Planning / Scheduling	Scale 3

The following information and associated forms must be included as part of the bid submission in "Attachment no. One - Qualifications".

1. BIDDER'S QUALIFICATIONS

a. Each bidder must provide three (3) projects completed by the bidder within the last five (5) years demonstrating previous experience on projects of similar context, scale, scope, and complexity specifically related to this tender scope. Projects must have been a minimum value of $ 800,000.00. These forms must be included as part of the bid submission in "Attachment no. One - QUALIFICATIONS".
b. Each bidder must certify that they are, or have team members with minimum of 5 years' experience in applications of products, systems and assemblies specified and with approval of Product manufacturers. These forms must be included as part of the bid submission in "Attachment no. One - QUALIFICATIONS".

i. Form No. 1 – Bidders' Experience in Installation
ii. Form No. 2 – Bidders certification of Minimum Experience.

The above Form No. 1 criteria will be evaluated in accordance with Scale 1.

2. BIDDER'S EXPERIECE IN EXPLOSION RATED ENVIRONMENT

a. Each Bidder must provide with their bid, one (1) similar project that contains EX-approved environment. Bidders must provide documentation of achieving compliance of ASHRAE and/or EU certification. Bidders must complete the forms included herein or a facsimile that includes all of the information contained therein. These forms must be included as part of the bid submission in "Attachment no. One - QUALIFICATIONS".

i. **Form No. 3 – Bidders' Experience in Explosion Rated Environment**

The above Form No. 3 criteria will be evaluated in accordance with Scale 2.

3. PLANNING / SCHEDULING

a. The bidder shall provide a detailed production and installation schedule with a duration of no more than 17 weeks total. This schedule shall include all the milestones, proper sequencing, shop drawing production / submission / review timeframe, coordination and connections with base building systems, and hand-over dates for each lab module. This schedule must be included as part of the bid submission in "Attachment no. One - QUALIFICATIONS".

The above schedule criteria will be evaluated in accordance with Scale 3.

APPENDIX 5 - QUALIFICATIONS FORM

FORM No. 1
BIDDERS' EXPERIENCE IN INSTALLATION
(THIS FORM OR A COPY IDENTICAL IN CONTENT & FORMAT, MUST BE INCLUDED IN Attachment no. 1 – QUALIFICATIONS)

Company Name : _____

Title of Project: _____

Name and Location of Work (Municipality and Province): _____

Final Completion Date: _____

Final Value of all Work: _____

Contact Name of Project Client: _____

E-mail address & Telephone of Project Client: _____

Description of Project and Scope of Services;

_____

This is to certify that we acted as the Bidder for the project referenced above.

_____
Signature

The following must be completed by the Project Client of the project described under Form 1

Date_____

This confirms that _____(insert name of Installer) completed the project on our location _____
(insert name and address of PROJECT) valued at $_____.00 (submit the Construction work value, taxes extra). The work carried out on this project has been completed to our satisfaction within the contract terms and conditions, schedule and agreed budget.

_____

Signed by the Project Client's Responsible Authority or Project Consultant Engineer

_____

Name of the Project Client

_____

Telephone Number

Please be advised that NRC reserves the right to contact the person named above to verify the information contained herein

APPENDIX 5 - QUALIFICATIONS FORM

SCALE 1
BIDDERS' EXPERIENCE IN INSTALLATION

Evaluated Items	Pass or Fail
Similar Project No. 1	
Similar Project No. 2	
Similar Project No. 3	

APPENDIX 5 - QUALIFICATIONS FORM

FORM No. 2
BIDDER'S CERTIFICATION OF MINIMUM EXPERIENCE

(THIS FORM OR A COPY IDENTICAL IN CONTENT & FORMAT, MUST BE INCLUDED IN Attachment no. 1 - QUALIFICATIONS)

The Bidder hereby certifies that they are or have team members with minimum of 5 years' experience in applications of products, systems and assemblies specified and with approval of Product manufacturers.

_____ Dated _____

Signature

APPENDIX 5 - QUALIFICATIONS FORM

FORM No. 3
BIDDERS' EXPERIENCE IN EXPLOSION RATED ENVIRONMENT
(THIS FORM OR A COPY IDENTICAL IN CONTENT & FORMAT, MUST BE INCLUDED IN Attachment no. 1 – QUALIFICATIONS)

Company Name : _____

Title of Project: _____

Name and Location of Work (Municipality and Province): _____

Final Completion Date: _____

Final Value of all Work: _____

Contact Name of Project Client: _____

E-mail address & Telephone of Project Client: _____

Description of Project and Scope of Services;

_____

This is to certify that we acted as the Bidder for the project referenced above.

_____
Signature

The following must be completed by the Project Client of the project described under Form 3

Date_____

This confirms that _____(insert name of Installer) completed the project on our location _____
(insert name and address of PROJECT) valued at $_____.00 (submit the Construction work value, taxes extra). The work carried out on this project has been completed to our satisfaction within the contract terms and conditions, schedule and agreed budget.

_____

Signed by the Project Client's Responsible Authority or Project Consultant Engineer

_____

Name of the Project Client

_____

Telephone Number

Please be advised that NRC reserves the right to contact the person named above to verify the information contained herein

APPENDIX 5 - QUALIFICATIONS FORM

SCALE 2
BIDDERS' EXPERIENCE EXPLOSION RATED ENVIRONMENT

Evaluated Items	Pass or Fail
Project No. 1 – Explosion Rated Environment	

APPENDIX 5 - QUALIFICATIONS FORM

SCALE 3
PLANNING / SCHEDULING

Evaluated Items	Pass or Fail
Schedule Completeness	
Indicated Milestones	
Proper Sequencing	
Shop Drawing Processes	
Base Building Coordination and Connections	
Coordination with Fume hoods/Casework installer	
Lab Module Connection/Hand-over	

BUY AND SELL NOTICE

NRC-Mississauga, Fit-Up Project

You are invited to submit one copy of a Technical Proposal and one copy of a Financial Proposal in two separate email attachment to fulfil the following requirement forming part of this Tender. One attachment **must** be clearly indicated 'Technical Proposal' and the other attachment **must** be marked 'Financial Proposal'. All financial information **must** be fully contained in the Financial Proposal, and only in the Financial Proposal. Vendors who provide financial information in the technical proposal will be disqualified.

Work under this contract covers Mechanical/Electrical modifications of NRC-Mississauga Building, located at 2620 Speakman Drive, Mississauga, Ontario of the National Research Council Canada.

Complete bid packages will only be accepted via email to:

alain.leroux@nrc-cnrc.gc.ca

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 Buyandsell.gc.ca TMA services provider. Addenda, when issued, will be available from the Buyandsell.gc.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.

The cost breakdown must be included with your bid at closing date. Failure to include this may result in your bid being disqualified.

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 6th, 2020 and July 8th, 2020 at 9:00 am. Meet Scott Jansen at Mississauga Building, Main Entrance, 2620 Speakman Drive Missisauga, ON. 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.**

* Due to COVID-19, we are taking additional measures to protect you and our employees at the site visits.

- To allow NRC to prepare for the site visits, all proponents are asked to pre-register 48 hours ahead of the job showing. Please register by emailing Masood JahanMir (Masood.jahanmir@nrc-cnrc.gc.ca). Proponents shall provide contact name, email and phone number of person attending.

- At the site visit, to limit contact and risks:

    - The proponents will stay and wait in their vehicle until being called to the site visit meeting point by the NRC Departmental Representative.

    - The proponents will not be asked to sign the Attendance Form. Upon arrival at the site visit meeting point, The NRC Departmental Representative will gather the proponent's identification and contact information verbally and mark it down on the Attendance Form on their behalf. It is the responsibility of all proponents to provide their identification and contact information as mandatory proof of attendance.

    - The proponents will sanitize their hands at the hand sanitizing station.

    - The site visit will proceed with a maximum of three (3) proponents at a time. Each group will have approximate 60 minutes to review the site. The site visit will continue with the next round of three (3) proponents until each one has had a chance to review the site.

    - The site visits will take longer than usual, therefore anticipate a longer meeting duration.

    - Physical distancing: keeping a distance of at least 2 arms-length (approximately 2 metres) from others is imperative.

- Depending on the anticipated amount of pre-registration, the NRC may decide to schedule time slots for every group of three (3) proponents. The time slot for your site visit will be confirmed by the NRC Departmental Representative by email upon pre-registration. That time will supersede the site visit meeting time specified above.

- Proposals submitted by bidders who have not attended the site visit or failed to submit their identification and contact information verbally at the site visit will be deemed non-responsive.

3. **CLOSING DATE**

Closing date is July 24th, 2020 at 14:00.

4. TENDER RESULTS

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

5.1 MANDATORY SECURITY REQUIREMENT:

This procurement contains a mandatory security requirement as follows:

1 The Contractor must, at all times during the performance of the Contract, hold a valid Designated Organization Screening (DOS), issued by the Canadian Industrial Security Director (CISD), Public Works Government Services Canada.

2 The Contractor personnel requiring access to sensitive work site(s) must EACH hold a valid RELIABILITY STATUS, granted or approved by CISD/PWGSC.

3 The Contractor must comply with the provisions of the:
a. Security Requirements Checklist attached at Appendix "D"
b. Industrial Security Manual (Latest Edition) available at: http://ssi-iss.tpsgc-pwgsc.gc.ca/ssi-iss-services/eso-oss-eng.html

5.2 VERIFICATION OF SECURITY CLEARANCE AT BID CLOSING

1 The Bidder must hold a valid Designated Organization Screening (DOS) issued by the Canadian Industrial Security Directorate (CISD), Public Works and Government Services Canada (PWGSC), TO BE INCLUDED WITH THEIR TENDER OR PROVIDED WITHIN 48 HOURS FROM THE DATE AND TIME OF TENDER CLOSING. Verifications will be made through CISD to confirm the security clearance status of the Bidder. Failure to comply with this requirement will render the bid non-compliant and no further consideration will be given to the bid.

2 Within 72 hours of tender closing, the General Contractor must name all of his sub-contractors, each of whom must hold a valid RELIABILITY STATUS, granted or approved by CISD/PWGSC, or any other Federal Department or Agency along with the names and birthdates or security clearance certificate numbers of all personnel who will be assigned to the project.

3 It is to be noted that any subcontractor required to perform any part of the work during the performance of the subsequent contract must also adhere to the mandatory security requirement of the contract. As well, no personnel without the required level of security will be allowed on site. It will be the responsibility of the successful bidder to ensure that the security requirement is met throughout the performance of the contract. The Crown will not be held liable or accountable for any delays or additional costs associated with the contractor's non-compliance to the mandatory security requirement. Failure to comply with the mandatory security requirement will be grounds for being declared in default of contract.

4 For any enquiries concerning the project security requirement during the bidding period, the Bidder/Tenderer must contact the Security Officer @ 613-993-8956.

6.0 WSIB (WORKPLACE SAFETY AND INSURANCE BOARD)

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

7.0 OFFICE OF THE PROCUREMENT OMBUDSMAN

1) Clause for solicitation documents and regret letters for unsuccessful bidders

The Office of the Procurement Ombudsman (OPO) was established by the Government of Canada to

provide an independent venue for Canadian bidders to raise complaints regarding the award of federal

contracts under $25,300 for goods and under $101,100 for services. Should you have any issues or concerns regarding the award of a federal contract below these dollar amounts, contact OPO by e-mail at boa.opo@boa-opo.gc.ca, by telephone at 1-866-734-5169, or by web at www.opo-boa.gc.ca. For more information about OPO, including the available services, please visit the OPO website.

2) Contract Clauses -Dispute Resolution

The Parties agree to make every reasonable eff01i, in good faith, to settle amicably all disputes or claims

relating to or arising from the Contract, through negotiations between the Parties' representatives authorized to settle. If the Parties do not reach a settlement within 10 working days, each party hereby consents to fully participate in ai1d bear the cost of mediation led by the Procurement Ombudsman pt1rsuai1t to Subsection 22.1(3)(d) of the *Department of Public Work and Government Services Act and Section 23 of the Procurement Ombudsman Regulations.*

The Office of the Procurement Ombudsman may be contacted by telephone at 1-866-734-5169, by e-mail at boa.opo@boa-opo.gc.ca, or by web at www.opo-boa.gc.ca.

3) Contract clause -Contract Administration

he 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 complainant respecting the administration of the 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.

To file a complaint, the Office of the Procurement Ombudsmai1 may be contacted by e-mail at

boa.opo@boa-opo.gc.ca, by telephone at 1-866-734-5169, or by web at www.opo-boa.gc.ca.

The Departmental Representative or his designate for this project is: Scott Jansen
Telephone: **613 852-1357.**

Contracting Authority for this project is: **Alain Leroux alain.leroux@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
Alain Leroux, Senior Contracting Officer

alain.leroux@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 coloured 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 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.

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

alain.leroux@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) a certified cheque payable to the Receiver General for Canada and drawn on a member of the Canadian Payments Association or a local cooperative credit society that is a member of a central cooperative credit society having membership in the Canadian Payments Association; **OR**

ii) bonds of the Government of Canada, or bonds unconditionally guaranteed as to principal and interest by the Government of Canada; **OR**

iii) 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.

2a) 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 Security must be in the ORIGINAL form. Fax or photocopies and NOT acceptable. FAILURE TO PROVIDE THE REQUIRED BID SECURITY SHALL INVALIDATE THE TENDER.

2b) If the tender is not accepted, the Bid Security submitted pursuant to Article 8 shall be returned to the tenderer.

3a) 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 amout 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.

3b) Should it not be possible to obtain a Labour Material Payment Bond as required under 3(a) above, on making application thereof to at least two acceptable Bonding Companies, an additional Security Deposit of a straight 10% of the amount payable under the contract must be furnished.

3c) Where a tender has been accompanied by a Security Deposit, as described in 1(b) above, the amount of the Security Deposit required under 3(a) above may be reduced by the amount of the Security Deposit which accompanied the tender.

3d) 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 6 – Interest On Security Deposits

1) Tenderers are notified that they must make their own arrangements with their bankers as to the interest, if any, on the amount of the certified cheque accompanying their tender. The Council will not pay interest on said cheque pending the awarding of the contract nor be responsible for the payments of interest under any arrangement made by the tenderers.

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.

2) 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 does not bind itself to accept the lowest or any tender.

Article 12 – Harmonized Sales Tax

1) The Harmonized Sales Tax (HST) which in 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.

Non-resident contractors

RST guide 804
Published August 2006
ISBN: 1-4249-2007-8 (Print), **1-4249-2009-4 (PDF), 1-4249-2008-6 (HTML)**

Publication Archived

Notice to the reader: For Retail Sales Tax (RST) – On July 1, 2010 the 13 per cent Harmonized Sales Tax (HST) took effect in Ontario replacing the existing provincial Retail Sales Tax (RST) and combining it with the federal Goods and Services Tax (GST). As a result, RST provisions described on this page and in other publications ended on June 30, 2010.

Effective July 1, 2010 this publication was archived for RST purposes **only**. Use caution when you refer to it, since it reflects the law in force for RST at the time it was released and may no longer apply.

- The information in this Guide explains the Retail Sales Tax (RST) responsibilities of a non-resident contractor who is awarded a construction contract to perform work in Ontario and their Ontario customers. Please note that this Guide replaces the previous version dated March 2001.

Non-Resident Contractor Defined

A non-resident contractor is a contractor located outside Ontario who has been awarded a construction contract to perform work in Ontario, and who has not maintained a permanent place of business in Ontario continuously for twelve months immediately prior to signing the contract, or which is not a company incorporated under the laws of Ontario. A construction contract is a contract for the erection, remodelling or repair of a building or other structure on land.
A contractor is a person who is in the business of constructing, altering, repairing or improving real property and includes, but is not limited to,

1. a general contractor and subcontractor,
2. a carpenter, bricklayer, stonemason, electrician, plasterer, plumber, painter, decorator, paver, and bridge builder,
3. a sheet metal, tile and terrazzo, heating, air conditioning, insulation, ventilating, papering, road, roofing and cement contractor, who installs or incorporates items into real property. (See RST Guide 206 - Real Property and Fixtures).

Registration and Guarantee Deposit

Non-resident contractors who are awarded a construction contract in Ontario are required to register with the Ministry of Finance (ministry), Centralized Programs Unit and post a guarantee equal to 4 per cent of the total of each Ontario contract. The guarantee can be paid in cash, by certified cheque (payable to the Minister of Finance), letter of credit or by a guarantee bond.

To register with the ministry and to obtain further information on posting a guarantee, contractors should contact the ministry's Centralized Programs Unit, 33 King Street West, PO Box 623, Oshawa, Ontario, L1H 8H7, toll-free 1 866 ONT-TAXS (1 866 668-8297) or fax to 905 435-3617.

Non-resident contractors who sell taxable goods on a supply only basis to Ontario customers, or provide taxable services in Ontario, may obtain a regular Vendor Permit to collect and remit RST on their sales. Non-resident contractors who have been issued a regular Vendor Permit must still register separately with the ministry and post a guarantee if they are awarded a construction contract in Ontario.

Letter of Compliance

After receiving the guarantee, the ministry mails out two copies of a "letter of compliance" to the contractor certifying the Retail Sales Tax (RST) requirements have been met. Contractors must give a copy of the letter to their customers.

If a copy of the compliance letter is not provided, the customer must withhold 4 per cent of all amounts payable to the non resident contractor and pay the withheld amounts to the Minister of Finance (minister). Details relating to the contract should be sent along with the payments to the Centralized Programs Unit. Customers may give the minister a guarantee bond equal to 4 per cent of the total contract price instead of making the 4 per cent payments.

Note: Customers who do not follow these requirements may be held liable for 4 per cent of all amounts payable to the non resident contractor or any other amount that the Ministry deems to be the RST payable resulting from the performance of the contract.

Calculation of RST

Fair Value

RST is payable on the "fair value" of materials, purchased or brought into Ontario, to be used for work performed in Ontario. "Fair value" includes:

- the purchase price in Canadian funds;
- all charges by the supplier for handling and delivery, and
- any federal customs duties and excise taxes paid (but not the federal Goods and Services Tax (GST)).

Contractors are also required to pay RST to Ontario suppliers on the purchase, rental or lease of taxable services, materials, machinery, or equipment.

Machinery and Equipment - Leased

If machinery or equipment is leased from a supplier outside Ontario and brought into the province, RST is payable on the lease payments for the period the machinery or equipment is in Ontario.

Machinery and Equipment - Owned by Contractor

If machinery or equipment is owned by the contractor, RST may be calculated in one of the following ways:

a. If a contractor brings machinery and equipment into Ontario for less than 12 months' use, RST is to be calculated using the following formula:

   1/36 × net book value at date of import × number of months in Ontario × tax rate

   For the purpose of this formula, RST is payable for each month or part of a month that the goods are in Ontario. A month is considered 31 consecutive days and a part month is considered more than 12 days. The RST payable is based on the number of days the machinery and equipment are located in Ontario and not the number of days the items are actually used.

Example: Equipment is brought into Ontario on March 28 and taken out on May 8. The items were in the province for 41 days. RST is payable on the first 31 days' temporary stay in Ontario vs. use of the equipment. Since the remainder (10 days) is not considered part of a month, no RST is payable on this portion.

b. If, at the time the goods are brought into Ontario, it is expected that the machinery or equipment will be in Ontario for more than twelve months, contractors must pay Retail Sales Tax (RST) on the following basis:

   net book value at date of import × tax rate

   If, at the time of import, the length of time is not known, vendors may use the formula under (a). If they later find it necessary to keep the machinery and equipment in Ontario for more than 12 months, the RST paid under (a) may be deducted from the RST payable under (b).

Using formula (a) or (b) above, contractors will calculate and remit the RST payable on the return that is filed when the contract is finished.

(See Completion of Contract section)

Manufacturing for Own Use

Contractors may need to manufacture items, such as doors and windows, for their construction contracts. Manufacturing is work done in a factory away from a construction site, or in a mobile unit or workshop that is on or near the construction site. Manufacturing occurs when raw materials are changed into manufactured goods for use in real property contracts.

Contractors are considered to be manufacturing contractors if they produce goods:
1. for their own use in real property contracts, and
2. the manufactured cost of the goods is more than $50,000 a year.

(See RST Guide 401 - Manufacturing Contractors)

Contracts with the Federal Government

Where a non-resident contractor enters into a construction contract with the federal government, for the construction of a building and/or the installation of equipment, the nature of the equipment will determine whether the contract should be let on a tax-included or tax excluded basis.

Contracts for the construction of a building and the installation of equipment that directly services that building (i.e., elevators, escalators, light fixtures, central heating and air conditioning, etc.) should be tendered on a tax -included basis. Contractors are the consumers of the materials used in fulfilling these contracts and must pay or account for RST on the materials used to complete the contracts. There is NO exemption just because the contract is with the federal government.

Contracts for the installation of equipment that becomes a fixture and does not directly service a building (i.e., material handling equipment, production machinery, communication equipment, training equipment) may be tendered on a tax-excluded basis. Contractors engaged in contracts of this nature are permitted to make tax exempt purchases of such equipment by issuing a valid Purchase Exemption Certificate (PEC) to their supplier. Only non-resident contractors who have registered with the ministry and posted a guarantee may issue a PEC.

Exemptions

Contractors may supply and install equipment or materials for certain customers that may be entitled to an exemption from RST (e.g., manufacturers, Indian band councils, farmers and diplomatic organizations). The equipment or materials, when installed, becomes real property if it is permanently attached to land, or a fixture if it is permanently attached to a building or real property structure. Since

contractors are liable for RST, they should contact the ministry to find out if the customer qualifies for exemption before tendering the contract on a tax-excluded basis.

Status Indians, Indian Bands and Band Councils

Non-resident contractors may purchase building materials exempt from Retail Sales Tax (RST) for certain buildings and structures situated on reserves. The cost of such projects must be paid by the band council, and the buildings must provide a community service for the reserve. Contracts for the construction of an exempt community building project should be made on an RST-excluded basis. Non-resident contractors may purchase the materials exempt from RST by providing suppliers with a valid Purchase Exemption Certificate (PEC). As noted previously, only non-resident contractors who have registered with the ministry and posted a guarantee may issue a PEC. (See RST Guide 204 - Purchase Exemption Certificates).

Non-resident contractors must pay RST on items purchased for incorporation into a building or structure built for individual status Indians on a reserve. (See RST Guide 808 - Status Indians, Indian Bands and Band Councils).

Completion of Contract

When a contract is completed, non-resident contractors who were required to post a guarantee must complete a Non-Resident Contractor Retail Sales Tax Return [PDF - 92 KB] that is provided by the ministry.

If a contractor's guarantee was given in cash or by certified cheque, the amount of the deposit can be deducted from the RST liability owed by the contractor. If the liability is greater than the deposit, the amount remaining must be paid by the contractor. If the deposit is more than the liability, the contractor will receive a refund.

If a guarantee bond was posted instead of cash, the bond will be discharged once the RST liability is paid in full.

All returns are subject to audit.

Legislative References

- Retail Sales Tax Act, Subsections 19(2) and 39(3)(4) and (5)
- Regulation 1012 under the Act, Subsections 15.3(1)(2)(5)(6) and (7)
- Regulation 1013 under the Act, Sections 1 and 3

For More Information

The information contained in this publication is only a guideline. For more information, please contact the Ontario Ministry of Finance at 1 866 ONT-TAXS (1 866 668-8297) or visit our website at ontario.ca/finance.

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

Standard Construction Contract – Articles of Agreement
(23/01/2002)

A1 Contract Documents

A2 Date of Completion of Work and Description of Work

A3 Contract Amount

A4 Contractor's Address

A5 Unit Price Table

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

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.

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:

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 **Seal**

of

on the_____

day of_____

2620 SPEAKMAN DRIVE
MISSISSAUGA, ONTARIO
L5K 2L1

NRC - MISSISSAUGA
RESEARCH AND
DEVELOPMENT PILOT PLANT
FACILITY

SP - 17-37 W2

Project Number IMC0248

Project Date 2020-05-30

END OF SECTION

□

PART 1 - GENERAL

1.1 ADMINISTRATIVE

.1 Submit to Departmental Representative submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.

.2 Do not proceed with Work affected by submittal until review is complete.

.3 Present shop drawings, product data, samples and mock-ups in SI Metric units.

.4 Where items or information is not produced in SI Metric units converted values are acceptable.

.5 Review submittals prior to submission to Departmental Representative. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.

.6 Notify Departmental Representative, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.

.7 Verify field measurements and affected adjacent Work are co-ordinated.

.8 Contractor's responsibility for errors and omissions in submission is not relieved by Departmental Representative's review of submittals.

.9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Departmental Representative review.

.10 Keep one reviewed copy of each submission on site.

.11 Submit number of hard copies specified for each type and format of submittal and also submit in electronic format as pdf files. Forward pdf, NMSEdit Professional spp, MS Word, MS Excel, MS Project and Autocad dwg files on USB compatible with PWGSC encryption requirements or through email or alternate electronic file sharing service such as ftp, as directed by Departmental Representative.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.

.2 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario of Canada.

.3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

.4 Allow 15 working days for Departmental Representative's review of each submission.

.5 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.

.6 Make changes in shop drawings as Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested.

.7 Accompany submissions with transmittal letter, in duplicate, containing:

.1 Date.

.2 Project title and number.

.3 Contractor's name and address.

.4 Identification and quantity of each shop drawing, product data and sample.

.5 Other pertinent data.

.8 Submissions shall include:

.1 Date and revision dates.

.2 Project title and number.

.3 Name and address of:

.1 Subcontractor.

.2 Supplier.

.3 Manufacturer.

.4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.

.5 Details of appropriate portions of Work as applicable:

.1 Fabrication.

.2 Layout, showing dimensions, including identified field dimensions, and clearances.

.3 Setting or erection details.

.4 Capacities.

.5 Performance characteristics.

.6 Standards.

.7 Operating weight.

.8 Wiring diagrams.

.9 Single line and schematic diagrams.

.10 Relationship to adjacent work.

.9 After Departmental Representative's review, distribute copies.

.10 Submit three hard copies and one electronic copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.

.11 Submit three hard copies and one electronic copy of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.

.12 Submit three hard copies and one electronic copy of test reports for requirements requested in specification Sections and as requested by Departmental Representative.

.1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.

.2 Testing must have been within 3 years of date of contract award for project.

.13 Submit three hard copies and one electronic copy of certificates for requirements requested in specification Sections and as requested by Departmental Representative.

.1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.

.2 Certificates must be dated after award of project contract complete with project name.

.14 Submit three hard copies and one electronic copy of manufacturers' instructions for requirements requested in specification Sections and as requested by Departmental Representative.

.1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.

.15 Submit three hard copies and one electronic copy of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.

.16 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

.17 Submit three hard copies and one electronic copy of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.

.18 Delete information not applicable to project.

.19 Supplement standard information to provide details applicable to project.

.20 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

.21 The review of shop drawings by Public Works and Government Services Canada (PWGSC) is for sole purpose of ascertaining conformance with general concept.

.1 This review shall not mean that PWGSC approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.

.2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.3 SAMPLES

.1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples with origin and intended use.

.2 Deliver samples prepaid to Departmental Representative's business address.

.3 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.

.4 Where colour, pattern or texture is criterion, submit full range of samples.

.5 Adjustments made on samples by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.

.6 Make changes in samples which Departmental Representative may require, consistent with Contract Documents.

.7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.4 MOCK-UPS

.1 Erect mock-ups in accordance with Section 01 45 00.

1.5 PHOTOGRAPHIC DOCUMENTATION

.1 Submit photographic documentation in accordance with Section 01 32 00.

1.6 FEES, PERMITS AND CERTIFICATES

.1 Provide authorities having jurisdiction with information requested.

.2 Pay fees and obtain certificates and permits required.

.3 Furnish certificates and permits.

.4 Submit acceptable certificate stating that suspended ceiling systems provide adequate support for electrical fixtures, as required by current bulletin of Electrical Safety Authority (ESA).

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 SECTION OVERVIEW

.1 Green Globes requirements and procedures

1.2 RELATED SECTIONS

.1 Division 3 Concrete

.2 Division 4 Masonry

.3 Division 6 Wood, Plastics and Composites

.4 Division 7 Thermal and Moisture Protection

.5 Division 8 Openings

.6 Division 9 Finishes

.7 Division 10 Specialties

.8 31 25 00 Temporary Erosion and Sediment Control

.9 01 74 19 Construction and Demolition Waste Management

.10 01 81 19 Indoor Air Quality Requirements

1.3 DEFINITIONS

.1 Green Globes: A third-party verification online green building rating and certification tool.

.2 Volatile Organic Compounds (VOCs): Organic chemicals that produce vapors readily at room temperature and normal atmospheric pressure (e.g. gasoline, solvents, etc.). VOCs react with sunlight and nitrogen to form ground-level ozone, a chemical that has detrimental effect on human health, agricultural crops, forests, soil, groundwater and ecosystems.

.3 Urea-Formaldehyde (UF): A combination of urea and formaldehyde the readily decomposes at room temperature. It is found in some glues/resins used to manufacture furniture, composite woods (e.g. particle board), agrifiber products and laminated assemblies. UF has detrimental effect on human health and may include symptoms such as eye, nose, and throat irritation, wheezing and coughing, fatigue, skin rash and severe allergic reaction.

.4 Volatile Organic Compounds (VOCs): Volatile organic compound (VOC) emissions from consumer and commercial products are a significant contributing factor in the creation of air pollution in urban areas. These emissions contribute to the formation of ground-level ozone and fine particulate matter, which form smog.

1.4 REFERENCES

.1 Chemical Abstracts Service (CASRN): cas.org/

.2 Canadian VOC Concentration Limits for Architectural Coatings: ec.gc.ca/lcpe-cepa/eng/regulations/detailReg.cfm?intReg=117

.3 CARB 93120 ATCM: arb.ca.gov/toxics/compwood/compwood.htm

.4 California Department of Public Health (CDPH) Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers CA/DHS/EHLB/R-174, July 14, 2004 with Addendum 2004-01, October 19, 2004: services.ul.com/service/cdph-standard-method-for-voc-emissions/

.5 Cradle-to-Cradle Certifed Product Standard: c2ccertifed.org/product_certifcation

.6 EcoLogo: industries.ul.com/environment/certificationvalidation-marks/ecologo-product-certification

.7 GREENGUARD Environmental Institute: Standard Method for Measuring and Evaluating Chemical Emissions From Building Materials, Finishes and Furnishings Using Dynamic Environmental Chambers (GGTM.P066.R8, 10/29/2008): greenguard.org

.8 Green Seal: greenseal.org

.9 Indoor REL developed by the California Office of Environmental Health and Hazard Assessment (OEHHA). https://oehha.ca.gov/

.10 SCS Indoor Advantage Gold: www.scsglobalservices.com/indoor-air-quality-certification

.11 SCS EC10.2 -2007, Environmental Certification Program—Indoor Air Quality Performance, May, 2007: https://www.scscertified.com/docs/SCS-EC10.2-2007.pdf

.12 South Coast Air Quality Management District (SCAQMD) Rule 1113, effective June 3, 2011., Architectural Coatings: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/r1113.pdf

.13 South Coast Air Quality Management District (SCAQMD) Amendment to South Coast Rule 1168, July 1, 2005, Adhesive and Sealant Applications: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1168.pdf

1.5 OBJECTIVES

.1 Construct a building that uses land, water, energy and material resources appropriately and efficiently and provides a safe, comfortable and productive indoor environment for building occupants in accordance with Green Globes requirements.

.2 No single manufacturer, fabricator, or subcontractor can fulfill the total requirements for Green Globes certification for the project. Green Globes certification requires the cooperation and diligence of all project participants for a successful application and acceptance for Green Globes certification.

.3 Source and select materials that materials that meet sustainable criteria detailed herein

1.6 DESCRIPTION OF WORK

.1 The Green Globes requirements in this section and the related sections shall apply to all Sections and Work for this Project, whether specifically indicated or not.

.2 Compliance with requirements needed to obtain targeted Green Globes credits will be used as one criterion to evaluate requests for substitutions or alternates.

PART 2 - PRODUCTS

2.1 SECTION OVERVIEW

.1 Product requirements for attempting Green Globes credits.

2.2 PAINTS

.1 All paints applied on site for wet applied products must comply with the following criteria:

PRODUCT TYPE	VOC LIMIT [g/L LESS WATER]
Paints – Interior Latex Coatings Flat	50
Paints – Interior Latex Coatings Non Flat	150
Untreated Masonry or Concrete	N/A

2.3 ADHESIVES AND SEALANTS, WALL, CEILING, INSULATION AND FLOOR MATERIAL

.1 All adhesives and sealants, wall, acoustic ceilings, insulation and floor covering material shall comply with either requirement:

.1 Have a VOC content less than the limits outlined in the South Coast Air Quality Management District (SCAQMD) Amendment to South Coast Rule 1168

.1 The VOC content limits of SCAQMD Rule 1168 are as follows:

ARCHITECTURAL APPLICATIONS	VOC LIMIT [g/L LESS WATER]
Carpet / Carpet Pads	50
Wood Flooring Adhesives	100
Rubber Flooring Adhesives	60
Subfloor Adhesives	50
Ceramic Tile Adhesives	65
VCT & Asphalt Adhesives	50
Drywall & Panel Adhesives	50
Cove Base Adhesives	50
Multipurpose Construction Adhesives	70
Structural Glazing Adhesives	100
Single-ply roof membrane	250
SPECIALITY APPLICATION	**VOC LIMIT [g/L LESS WATER]**
PVC Welding	510
CPVC Welding	490
ABS Welding	325
Plastic Cement Welding	250
Adhesive Primer for Plastic	550
Contact Adhesive	80
Special Purpose Contact Adhesive	250

SUBSTRATE SPECIFIC	VOC LIMIT [g/L LESS WATER]
Metal to Metal	30
Plastic Foams	50
Porous Material (except wood)	50
Wood	30
Fiberglass	80
SEALANTS	**VOC LIMIT [g/L LESS WATER]**
Architectural	250
Nonmembrane roof	300
Single-ply roof membrane	450
SEALANT PRIMERS	**VOC LIMIT [g/L LESS WATER]**
Architectural, nonporous	250
Architectural, porous	775
Other	750

.2 Or a product that has passed the testing methods and holds certification in the following product certifications such as:

.1 Green Label Plus® (Carpet & Carpet Adhesive) – Carpet and Rug Institute

.1 Carpet Policy & Procedure Manual – GLCm_071809Ver0

.2 Adhesive Policy & Procedure Manual – GLAm_062509Ver0

.2 Green Label® (Carpet Cushion) – Carpet and Rug Institute

.1 EcoLogo (Paints & Adhesives) – Environmental Choice

.2 EcoLogo Standard for Adhesives – CCD-046

.3 EcoLogo Standard for Paints – Architectural Surface Coatings CCD-047

.4 EcoLogo Standard for Recycled Paints – Architectural Surface Coatings – Recycled Water-bourne CCD-048

.3 Green Seal® (Paints & Adhesives)

.1 Green Seal Environmental Standard for Paints and Coatings, GS-11

.2 Green Seal Environmental Standard for Commercial Adhesives, GS-36

.4 FloorScore® (Resilient Flooring) – Resilient Floor Covering Institute

.1 California Department of Health Services Standard Practice for the Testing Of Volatile Organic Emissions Sources Using Small Scale Environmental Chambers (CA/DHS/EHLB/R-174), JULY 15, 2004 with Addendum 2004-01

.2 SCS - EC10.2 -2007, Environmental Certification Program— Indoor Air Quality Performance. May, 2007

.5 GREENGUARD Children & Schools – GREENGUARD Environmental Institute

.1 "Program Manual For GREENGUARD Product Certification Programs" GG.PM.01 2009

.2 GREENGUARD Environmental Institute: Standard Method for Measuring and Evaluating Chemical Emissions From Building Materials, Finishes and Furnishings Using Dynamic Environmental Chambers (GGTM.P066.R8, 10/29/2008)

.6 Indoor Advantage Gold TM – Scientific Certification Systems

.1 California Department of Health Services Standard Practice for the Testing Of Volatile Organic Emissions Sources Using Small Scale Environmental Chambers (CA/DHS/EHLB/R-174, JULY 15, 2004 with Addendum 2004-01)

.2 SCS - EC10.2 -2007, Environmental Certification Program—Indoor Air Quality Performance, May, 2007

PART 3 – EXECUTION

.1 NOT USED

END OF SECTION

1.1 REFERENCES

.1 Canadian Standards Association (CSA): Canada

.1 CSA S350-M1980(R2003), Code of Practice for Safety in Demolition of Structures.

.2 National Building Code 2015 (NBC):

.1 NBC 2015, Division B, Part 8 Safety Measures at Construction and Demolition Sites.

.3 National Fire Code 2015 (NFC):

.1 NFC 2015, Division B, Part 5 Hazardous Processes and Operations, subsection 5.6.1.3 Fire Safety Plan.

.4 Province of Ontario:

.1 Occupational Health and Safety Act Revised Statutes of Ontario 1990, Chapter O.1 as amended, and Regulations for Construction Projects, O. Reg. 213/91 as amended.

.2 O. Reg. 490/09, Designated Substances.

.3 Workplace Safety and Insurance Act, 1997.

.4 Municipal statutes and authorities.

.5 Treasury Board of Canada Secretariat (TBS):

.1 Treasury Board, Fire Protection Standard April 1, 2010 www.tbs-sct.gc.ca/pol/doc-eng.aspx ?id=17316&section=text.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Submit site-specific Health and Safety Plan: Within 7 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:

.1 Results of site specific safety hazard assessment.

.2 Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.

.3 Measures and controls to be implemented to address identified safety hazards and risks.

.3 Provide a Fire Safety Plan, specific to the work location, in accordance with NBC, Division B, Article 8.1.1.3 prior to commencement of work. Deliver two copies of the Fire Safety Plan to the Departmental Representative not later than 14 days before commencing work.

.4 Contractor's and Sub-contractors' Safety Communication Plan.

.5 Contingency and Emergency Response Plan addressing standard operating procedures specific to the project site to be implemented during emergency situations. Coordinate plan with Emergency Response requirements and procedures provided by Departmental Representative.

.6 Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 30 days after receipt of plan. Revise plan as appropriate and resubmit plan to Departmental Representative within 10 days after receipt of comments from Departmental Representative.

.7 Departmental Representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.

.8 Submit names of personnel and alternates responsible for site safety and health.

.9 Submit records of Contractor's Health and Safety meetings when requested.

.10 Submit 1 copy of Contractor's authorized representative's work site health and safety inspection reports to Departmental Representative, weekly.

.11 Submit copies of orders, directions or reports issued by health and safety inspectors of the authorities having jurisdiction.

.12 Submit copies of incident and accident reports.

.13 Submit Material Safety Data Sheets (MSDS).

.14 Submit Workplace Safety and Insurance Board (WSIB)- Experience Rating Report.

.15 Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel, in accordance with O. Reg. 490, prior to commencement of Work, and submit additional certifications for any new site personnel to Departmental Representative.

1.3 FILING OF NOTICE

.1 File Notice of Project with Provincial authorities prior to commencement of Work.

1.4 WORK PERMIT

.1 Obtain building permits related to project prior to commencement of Work.

1.5 SAFETY ASSESSMENT

.1 Perform site specific safety hazard assessment related to project.

1.6 MEETINGS

.1 Schedule and administer Health and Safety meeting with Departmental Representative prior to commencement of Work.

1.7 REGULATORY REQUIREMENTS

.1 Comply with the Acts and regulations of the Province of Ontario.

.2 Comply with specified standards and regulations to ensure safe operations at site.

1.8 GENERAL REQUIREMENTS

.1 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.

.2 Departmental Representative may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns either accepting or requesting improvements.

.3 Relief from or substitution for any portion or provision of minimum Health and Safety standards specified herein or reviewed site-specific Health and Safety Plan shall be submitted to Departmental Representative in writing.

1.9 COMPLIANCE REQUIREMENTS

.1 Comply with Ontario Occupational Health and Safety Act, R.S.O. 1990 Chapter 0.1, as amended.

1.10 RESPONSIBILITY

.1 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.

.2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

.3 Where applicable the Contractor shall be designated "Constructor", as defined by Occupational Health and Safety Act and Regulations for Construction Projects for the Province of Ontario.

1.11 UNFORSEEN HAZARDS

.1 Should any unforeseen or peculiar safety-related factor, hazard, or condition become evident during performance of Work, immediately stop work and advise Departmental Representative verbally and in writing.

.2 Follow procedures in place for Employees Right to Refuse Work as specified in the Occupational Health and Safety Act for the Province of Ontario.

1.12 HEALTH AND SAFETY CO-ORDINATOR

.1 Employ and assign to Work, competent and authorized representative as Health and Safety Co-ordinator. Health and Safety Co-ordinator must:

.1 Have working knowledge of occupational safety and health regulations.

.2 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.

.3 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.

.4 Be on site during execution of Work and report directly to and be under direction of site supervisor.

1.13 POSTING OF DOCUMENTS

.1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Province of Ontario, and in consultation with Departmental Representative.

.1 Contractor's Safety Policy.

.2 Constructor's Name.

.3 Notice of Project.

.4 Name, trade, and employer of Health and Safety Representative or Joint Health and Safety Committee members (if applicable).

.5 Ministry of Labour Orders and reports.

.6 Occupational Health and Safety Act and Regulations for Construction Projects for Province of Ontario.

.7 Address and phone number of nearest Ministry of Labour office.

.8 Material Safety Data Sheets.

.9 Written Emergency Response Plan.

.10 Site Specific Safety Plan.

.11 Valid certificate of first aider on duty.

.12 WSIB "In Case of Injury At Work" poster.

.13 Location of toilet and cleanup facilities.

1.14 CORRECTION OF NON-COMPLIANCE

.1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Departmental Representative.

.2 Provide Departmental Representative with written report of action taken to correct non-compliance of health and safety issues identified.

.3 Departmental Representative may stop Work if non-compliance of health and safety regulations is not corrected.

1.15 BLASTING

.1 Blasting or other use of explosives is not permitted without prior receipt of written instruction by Departmental Representative.

1.16 POWDER ACTUATED DEVICES

.1 Use powder actuated devices only after receipt of written permission from Departmental Representative.

1.17 WORK STOPPAGE

.1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

.2 Assign responsibility and obligation to Health and Safety Coordinator to stop or start Work when, at Health and Safety Coordinator's discretion, it is necessary or advisable for reasons of health or safety. Departmental Representative may also stop Work for health and safety considerations.

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 SECTION INCLUDES

.1 Inspection and testing, administrative and enforcement requirements.

.2 Tests and mix designs.

.3 Mock-ups.

.4 Mill tests.

.5 Equipment and system adjust and balance.

1.2 RELATED SECTIONS

.1 Section 01 %1 00 — Commissioning - General Requirements.

1.3 INSPECTION

.1 Allow Departmental Representative access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.

.2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Departmental Representative instructions, or law of Place of Work.

.3 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.

.4 Departmental Representative may order any part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction. If such Work is found in accordance with Contract Documents, Departmental Representative shall pay cost of examination and replacement.

1.4 INDEPENDENT INSPECTION AGENCIES

.1 Independent Inspection/Testing Agencies will be engaged by Departmental Representative for purpose of inspecting and/or testing portions of Work above and beyond those required of the Contractor. Cost of such services will be borne by Departmental Representative.

.2 Provide equipment required for executing inspection and testing by appointed agencies.

.3 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.

.4 If defects are revealed during inspection and/or testing, appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Departmental Representative at no cost to Departmental Representative. Pay costs for retesting and reinspection.

1.5 ACCESS TO WORK

.1 Allow inspection/testing agencies access to Work, off site manufacturing and fabrication plants.

.2 Co—operate to provide reasonable facilities for such access.

1.6 PROCEDURES

.1 Notify appropriate agency and Departmental Representative in advance of requirement for tests, in order that attendance arrangements can be made.

.2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in an orderly sequence so as not to cause delay in Work.

.3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

1.7 REJECTED WORK

.1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Departmental Representative as failing to conform to Contract Documents. Replace or re—execute in accordance with Contract Documents.

.2 Make good other Contractor's work damaged by such removals or replacements promptly.

.3 If in opinion of Departmental Representative it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Departmental Representative may deduct from Cor-tract Amount difference in value between Work performed and that called for by Contract Documents, amount of which shall be determined by Departmental Representative.

1.8 REPORTS

.1 Submit 4 copies of inspection and test reports to Departmental Representative.

.2 Provide copies to Subcontractor of work being inspected or tested, manufacturer or fabricator of material being inspected or tested.

1.9 TESTS AND MIX DESIGNS

.1 Furnish test results and mix designs as may be requested.

.2 The cost of tests and mix designs beyond those called for in Contract Documents or beyond those required by law of Place of Work shall be appraised by Departmental Representative and may be authorized as recoverable.

1.10 MOCK—UPS

.1 Prepare mock-ups for Work specifically requested in specifications. Include for Work of all Sections required to provide mock-ups.

.2 Construct in all locations acceptable to Departmental Representative or as specified in specific Section.

.3 Prepare mock—ups for Departmental Representative's review with reasonable promptness and in an orderly sequence, so as not to cause any delay in Work.

.4 Failure to prepare mock-ups in ample time is not considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed.

.5 If requested, Departmental Representative will assist in preparing a schedule fixing dates for preparation.

.6 Mock-ups may remain as part of Work unless otherwise specified or directed by Departmental Representative.

1.11 MILL TESTS

.1 Submit mill test certificates as requested or as required of specification Sections.

1.12 EQUIPMENT AND SYSTEMS

.1 Submit testing, adjusting and balancing reports for mechanical, electrical, and building equipment systems.

.2 Submit Commissioning Documentation in accordance with Section 01 91 00.

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 INSPECTION AND DECLARATION

.1 Contractor's Inspection: Contractor and all Subcontractors shall conduct an inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.

.1 Notify Departmental Representative in writing of satisfactory completion of Contractor's Inspection and that corrections have been made.

.2 Request Departmental Representative's Inspection.

.2 Departmental Representative's Inspection: Departmental Representative and Contractor will perform inspection of Work to identify obvious defects or deficiencies. Contractor to correct Work accordingly.

.3 Completion: submit written certificate that following have been performed:

.1 Work has been completed and inspected for compliance with Contract Documents.

.2 Defects have been corrected and deficiencies have been completed.

.3 Equipment and systems have been tested, adjusted and balanced and are fully operational.

.4 Certificates required have been submitted.

.5 Operation of systems have been demonstrated to Departmental Representative.

.6 Work is complete and ready for final inspection.

.4 Final Inspection: when items noted above are completed, request final inspection of Work by Departmental Representative and Contractor. If Work is deemed incomplete by Departmental Representative, complete outstanding items and request reinspection.

1.2 CLEANING

.1 In accordance with Section 01 74 11.

.2 Remove waste and surplus materials, rubbish and construction facilities from the site in accordance with Section 01 74 20.

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 SECTION INCLUDES

.1 As-built, samples, and specifications.

.2 Equipment and systems.

.3 Product data, materials and finishes, and related information.

.4 Operation and maintenance data.

.5 Spare parts, special tools and maintenance materials.

.6 Warranties and bonds.

.7 Final site survey.

1.2 RELATED SECTIONS

.1 Section 01 91 00 - Commissioning - General Requirements.

.2 Section 01 79 00 - Demonstration and Training.

1.3 SUBMISSION

.1 Prepare instructions and data using personnel experienced in maintenance and operation of described products.

.2 Copy will be returned after final inspection, with Departmental Representative's comments.

.3 Revise content of documents as required prior to final submittal.

.4 Two weeks prior to Substantial Performance of the Work, submit to the Departmental Representative, four final copies of maintenance manuals and commissioning documentation in English.

.5 Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of same quality and manufacture as products provided in Work.

.6 If requested, furnish evidence as to type, source and quality of products provided.

.7 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.

.8 Pay costs of transportation.

1.4 FORMAT

.1 Organize data in the form of an instructional manual.

.2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.

.3 When multiple binders are used, correlate data into related consistent groupings. Identify contents of each binder on spine.

.4 Cover: Identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.

.5 Arrange content by systems under Section numbers and sequence of Table of Contents.

.6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.

.7 Text: Manufacturer's printed data, or typewritten data.

.8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

.9 Provide 1:1 scaled CAD files in dwg format. Forward pdf, NMSEdit Professional spp, MS Word, MS Excel, MS Project and Autocad dwg files on USB compatible with PWGSC encryption requirements or through email or alternate electronic file sharing service such as ftp, as directed by Departmental Representative.

1.5 CONTENTS - EACH VOLUME

.1 Table of Contents: provide title of project; date of submission; names, addresses, and telephone numbers of Contractor with name of responsible parties; schedule of products and systems, indexed to content of volume.

.2 For each product or system:

.1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.

.3 Product Data: mark each sheet to clearly identify specific products and component parts, and data applicable to installation; delete inapplicable information.

.4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.

.5 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00.

.6 Training: Refer to Section 01 79 00.

1.6 AS-BUILTS AND SAMPLES

.1 Maintain at the site for Departmental Representative one record copy of:

.1 Contract Drawings.

.2 Specifications.

.3 Amendments and addenda.

.4 Change Orders and other modifications to the Contract.

.5 Reviewed shop drawings, product data, and samples.

.6 Field test records.

.7 Inspection certificates.

.8 Manufacturer's certificates.

.2 Store record documents and samples in field office apart from documents used for construction. Provide files, racks, and secure storage.

.3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.

.4 Maintain record documents in clean, dry and legible condition. Do not use record documents for construction purposes.

.5 Keep record documents and samples available for inspection by Departmental Representative.

.6 Turn one set, paper copy and electronic copy, of AS-BUILT drawings and specifications over to Departmental Representative on completion of work. Submit files on USB compatible with PWGSC encryption requirements or through email or alternate electronic file sharing service such as ftp, as directed by Departmental Representative.

.7 If project is completed without significant deviations from Contract drawings and specifications submit to Departmental Representative one set of drawings and specifications marked "AS-BUILT".

1.7 RECORDING ACTUAL SITE CONDITIONS

.1 Record information on set of black line opaque drawings, and in copy of Project Manual, provided by Departmental Representative.

.2 Provide felt tip marking pens, maintaining separate colours for each major system, for recording information.

.3 Record information concurrently with construction progress. Do not conceal Work until required information is recorded.

.4 Contract Drawings and shop drawings: legibly mark each item to record actual construction, including:

.1 Measured depths of elements of foundation in relation to finish first floor datum.

.2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

.3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.

.4 Field changes of dimension and detail.

.5 Changes made by change orders.

.6 Details not on original Contract Drawings.

.7 References to related shop drawings and modifications.

.5 Specifications: legibly mark each item to record actual construction, including:

.1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.

.2 Changes made by Amendments and change orders.

.6 Other Documents: maintain manufacturer's certifications, inspection certifications, and field test records, required by individual specifications sections.

1.8 FINAL SURVEY

.1 Submit final site survey certificate in accordance with Section 01 71 00, certifying that elevations and locations of completed Work are in conformance, or non-conformance with Contract Documents.

1.9 EQUIPMENT AND SYSTEMS

.1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

.2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.

.3 Include installed colour coded wiring diagrams.

.4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

.5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

.6 Provide servicing and lubrication schedule, and list of lubricants required.

.7 Include manufacturer's printed operation and maintenance instructions.

.8 Include sequence of operation by controls manufacturer.

.9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

.10 Provide installed control diagrams by controls manufacturer.

.11 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.

.12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

.13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

.14 Include test and balancing reports as specified in Section 01 45 00 and 01 91 00.

.15 Additional requirements: As specified in individual specification sections.

1.10 MATERIALS AND FINISHES

.1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured products.

.2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.3 Moisture-protection and Weather-exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.4 Additional Requirements: as specified in individual specifications sections.

1.11 SPARE PARTS

.1 Provide spare parts, in quantities specified in individual specification sections.

.2 Provide items of same manufacture and quality as items in Work.

.3 Deliver to site; place and store.

.4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

.5 Obtain receipt for delivered products and submit prior to final payment.

1.12 MAINTENANCE MATERIALS

.1 Provide maintenance and extra materials, in quantities specified in individual specification sections.

.2 Provide items of same manufacture and quality as items in Work.

.3 Deliver to location as directed; place and store.

.4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

.5 Obtain receipt for delivered products and submit prior to final payment.

1.13 SPECIAL TOOLS

.1 Provide special tools, in quantities specified in individual specification section.

.2 Provide items with tags identifying their associated function and equipment.

.3 Deliver to location as directed; place and store.

.4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

1.14 STORAGE, HANDLING AND PROTECTION

.1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.

.2 Store in original and undamaged condition with manufacturer's seal and labels intact.

.3 Store components subject to damage from weather in weatherproof enclosures.

.4 Store paints and freezable materials in a heated and ventilated room.

.5 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.

1.15 WARRANTIES AND BONDS

.1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.

.2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

.3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten days after completion of the applicable item of work.

.4 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Certificate of Substantial Performance is determined.

.5 Verify that documents are in proper form, contain full information, and are notarized.

.6 Co-execute submittals when required.

.7 Retain warranties and bonds until time specified for submittal.

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 WORK INCLUDED

.1 Conform to the requirements of Division 1, which applies to and forms part of all sections of the work.

.2 Conform to all the requirements to comply with the Green Globe Standard. Refer to Section 01 33 29.

.3 The Specification is divided into Sections which are not intended to identify contractual limits between Subcontractors nor between the Contractor and his Subcontractors. The requirements of any one Section apply to all Sections. Refer to other Divisions and Sections to ensure a complete and operational system.

.4 Provide mechanical components and accessories which may not be specifically shown on the Drawings or stipulated in the Specifications, but are required to ensure complete and operational systems

1.2 INTENT

.1 Mention in the Specifications or indication on the Drawings of equipment, materials, operation and methods, requires provision of the quality noted, the quantity required, and the systems complete in every respect.

.2 The Specifications are an integral part of the accompanying Drawings. Any item or subject omitted from one or the other, but which is either mentioned or reasonably implied, shall be considered as properly and sufficiently specified.

.3 Be completely responsible for the acceptable condition and operation of all systems, equipment and components forming part of the installation or directly associated with it. Promptly replace defective material, equipment and part of equipment and repair related damages.

1.3 SECTIONS AFFECTED

.1 These instructions apply to and form a part of all Mechanical Sections.

1.4 REGULATIONS

.1 Work shall be performed in accordance with codes, rules, regulations, by-laws and requirements of the authorities having jurisdiction.

.2 The plumbing and drainage systems shall comply with regulations respecting plumbing made under the National Building Code except as modified by rules, regulations and by-laws of authorities having jurisdiction.

.3 Natural gas systems shall be in accordance with the Gas Protection Act and Natural Gas and Propane Installation Code CSA B149.1-15.

.4 These specifications are supplementary to the requirements above.

.5 Drawings and specifications should not conflict with the above regulations but where there are apparent discrepancies the Contractor shall notify the Departmental Representative.

1.5 PERMITS, FEES INSPECTION

.1 Obtain all permits, make submissions, pay all fees and arrange for all inspections required for the work of this Division.

1.6 DRAWINGS, CHANGES AND INSTALLATION

.1 The Drawings shall be considered to show the general character and scope of the work and not the exact details of the installation. The installation shall be complete with all accessories required for a complete and operational installation.

.2 The location, arrangement and connection of equipment and material as shown on the Drawings represents a close approximation to the intent and requirements of the work. The right is reserved by the Departmental Representative. To make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to the Owner.

.3 In order to show more clearly the arrangement of the work, plans and sections do not show every valve, thermometer, pressure gauge or other system accessory. Refer to the Mechanical Standard Details and to the Specifications to determine the requirements.

.4 Equipment installed by this Division shall installed in accordance with the manufacturer's installation requirements. In the event of conflicts between the Drawings or Specifications and the manufacturer's installation requirements, the Contractor shall notify the Departmental Representative.

.5 Certain Details indicated on the Drawings are general in nature and specific labelled detail references to each and every occurrence of use are not indicated, however, such details shall be applicable to every occurrence.

.6 All piping and ductwork in finished areas shall be concealed in ceiling spaces and shafts or chased into walls. No exposed piping or ductwork shall be installed in such areas unless specifically reviewed and accepted by the Departmental Representative. No piping shall be concealed in outside walls.

.7 Vent pipes, exhaust hoods or other mechanical equipment mounted on the roof, or housing for such equipment shall not be closer to the edge of the roof than a distance equal to the height of the pipe, hood or equipment, unless specifically reviewed and accepted by the Departmental Representative.

.8 The location and size of existing services shown on the Drawings are based on the best available information. The actual location of existing services shall be verified in the field before work is commenced. Particular attention shall be paid to buried services.

.9 Changes and modifications necessary to ensure co-ordination and to avoid interference and conflicts with other Trades, or to accommodate existing conditions, shall be made at no extra cost to the Departmental Representative.

.10 Leave areas clear of piping and ducts where space is indicated as reserved for future equipment and equipment for other Trades.

.11 Adequate space and provisions shall be left for removal of coils and servicing of equipment, with minimum inconvenience to the operation of systems.

.12 Where equipment is shown to be 'roughed-in only' obtain accurate information from the Departmental Representative before proceeding with the work.

.13 Before fabricating ductwork or piping for installation, make certain that such items can be installed as shown on the Drawings without interfering with the structure or the work of other Trades. Any problems that cannot be solved in agreement with the other Trades affected, shall be submitted for decision. If ductwork or piping is prefabricated prior to the investigation and reaching of a solution to possible interference problems, necessary changes in such prefabricated items shall be made at no extra cost to the Owner.

.14 Location of diffusers, grilles registers, thermostats, sprinklers and all other equipment shown on plans is diagrammatic. Layout of each device in finished areas is critical in terms of symmetry and location. Refer to Architectural Drawings and to site instructions in all regards. Any work not installed in the correct location (at the sole discretion of the Departmental Representative) shall be remedied by this Contractor at his expense. This Contractor is responsible for mark-out of his work, fully co-ordinated with all other trades, in sufficient time for review by Departmental Representative prior to rough-in. All mechanical and sprinkler services shall be located precisely.

.15 Prepare dimensioned layouts of each room prior to rough-in for review by the Departmental Representative. Do not proceed with any work until the Departmental Representative has reviewed the layout.

1.7 INSTALLATION, INTERFERENCE AND SETTING DRAWINGS

.1 Installation, interference and setting Drawings dimensioned and to scale, shall be submitted for review by the Departmental Representative, as may be required or requested by the Departmental Representative to make clear the work intended or to show its relation to adjacent work or to the work of other trades. When an alternative piece of equipment is to be substituted for equipment shown, Drawings of the area involved shall be prepared by this Division. Three copies of such Drawings shall be submitted for review, of which one will be retained by the Departmental Representative.

.2 Installation working Drawings to 1:50 scale for mechanical rooms showing plan and sections of the plant, services, bases, curbs, drains, motor terminals, shall be prepared by this Division.

.3 Interference Drawings are required for shafts, ceiling spaces, typical floors and wherever there is possible conflict with the positioning of mechanical equipment, piping or ductwork and architectural or structural features or the work of other trades.

.4 The design of the structural framing of the mechanical rooms and pipe spaces and major pipe run supports has been based on assumed loadings supplied during the design phase. Well ahead of the construction of the affected areas, prepare and submit Drawings for review by the Departmental Representative showing the layout and weights of all finally selected mechanical equipment including details of concrete pads, concentrated pipe loads and point reactions of the equipment onto the structure.

.5 This Division shall prepare sleeving Drawings indicating the size and locations of openings required in concrete floor slabs, roof slabs/decks and walls for piping, ductwork and equipment. In case of failure to provide information in time (i.e. before the concrete is poured) any extras incurred shall be at the expense of this Division.

.6 Work shall not proceed in areas involved until after final review of such Drawings has been obtained.

1.8 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for all equipment.

.3 Shop drawings:

.1 Drawings to show:

.1 Mounting arrangements.

.2 Operating and maintenance clearances.

.2 Drawings and product data accompanied by:

.1 Detailed drawings of bases, supports, and anchor bolts.

.2 Acoustical sound power data, where applicable.

.3 Points of operation on performance curves.

.4 Manufacturer to certify current model production.

.5 Certification of compliance to applicable codes, including ASHRAE 90.1 and the Model National Energy Code of Canada for Buildings.

.3 In addition to transmittal letter referred to in Section 01 33 00: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

1.9 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00.

.2 Operation and Maintenance Data: submit operation and maintenance data for all equipment.

.1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.

.2 Operation data to include:

.1 Control schematics for systems including environmental controls.

.2 Description of systems and their controls.

.3 Description of operation of systems at various loads together with reset schedules and seasonal variances.

.4 Operation instruction for systems and component.

.5 Description of actions to be taken in event of equipment failure.

.6 Valves schedule and flow diagram.

.7 Colour coding chart.

.3 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.

.4 Performance data to include:

.1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.

.2 Equipment performance verification test results.

.3 Special performance data as specified.

.4 Testing, adjusting and balancing reports as specified in Section 23 05 93.

.5 Approvals:

.1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.

.2 Make changes as required and re-submit as directed by Departmental Representative.

.6 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.7 Site records:

.1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.

.2 Transfer information weekly to reproducible, revising reproducible to show work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection.

.8 As-Built drawings:

.1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.

.2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW

MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).

.3 Submit to Departmental Representative for approval and make corrections as directed.

.4 Perform testing, adjusting and balancing for HVAC using as-built drawings.

.5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

.9 Submit copies of as-built drawings for inclusion in final TAB report.

1.10 MAINTENANCE MATERIAL SUBMITTALS

.1 Submit in accordance with Section 01 78 00.

.2 Furnish spare parts as follows:

.1 One set of packing for each pump.

.2 One casing joint gasket for each size pump.

.3 One head gasket set for each heat exchanger.

.4 One glass for each gauge glass.

.5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

.3 Provide one set of special tools required to service equipment as recommended by manufacturers.

.4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.11 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions and with Section 01 61 00.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect all equipment from nicks, scratches, and blemishes

.3 Replace defective or damaged materials with new.

.4 Develop Construction Waste Management Plan related to Work of this Section.

.5 Packaging Waste Management: as specified in Construction Waste Management Plan in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 HVAC&R Equipment:

.1 Refrigerant:

.1 HCFC based refrigerant.

.2 HFC based refrigerant.

.2 Metering Equipment

PART 3 - EXECUTION

3.1 CO-OPERATION WITH DEPARTMENTAL REPRESENTATIVES

.1 To assist in the successful execution of the project, the Contractor shall receive a job report that summarizes the expectations of the Departmental Representative and the Contractor. This document covers topics such as progress billings breakdowns, shop drawing requirements, change order pricing breakdowns, the commissioning process, installation drawings, the specifications, as-builts and O+M manuals, along with a number of other items. This job report is intended to reiterate and elaborate on key items of the Contract Documents and is not intended to impose new requirements.

.2 At the appropriate time during construction the Contractor shall submit the applicable documentation listed in the Mechanical/Electrical Unfinished Building Occupancy Checklist. The list shall be issued by the Departmental Representative during the course of the project; however, a sample checklist can be provided at any time upon request. The checklist shall be completed by the Contractor when the information required for occupancy is submitted. The Departmental Representative shall review the information and checklist and shall identify when the information is complete. The Departmental Representative’s general review letter (required for building occupancy) shall only be issued when all the information requested in the checklist is submitted by the Contractor and deemed to be complete by the Departmental Representative.

3.2 CO-OPERATION WITH OTHER DIVISIONS

.1 Particular attention must be paid to the proximity of electrical conduit and cable to mechanical piping and equipment.

.2 Pipes transporting hot fluids shall be installed at least 150 mm (6 in.) away from pipes carrying cold fluids, unless approval from the Departmental Representative is obtained to install services closer than 150 mm (6 in.).

.3 Electrical conduits shall not touch or be supported from piping or ductwork.

.4 Each Section shall confine itself to installing all materials in the spaces shown without encroaching upon space for materials installed under other Sections or Divisions. Where the space allocated to another Section or Division is encroached upon, the materials shall be relocated to their proper space allocation in such a manner to complete the work using space allocated to the various Sections and Divisions. Relocation of materials and work involved shall be paid for by the Section responsible for the encroachment at no extra cost to the Owner.

.5 Supply all items to be built in ample time for rapid progress of the work. Schedule and proceed with work as required to satisfy the construction schedule.

.6 The Contractor shall confirm the available voltage for all single phase and three phase motors or other similar electrically driven equipment with the Electrical Division prior to ordering the equipment. Any discrepancy between the requirements identified within the Contract Documents and those of the Electrical Division shall be reported to the Departmental Representative and the equipment shall be adjusted to suit the appropriate power requirements. Failure to perform this coordination prior to ordering of the motors or equipment shall result in correction at no additional cost to the Owner.

3.3 TEMPORARY USE OF EQUIPMENT

.1 Where the mechanical systems are operated during construction, the Contractor shall maintain the system and equipment in proper operating condition.

.2 Prior to application for substantial performance of the work as certified by the Departmental Representative, the systems and equipment shall be returned to the initial new condition by replacing used air filters with new air filters, cleaning the air side of all coils in the air handling systems, replacing used belts in belt drives with new belts, lubricating all bearings according to manufacturer’s factory standards and adjusting the thermostatic control system according to specifications and/or to suit the Owner.

3.4 PROVISION FOR FUTURE EXPANSION

.1 Where piping, ductwork and equipment is indicated for use in future expansion of the building, the Contractor shall leave sufficient clear space and shall install the piping, ductwork and equipment in such manner that connections to the future building expansion can be made without dismantling existing piping, ductwork and equipment and without removing existing floors, walls and ceilings.

3.5 HOUSEKEEPING PADS, CURBS AND SUPPORT PIERS

.1 Housekeeping pads, curbs and support piers under all floor mounted mechanical equipment and around all floor penetrations for pipes and ducts shall be provided by Division 03. This Division shall coordinate all sizes and locations for housekeeping pads and curbs. Provide dimensioned drawings for review by the Departmental Representative. All housekeeping pads shall be minimum 100 mm (4 in.) high unless detailed otherwise. Refer to the Drawings and Details for additional information.

3.6 SYSTEM CLEANING

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

3.7 FIELD QUALITY CONTROL

.1 Site Tests: conduct following tests in accordance with Section 01 45 00 and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.2 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.2 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.

3.8 DEMONSTRATION

.1 Departmental Representative will 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 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 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.

.4 Instruction duration time requirements as specified in appropriate sections.

.5 Departmental Representative will record these demonstrations on video tape for future reference.

3.9 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

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

PART 1 -

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 REFERENCE STANDARDS

.1 Electrical Equipment Manufacturers Association of Canada (EEMAC)

1.3 WORK INCLUDED

.1 All power and control wiring from starters, fused and non-fused switches, whether mounted in M.C.C.'s or individually, to all mechanical devices and equipment shall be provided by this Division except where shown and specified under the Electrical Division.

.2 All starters for devices supplied by this Division shall be provided by this Division except where shown and specified under the Electrical Division.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Further to requirements of Section 21 05 00, submit Shop Drawings of following:

.1 Submit an overload thermal element list with all supporting data for review prior to installation of the elements.

.2 Submit samples of nameplates for review before manufacturing.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

.1 Disconnect safety switches shall either be fusible or non-fusible safety switches and shall be heavy duty type A with quick-make, quick-break contacts, and shall be horsepower rated to match motor protected. Manufacturer shall be Schneider. Provide hole for padlock in off position.

.2 Fuse clips shall be supplied with non-renewable type fuses suitably rated to motor nameplate current for proper short circuit protection. All fuse holders shall be suitable for HRC Class J time delay fuses. Supply three (3) additional sets of spare fuses for each size of fuse used.

.3 Utilize switches of one manufacturer throughout the building.

2.2 MOTOR CONTROL CENTRES

.1 All motor control centres shall be free standing EEMAC 1 Class II, Type B construction in all areas without sprinklers and shall be EEMAC 2 drip-proof in all areas with sprinklers as manufactured by Schneider.

.2 All buswork shall be fully insulated and shall be copper, braced to withstand 40,000 AMP short circuit symmetrical.

.3 No more than 7 NEMA size 1 or smaller combination of standard starters shall be installed in one section. Leave space for a fire alarm shutdown relay compartment as required.

.4 All starters shall be complete with control transformer, pilot lights, and two normally open, normally closed auxiliary contacts. Separate pilot lights shall be used to indicate ON, OFF, LOW SPEED, and/or HIGH SPEED. Selector switches and pilot lights shall be heavy duty type. Provide high/low speed test positions in the hand mode for multi-speed motors. Starters smaller than size 1 shall not be used.

.5 Provide elementary wiring diagrams to Class 2B standards to indicate the control scheme. A separate elementary wiring diagram shall be provided for each fan or pump and the following shall be indicated in each wiring diagram:

.1 Breaker size
.2 Motor hp
.3 Motor F.L.A.
.4 Control transformer KVA
.5 Overload size
.6 Interlock scheme
.7 Remote connection, etc.
.8 Thermistors

.6 In each starter identify each wire and terminal with permanent number markings identical to the wiring diagrams.

.7 The latching relay, pilot light and the alarm contact shall be housed as part of the starter in the motor control starter.

.8 Size the overload thermal elements to the motor nameplate data and to the test curves (time/current/torque).

.9 Overload relays, thermistor relays, heater elements and other devices shall be sized to fully protect the motor for all starting and locked rotor conditions with the overloads remaining active in the circuit at all times.

.10 All three phase starters shall have 3 phase overload relays.

All starters shall operate with 120 V control circuits. The control circuit fuse shall be on the secondary side of the control transformer.

.12 Provide an engraved lamacoid nameplate for the motor control centre and each individual starter within the motor control centre. M.C.C. identification shall be 50 mm (2 in.) high letters. All other identified shall be 6 mm (1/4 in.) high letters.

Typical Identification Plate for Motor Control Centre

First Line - M.C.C. #1
Second Line - Voltage/Phase/# of Wires
Third Line - Fed from main secondary switchboard
Fourth Line - In main electrical room

Typical Identification Plate for Individual Starters

First Line - Supply Fan SF-1
Second Line - Voltage/Phase/# of Wires

All nameplates shall be fastened with self-tapping screws.

2.3 INDIVIDUAL STARTERS

.1 Individual starters shall meet all requirements specified for M.C.C.'s except as noted below.

.2 Individually mounted manual starters shall generally be the toggle operated type with quick-make, quick-break mechanism, and heavy duty sliding contacts in EEMAC 1 general purpose enclosure in all areas without sprinklers and in EEMAC 2 (drip proof) enclosure in all areas with sprinklers, pilot lights in cover and cover engraved with ON-TRIP-OFF positions.

.3 Manual starters installed in finished areas shall be as above except suitable for flush mounting with stainless or bronze coverplates.

.4 All magnetic starters individually mounted, standard or combination type, shall be for operation with a 120 V AC control transformer and coil, three phase overload protection, pilot lights, reset and pushbuttons or selector switches on the cover. All magnetic starters shall have auxiliary contacts.

.5 All combination starters individually mounted shall be combination fusible type complete with pilot lights, on/off selector and reset button on cover. All combination starters shall have auxiliary contacts.

Provide an engraved lamacoid nameplate for each individual starter. Identification shall be 6 mm (1/4 in.) high letters.

Typical Identification Plate
First Line - Exhaust Fan EF-1
Second Line - 208 V/3 ph/3 W
Third Line - Fed from splitter #1

PART 3 - EXECUTION

3.1 INSTALLATION

.1 All wiring and starters provided by this Division shall comply with the requirements of the Electrical Division of the Specifications.

.2 Refer to Electrical Drawings and Specifications for work provided under that Division.

.3 This Division shall review the shop Drawings for the motor starters submitted by the Electrical Division to ensure that all field connections are shown, the motor horsepower are correct and that the motor control schematics reflect all requirements.

.4 Unless otherwise stated, this Section shall be responsible for the complete supply, installation and wiring of all starters, fused and non-fused switches and circuit breakers, auxiliary 120

V controls such as relays and pushbutton stations for the equipment supplied under other Sections of this Division.

.5 Use non-fused disconnect switches for local equipment isolation only (e.g. fan motor downstream of fused starter in M.C.C.) all other disconnect shall be fused.

.6 Where required provide a galvanized steel hood over switches, M.C.C.’s and individual starters. Hoods shall be suitably reinforced and securely supported from the structure.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 REFERENCE STANDARDS

.1 National Fire Prevention Association (NFPA)

.1 NFPA 13-2016, Standard for the Installation of Sprinkler Systems.

.2 NFPA 20-2016, Standard for the Installation of Stationary Pumps for Fire Protection.

.3 NFPA 24-2016, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

.4 NFPA 25-2017, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

.2 Underwriter's Laboratories of Canada (ULC)

.1 CAN4 S543-M1984, Standard for Internal Lug Quick Connect Couplings for Fire Hose.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.

.2 Indicate:

.1 Materials.

.2 Finishes.

.3 Method of anchorage

.4 Number of anchors.

.5 Supports.

.6 Reinforcement.

.7 Assembly details.

.8 Accessories.

.4 Samples:

.1 Submit samples of following:

.1 Each type of sprinkler head.

.2 Signs.

.5 Test reports:

.1 Submit certified test reports for wet pipe fire protection sprinkler systems from approved independent testing

laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

.6 Certificates:

.1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.7 Manufacturers' Instructions:

.1 Provide manufacturer's installation instructions.

.8 Field Quality Control Submittals:

.1 Manufacturer's Field Reports: manufacturer's field reports specified.

1.4 CLOSEOUT SUBMITTALS

.1 Provide operation, maintenance and engineering data for incorporation into manual specified in Section 01 78 00 in accordance with NFPA 20.

.2 Manufacturer's catalogue Data, including specific model, type, and size for:

.1 Pipe and fittings.

.2 Alarm valves.

.3 Valves, including gate, check, and globe.

.4 Water motor alarms.

.5 Sprinkler heads.

.6 Pipe hangers and supports.

.7 Pressure or flow switch.

.8 Fire department connections.

.9 Excess pressure pump.

.10 Mechanical couplings.

.3 Drawings:

.1 Sprinkler heads and piping system layout.

.1 Prepare detail working drawings of system layout in accordance with NFPA 13, "Working Drawings (Plans)".

.2 Show data essential for proper installation of each system.

.3 Show details, plan view, elevations, and sections of systems supply and piping.

.4 Show piping schematic of systems supply, devices, valves, pipe, and fittings. Show point to point electrical wiring diagrams.

.2 Electrical wiring diagrams.

.4 Design Data:

.1 Calculations of sprinkler system design.

.2 Indicate type and design of each system and certify that each system has performed satisfactorily in the manner intended for not less than 18months.

.5 Field Test Reports:

.1 Preliminary tests on piping system.

.6 Records:

.1 As-built drawings of each system.

.1 After completion, but before final acceptance, submit complete set of as-built drawings of each system for record purposes.

.2 Submit drawings on reproducible Mylar film with title block similar to full size contract drawings.

.7 Operation and Maintenance Manuals:

.1 Provide detailed hydraulic calculations including summary sheet, and Contractors Material and Test Certificate for aboveground piping and other documentation for incorporation into manual in accordance with NFPA 13.

1.5 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: company or person specializing in wet sprinkler systems with documented experience.

.2 Supply grooved joint couplings, fittings, valves, grooving tools and specialties from a single manufacturer. Use date stamped castings for coupling housings, fittings, valve bodies, for quality assurance and traceability.

1.6 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 00.

.2 Provide spare sprinklers and tools in accordance with NFPA 13.

1.7 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.

.3 Storage and Protection:

.1 Store materials indoors.

.2 Store and protect materials from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

.1 Design automatic wet pipe fire suppression sprinkler systems in accordance with required and advisory provisions of NFPA 13, by hydraulic calculations for uniform distribution of water over design area.

.2 Include with each system materials, accessories, and equipment inside and outside building to provide each system complete and ready for use.

.3 Design and provide each system to give full consideration to blind spaces, piping, electrical equipment, ducts, and other construction and equipment in accordance with detailed shop drawings.

.4 Locate sprinkler heads in consistent pattern with ceiling grid, lights, and air supply diffusers.

.5 Devices and equipment for fire protection service: ULC approved for use in wet pipe sprinkler systems.

.6 Location of Sprinkler Heads:

.1 Locate heads in relation to ceiling and spacing of sprinkler heads not to exceed that permitted by NFPA 13 for hazard occupancy indicated on the drawings.

.2 Uniformly space sprinklers on branch.

.7 Water Distribution:

.1 Make distribution uniform throughout the area in which sprinkler heads will open.

.2 Discharge from individual heads in hydraulically most remote area to be 100% of specified density.

.8 Density/Area Requirements:

.1 The following minimum density and area requirements are to be the basis of the hydraulic design. Any request for modifying the density requirement must be submitted by the Contractor for review by the Departmental Representative.

Location Served	Hazard	Density L/m/sq. m. (gpm/sq. ft)	Area Sq. m. (sq. ft)	Remarks
Office Areas	Light	2.9 (0.07)	279 (3000)	Wet Type
Penthouse Areas, Mechanical rooms	Ordinary Group 1	4.9 (0.12)	279 (3000)	Wet Type
Laboratory Spaces	Ordinary Group 2	8.1 (0.20)	140 (1500)	Wet Type
High Bay Space	Ordinary Group 2	8.1 (0.20)	140 (1500)	Wet Type
Electrical, Communications	Ordinary Group 1	4.9 (0.12)	362 (3900)	Wet Type.

and Telephone Rooms				
Loading Dock, Chemical Storage Rooms	Extra Hazard Group 2	16.2 (0.4)	232(2500)	Dry Type

.9 Outside Hose Allowances:

.1 Include allowance in hydraulic calculations in accordance with NFPA.

.10 Friction Losses:

.1 Calculate losses in piping in accordance with Hazen-Williams formula with 'C' value of 120 for steel piping, 150 for copper tubing, and 140 for cement-lined ductile-iron piping.

.11 Water Supply:

.1 Obtain water flow data of street mains prior to starting hydraulic calculations. Base hydraulic calculations on static pressure of 207 kPa (30 psi) if no information is available.

2.2 ABOVE GROUND PIPING SYSTEMS

.1 Provide fittings for changes in direction of piping and for connections.

.1 Make changes in piping sizes through tapered reducing pipe fittings, bushings will not be permitted.

.2 Conceal piping in areas with suspended ceiling.

2.3 PIPE, FITTINGS AND VALVES

.1 Pipe:

.1 Ferrous: to NFPA 13.

.2 Copper tube: to NFPA 13.

.2 Fittings and joints to NFPA 13:

.1 Ferrous: screwed, welded, flanged or roll grooved.

.1 Grooved joints designed with two ductile iron housing segments, pressure responsive gasket, and zinc-electroplated steel bolts and nuts. Cast with offsetting angle-pattern bolt pads for rigidity and visual pad-to-pad offset contact.

.2 Copper tube: screwed, soldered, brazed, grooved.

.3 Provide welded, threaded, or grooved-end typefittings into which sprinkler heads, sprinkler head riser nipples, or drop nipples are threaded.

.4 Plain-end fittings with mechanical couplings and fittings which use steel gripping devices to bite into pipe when pressure is applied will notbe permitted.

.5 Rubber gasketted grooved-end pipe and fittings with mechanical couplings are permitted in pipe sizes 32mm and larger.

.6 Fittings: ULC approved for use in wet pipe sprinkler systems.

.7 Ensure fittings, mechanical couplings, and rubber gaskets are supplied by same manufacturer.

.8 Side outlet tees using rubber gasketted fittings are notpermitted.

.9 Sprinkler pipe and fittings: metal.

.3 Valves:

.1 ULC listed for fire protection service.

.2 Gate valves: open by counter-clockwise rotation.

.3 Provide rising stem valve beneath each alarm valve in each riser when more than one alarm valve is supplied from same water supply pipe.

.4 Check valves: flanged clear opening swing or spring actuated check type with flanged inspection and access cover plate for sizes 10cm and larger.

.4 Pipe hangers:

.1 ULC listed for fire protection services in accordance with NFPA.

2.4 SPRINKLER HEADS

.1 General: to NFPA 13 and ULC listed for fire services.

.2 Sprinkler Head Type:

.1 Sprinkler heads in areas without ceiling: upright bronze.

.2 Sprinkler heads in areas with acoustic or gypsum wall board ceiling indicated as light hazard or ordinary hazard: quick response, concealed type with white cover plate.

.3 Sprinkler heads in areas with wood ceilings: Quick Response, Semi recessed, chrome plated type.

.4 Sprinklers located in chemical storage areas: complete with the manufacturer’s applied, approved waxed coating

.5 Sidewall heads: quick response concealed type with white cover plate

.6 Window sprinkler heads: horizontal or pendent vertical sidewall and installed to comply with Architectural Details.

.3 Provide nominal 1.2cm orifice sprinkler heads.

.1 Release element of each head to be of intermediatetemperature rating or higher as suitable for specific application.

.2 Provide polished chromium-plated pendent sprinklers below suspended ceilings.

.3 Provide corrosion-resistant sprinkler heads and sprinkler head guards in accordance with NFPA 13.

.4 Deflector: not more than 75mm below suspended ceilings.

.5 Ceiling plates: not more than 25mm deep.

.6 Ceiling cups: not permitted.

2.5 PIPE SLEEVES

.1 Provide pipe sleeves where piping passes through walls and floors.

.2 Secure sleeves in position and location during construction.

.3 Provide sleeves of sufficient length to pass through entire thickness of floors and walls.

.4 Provide 2.5cm minimum clearance between exterior of piping and interior of sleeve or core-drilled hole.

.1 Firmly pack space with mineral wool insulation.

.2 Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to firm but pliable mass, or provide mechanically adjustable segmented elastomeric seal.

.3 In fire walls and fire floors, seal both ends of pipe sleeves or core-drilled holes with ULC listed fill, void, or cavity material.

.5 Sleeves in Masonry and Concrete Walls, Floors, and Roofs:

.1 Provide cast-iron sleeves, ductile-iron, or hot-dip galvanized steel.

.2 Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in core-drilled hole are completely grouted smooth.

.6 Sleeves in Other Than Masonry and Concrete Walls, Floors, and Roofs:

.1 Provide 0.61mm thick galvanized steel sheet.

2.6 ESCUTCHEON PLATES

.1 Provide split hinge or one piecetype metal plates for piping passing through walls, ceilings floors, in exposed spaces.

.2 Provide satin finish stainless steel, satin finish chrome or nickel plated brass with non-ferrous set screws in finished spaces.

.3 Provide paint finish on metal plates in unfinished spaces.

2.7 INSPECTOR'S TEST CONNECTION

.1 Locate inspector's test connection at hydraulically most remote part of each system, provide test connections approximately 3m above floor for each sprinkler system or portion of each sprinkler system equipped with alarm device.

.2 Provide test connection piping to location where discharge will be readily visible and where water may be discharged without property damage.

.3 Provide discharge orifice of same size as corresponding sprinkler orifice.

2.8 SIGNS

.1 Attach properly lettered and approved metal signs to each valve and alarm device to NFPA 13.

.2 Permanently fix hydraulic design data nameplates to riser of each system.

2.9 SPARE PARTS CABINET

.1 Provide metal cabinet with extra sprinkler heads and sprinkler head wrench adjacent to each alarm valve. Number and types of extra sprinkler heads as specified in NFPA 13.

PART 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, inspect and test to acceptance in accordance with NFPA 13 and NFPA 25.

3.3 PIPE INSTALLATION

.1 Install piping straight and true to bear evenly on hangers and supports. Do not hang piping from plaster ceilings.

.2 Keep interior and ends of new piping and existing piping thoroughly cleaned of water and foreign matter.

.3 Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter.

.4 Inspect piping before placing into position.

3.4 ELECTRICAL CONNECTIONS

.1 Provide electrical work associated with this section under Section 26 05 00.

.2 Provide fire alarm system under Section 28 31 00.

.3 Provide control and fire alarmwiring, including connections to fire alarm systems,in accordance with National Electrical Code.

.4 Provide wiring in rigid metal conduit or intermediate metal conduit.

3.5 DISINFECTION

.1 Disinfect new piping.

.2 Fill piping systems with solution containing minimum of 50parts per million of chlorine and allow solution to stand for minimum of 24hours.

.3 Flush solution from systems with clean water until maximum residual chlorine content is not greater than 0.2part per million or residual chlorine content of domestic water supply.

.4 Obtain at least two consecutive satisfactory bacteriological samples from piping, analyzed by certified laboratory, and submit results prior to piping being placed into service.

3.6 FIELD PAINTING

.1 Clean, pretreat, prime, and paint new systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories.

.2 Apply coatings to clean, dry surfaces, using clean brushes.

.3 Clean surfaces to remove dust, dirt, rust, and loose mill scale.

.4 Immediately after cleaning, provide metal surfaces with 1 coat of pretreatment primer applied to minimum dry film thickness of 0.3ml, and one coat of zinc chromate primer applied to minimum dry film thickness of 1.0ml.

.5 Shield sprinkler heads with protective covering while painting is in progress.

.6 Upon completion of painting, remove protective covering from sprinkler heads.

.7 Remove sprinkler heads which have been painted and replace with new sprinkler heads.

.8 Provide primed surfaces with following:

.1 Piping in Finished Areas:

.1 Provide primed surfaces with 2 coats of paint to match adjacent surfaces.

.2 Provide valves and operating accessories with 1coat of red alkyd gloss enamel applied to minimum dry film thickness of 0.0254mm(1.0mil).

.3 Provide piping with self-adhering red plastic bands 50 mm wide red enamel bandsspaced at maximum of 6m intervals throughout piping systems.

.2 Piping in Unfinished Areas:

.1 Provide primed surfaces with onecoat of red alkyd gloss enamel applied to minimum dry film thickness of 1.0mil in attic spaces, pipe chases, mechanical equipment room, spaces above suspended ceilings, crawl spaces, spaces where walls or ceiling are not painted or not constructed of a prefinished material.

.2 Provide piping with self-adhering red plastic bands 50 mm wide red enamel bandsspaced at maximum of 6m intervals.

3.7 FIELD QUALITY CONTROL

.1 Site Test, Inspection:

.1 Perform test to determine compliance with specified requirements in presence of Departmental Representative.

.2 Test, inspect, and approve piping before covering or concealing.

.3 Preliminary Tests:

.1 Hydrostatically test each system at 200psig for a 2hour period with no leakage or reduction in pressure.

.2 Flush piping with potable water in accordance with NFPA 13.

.3 Piping above suspended ceilings: tested, inspected, and approved before installation of ceilings.

.4 Test alarms and other devices.

.5 Test water flow alarms by flowing water through inspector's test connection. When tests have been completed and corrections made, submit signed and dated certificate in accordance with NFPA 13.

.4 Formal Tests and Inspections:

.1 Do not submit request for formal test and inspection until preliminary test and corrections are completed and approved.

.2 Submit written request for formal inspection at least 15days prior to inspection date.

.3 Repeat required tests as directed.

.4 Correct defects and make additional tests until systems comply with contract requirements.

.5 Furnish instruments, appliances, connecting devices, equipment, personnel for tests.

.6 Authority of Jurisdiction, will witness formal tests and approve systems before they are accepted.

.2 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.2 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 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

.3 Site Tests:

.1 Testing to be witnessed by authority having jurisdiction.

.2 Develop, with Departmental Representativeassistance, detailed instructions for O & M of this installation.

3.8 CLEANING

.1 Clean in accordance with Section 01 74 11.

Remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

.2 Section 23 05 23.01.

.3 Section 23 05 23.02.

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers International (ASME)

.1 ASME B16.15-13, Cast Cooper Alloy Threaded Fittings, Classes 125 and 250.

.2 ASME B16.18-12, Cast Copper Alloy Solder Joint Pressure Fittings.

.3 ASME B16.22-13, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

.4 ASME B16.24-11, Cast Copper Alloy Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.

.5 ASME B16.26-13, Cast Copper Alloy Fittings for Flared Copper Tubes.

.6 ASME B31.9-14, Building Services Piping.

.7 ASME B36.19M-04, Stainless Steel Pipe.

.2 ASTM International

.1 ASTM A182/182M-17, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.

.2 ASTM A269/A269M-15a, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

.3 ASTM A307-14el, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.4 ASTM A312/A312M-17, Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

.5 ASTM A351/A351M-16, Castings, Austenitic, for Pressure Containing Parts.

.6 ASTM A403/A403M-16, Wrought Austenitic Stainless Steel Piping Fittings.

.7 ASTM A536-84(2014), Standard Specification for Ductile Iron Castings.

.8 ASTM B32-08(2014), Standard Specification for Solder Metal.

.9 ASTM B42-15a, Seamless Copper Tube, Standard Sizes.

.10 ASTM B88M-16, Standard Specification for Seamless Copper Water Tube (Metric).

.3 American National Standards Institute/American Water Works Association (AWWA)

.1 AWWA C111/A21.11-12, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.2 ANSI/AWWA C151/A21.51-09, Ductile Iron Pipe, Centrifugally Cast, for Water.

.4 CSA Group

.1 CSA B242-05(2016), Groove and Shoulder Type Mechanical Pipe Couplings.

.5 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC S101-14, Fire Endurance Tests of Buildings Construction and Materials.

.2 CAN/ULC S102.2-10, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings and Miscellaneous Materials and Assemblies.

.3 CAN/ULC S115-11, Standard Method of Fire Tests of Firestop.

.6 Manufacturers Standardization Society

.1 MSS SP-67-2017, Butterfly Valves

.2 MSS SP-70-2011, Gray Iron Gate Valves, Flanged and Threaded Ends

.3 MSS SP-71-2011, Gray Iron Swing Check Valves, Flanged and Threaded Ends

.4 MSS SP-80-2013, Bronze Gate, Globe, Angle and Check Valves

.7 National Sanitation Foundation (NSF)

.1 NSF/ANSI 61-13, Drinking Water System Components-Health Effects.

.2 NSF 372-11, Drinking Water System Components - Lead Content.

.8 Department of Justice Canada (Jus)

.1 Canadian Environmental Protection Act, 1999, c. 33 (CEPA).

.9 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.10 National Research Council (NRC)

.1 National Plumbing Code of Canada (NPC) 2015.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product Data

.1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Closeout Submittals:

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00.

PART 2 - PRODUCTS

2.1 PIPING

.1 Domestic hot, cold and recirculation systems, within building.

.1 Above ground:

.1 Copper tube, hard drawn, type L: to ASTM B88M.

.2 Buried or embedded:

.1 Copper tube, soft annealed, type K: to ASTM B88M, in long lengths and with no buried joints.

2.2 FITTINGS

.1 Cast copper, solder type: to ASME B16.18.

.2 Wrought copper and copper alloy, solder type: to ASME B16.22.

.3 NPS 2 and larger:

.1 ASME B16.18 or ASME B16.22 roll grooved to CSA B242.

.4 NPS 1 ½ and smaller:

.1 Wrought copper to ASME B16.22 or cast copper to ASME B16.18; with 301 stainless steel internal components and EPDM seals. Suitable for operating pressure to 1380kPa.

2.3 JOINTS

.1 Solder: tin copper alloy 95/5, 96-6 tin silver, or 96-4 tin silver solder, ASTM B32.

.2 Teflon tape: for threaded joints.

.3 Grooved couplings: designed with angle bolt pads to provide rigid joint, complete with grade EHP gasket, rated for -35 deg. C. to 110 deg. C. Copper tubing standard coupling complete with EPDM flush seal gaskets rated for -35 deg. C. to 110 deg. C.

.4 Dielectric connections between dissimilar metals: dielectric fitting, complete with thermoplastic liner.

2.4 BALL VALVES

.1 NPS 2 and under, screwed:

.1 Class 150.

.2 Forged Brass or Bronze body, Solid ball, PTFE adjustable packing, brass gland and PTFE seat, steel lever handle as specified Section 23 05 23.01.

.3 Provide extended stems on all valves on insulated piping.

.4 All valves to be lockable type.

2.5 REVERSE OSMOSIS WATER DISTRIBUTION SYSTEM

.1 Above ground, Poly propylene:

.1 The purified water distribution system shall be polypropylene manufactured specifically for this application.

.2 Self draining diaphragm valves, zero dead leg valves and ball valves shall be polypropylene construction specifically for use in purified water systems.

.3 Hangers shall be specifically manufactured for handing this polypropylene piping system.

.2 Above ground, Stainless Steel:

.1 The purified water distribution system shall be Type 316L TIG welded stainless steel tubing. The inside of the tubing shall be polished to 180 grit and the outside of the tubing shall be polished to 150 grit.

.2 The purified water distribution system shall meet the requirements of ASTM A213.

.3 Self-draining diaphragm valves, zero dead leg valves, and ball valves shall be stainless steel construction specifically for use in purified water systems.

.4 Hangers shall be specifically manufactured for hanging stainless steel tubing and shall be all stainless steel construction with rubber insulators.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

.1 Install in accordance with local authority having jurisdiction, National Plumbing Code.

.2 Install pipe work in accordance with Section 23 05 05, supplemented as specified herein.

.3 Assemble piping using fittings manufactured to ANSI and Standard Council of Canada (SCC) standards.

.4 Install CWS piping below and away from HWS and HWC and other hot piping so as to maintain temperature of cold water as low as possible.

.5 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.

.6 The following publications shall be used to establish class of bedding and class of piping for installation other than the above. They shall also serve as guide for preparation of bedding, installation and testing.

.1 Installation manual of the Ontario Concrete Pipe Association.

.2 Design data of the American Concrete Pipe Association as distributed by the Ontario Concrete Pipe Association.

.3 Cast iron soil pipe and fittings handbook of the cast iron soil pipe institute.

.4 Sewer pipe manual of Canron.

.5 Sewer Design & Construction of the Water Pollution Control Federation.

.6 The Blue Brute and Ring Tite PVC gravity sewer pipe installation Guide by Manville.

.7 Provide thrust blocks of 20 mPa (3000 psi) concrete at each tee, elbow, valve and other fitting where thrust forces could occur. Thrust blocks shall be sized to suit the local authorities requirements, but in no case be smaller than 150 mm (6 in.) greater on all sides than the pipe served.

.8 PC4 joiting material shall not be used on underground piping. PC4 or similar jointing material shall be used for caulking waste pipes from sinks or dishwashers and other waste pipes carrying hot discharge liquids.

.7 Valves

.1 Isolate equipment, fixtures and branches with gate valves. Gate valves shall be installed at the base of each riser and at each branch take-off.

.2 Balance recirculation system using lockshield globe valves. Mark settings and record on as-built drawings on completion.

.3 Valves shall be provided as shown and as required for the satisfactory operation and control of all equipment and shall be installed to enable each piece of equipment to be isolated.

.4 Drain valves shall be installed at each low point in the piping systems and at each tank.

.5 Blow-off valves shall be provided on each 65 mm (2-1/2 in.) strainer and larger.

.6 Globe valves shall be installed as shown and in each bypass.

.7 Check valves shall be installed as shown and where required to prevent backflow.

3.3 FIELD QUALITY CONTROL

.1 Pressure Tests

.1 Conform to requirements of Section 21 05 01.

.2 Test pressure: greater of 1 times maximum system operating pressure or 860 kPa.

3.4 FLUSHING

.1 Flush entire system for 8 h. Ensure outlets flushed for 2 hours. Let stand for 24 hours, then draw one sample off longest run. Submit to testing laboratory to verify that system is clean to

Federal potable water guidelines. Let system flush for additional 2 hours, then draw off another sample for testing.

3.5 PRE-START-UP INSPECTIONS

.1 Systems to be complete, prior to flushing, testing and start-up.

.2 Verify that system can be completely drained.

.3 Ensure that pressure booster systems are operating properly.

.4 Ensure that air chambers, expansion compensators are installed properly.

3.6 DISINFECTION

.1 Flush out, disinfect and rinse system to requirements of authority having jurisdiction approval of Departmental Representative.

.2 Coordinate with Section 33 11 16 and Section 33 11 16.01.

.3 Upon completion, provide laboratory test reports on water quality for Departmental Representative approval.

3.7 START-UP

.1 Timing: start up after:

.1 Pressure tests have been completed.

.2 Disinfection procedures have been completed.

.3 Certificate of static completion has been issued.

.4 Water treatment systems operational.

.2 Provide continuous supervision during start-up.

.3 Start-up procedures:

.1 Establish circulation and ensure that air is eliminated.

.2 Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.

.3 Commission water conditioning specified Section 22 31 13.

.4 Bring HWS storage tank up to design temperature slowly.

.5 Monitor piping HWS and HWC piping systems for freedom of movement, pipe expansion as designed.

.6 Check control, limit, safety devices for normal and safe operation.

.4 Rectify start-up deficiencies.

3.8 PERFORMANCE VERIFICATION

.1 Scheduling:

.1 Verify system performance after pressure and leakage tests and disinfection are completed, and Certificate of Completion has been issued by authority having jurisdiction.

.2 Procedures:

.1 Verify that flow rate and pressure meet Design Criteria.

.2 TAB HWC in accordance with Section 23 05 93- Testing, Adjusting and Balancing for HVAC.

.3 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.

.4 Sterilize HWS and HWC systems for Legionella control.

.5 Verify performance of temperature controls.

.6 Verify compliance with safety and health requirements.

.7 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or re-charge air chambers. Repeat for outlets and flush valves.

.8 Confirm water quality consistent with supply standards, and ensure no residuals remain as result of flushing or cleaning.

.3 Reports:

.1 In accordance with Section 01 91 13: Reports, using report forms as specified in Section 01 91 13: Report Forms and Schematics.

.2 Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

3.9 OPERATION REQUIREMENTS

.1 Co-ordinate operation and maintenance requirements including, cleaning and maintenance of specified materials and products with Section 23 05 05.

.2 Operational requirements in accordance with Section 01 47 19: Operation, include:

.1 Cleaning materials and schedules.

.2 Repair and maintenance materials and instructions.

3.10 CLEANING

.1 Clean in accordance with Section 01 74 11.

.2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 20

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 REFERENCE STANDARDS

.1 ASTM International Inc.

.1 ASTM B32-08(2014), Standard Specification for Solder Metal.

.2 ASTM B306-13 Standard Specification for Copper Drainage Tube (DWV).

.3 ASTM C564-14, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

.4 ASTM C1053-00(2015), Standard Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications

.2 Canadian Standards Association (CSA International).

.1 CSA B67-Series 17), Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.

.2 CSA-B70-12(R2016), Cast Iron Soil Pipe, Fittings and Means of Joining.

.3 CSA B125.3-12, Plumbing Fittings.

.4 CSA B602-16 Mechanical couplings for drain, waste, and vent pipe and sewer pipe

.3 Green Seal Environmental Standards (GSES)

.1 Standard GS-36-13, Commercial Adhesives.

.4 National Research Council Canada (NRC)

.1 National Plumbing Code of Canada 2015(NPC).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: in accordance with Section 01 74 21.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

.1 Above ground sanitary and vent Type DWV to: ASTM B306.

.2 ABS and PVC pipes are not acceptable.

.1 Fittings.

.1 Cast brass: to CSA B125.3.

.2 Wrought copper: to CSA B125.3.

.2 Solder: 95-5

.3 Vent stack covers 1100-0T alloy aluminum with vandal proof removable cap and EPDM base seal, pvc coated deck flange or bituminous deck flange as required to suit roof membrane.

2.2 CAST IRON PIPING AND FITTINGS

.1 Buried storm, sanitary and vent minimum NPS 3, to: CAN/CSA-B70, black bituminous coating

.1 Joints:

.1 Mechanical joints:

.1 Neoprene or butyl rubber compression gaskets: to CSA-B70.

.2 Stainless steel clamps.

.2 Hub and spigot:

.1 Caulking: to CSA B67.

.2 Cold caulking compounds.

.2 Above ground sanitary, storm and vent: to CSA-B70.

.1 Mechanical couplings for drain, waste, vent pipe and sewer pipe to meet the requirements of CSA B602.

.2 Joints:

.1 Hub and spigot:

.1 Caulking: to CSA B67.

.2 Mechanical joints:

.1 Neoprene or butyl rubber compression gaskets with stainless steel clamps.

2.3 LABORATORY DRAINAGE SYSTEM

.1 Laboratory drainage systems are shown on the Drawings as AD – Acid Resistant Drainage, AV – Acid Resistant Vent, AFD – Acid Resistant Floor Drain, ACO – Acid Resistant Cleanout.

.2 All cleanouts and manholes on the laboratory drainage and venting system shall be same material as the piping and shall be specifically labelled as acid resistant.

.3 Glass

.1 Borosilicate glass conforming to ASTM C1053. Where laboratory drain branches enter mains of standard materials. The Y or TY connection shall be glass and with the manufacturer’s recommended adapter from the glass pipe to the standard material shall be used. Vent termination through roof shall be glass.

.2 Coupling outer shall, nut and bolt to be made from 300 series stainless steel. Coupling compression liner shall be made of rubber compound. Seal ring gasket shall be tetra-fluoro-ethylene. Couplings shall provide leak free joint when deflected up to 4 degrees.

.3 Buried glass piping shall be provided by the manufacturer in maximum 1500 mm (60 in.) lengths and covered by expanded polystyrene. All underground fittings shall be protected prior to backfilling by wrapping in .127mm (5 mil) polyvinyl film and shall be laid in sand bedding as recommended by the manufacturer.

.4 Hangers for glass piping shall be SMS Series 302-G with heavy plastisol coating.

.5 Obtain and submit for review a list of chemicals to confirm suitability of pipe material and liners.

.4 Polypropylene

.1 Schedule 40 to ASTM D1785, polypropylene pipe. Where laboratory drain branches enter mains of standard material, the manufacturer’s recommended adapter from the polypropylene pipe to the standard material shall be used. Vent termination through roof shall be polypropylene.

.2 The laboratory drainage and vent system shall meet the requirements of CSA-B181.3 Polyolefin Laboratory Drainage Systems and CSA-B182.1 Plastic Drain and Sewer Pipe and Pipe Fittings. Flame requirements shall be based on ASTM D635.

.3 Obtain and submit for review a list of chemicals to confirm suitability of pipe material and liners.

PART 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 INSTALLATION

.1 In accordance with Section 23 05 05.

.2 Install in accordance with National Plumbing Code.

.3 Vent stack covers shall be properly sized for each vent penetrating the roof. Division 23 shall supply vent stack covers for installation and flashing by the roofing contractor.

.4 Polypropylene shall not be used for vertical risers and piping in ceiling spaces acting as a return air plenum. Piping in risers and ceilings shall be glass piping.

.5 Pipes penetrating a fire separation shall be sealed by a fire stop system than, when subject to the fire test method in ULC S115 has an FT rating not less than the fire rating resistance of the fire separation.

.6 Install laboratory drainage system in strict accordance with the current manufacturer’s installation instructions.

3.3 TESTING

.1 Pressure test buried systems before backfilling.

.2 Hydraulically test to verify grades and freedom from obstructions.

3.4 PERFORMANCE VERIFICATION

.1 Cleanouts:

.1 Ensure accessible and that access doors are correctly located.

.2 Open, cover with linseed oil and re-seal.

.3 Verify that cleanout rods can probe as far as the next cleanout, at least.

.2 Test to ensure traps are fully and permanently primed.

.3 Storm water drainage:

.1 Verify domes are secure.

.2 Ensure weirs are correctly sized and installed correctly.

.3 Verify provisions for movement of roof system.

.4 Ensure that fixtures are properly anchored, connected to system and effectively vented.

.5 Affix applicable label (storm, sanitary, vent, pump discharge etc.) c/w directional arrows every floor or 4.5 m (whichever is less).

3.5 CLEANING

.1 Clean in accordance with Section 01 74 11.

.2 Waste Management: in accordance with Section 01 74 20.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

.2 Section 23 05 17

.3 Section 23 08 01

.4 Section 23 08 02

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME Boiler and Pressure Vessel Code Section VIII Pressure Vessels.

.1 BPVC-VIII B - 2017, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 1.

.2 BPVC-VIII-2 B - 2017, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 2 - Alternative Rules.

.3 BPVC-VIII-3 B - 2017, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 3 - Alternative Rules High Press Vessels.

.2 ASME B16.5-17, Pipe Flanges and Flanged Fittings.

.3 ASME B16.11-16, Forged Fittings, Socket-Welding and Threaded.

.4 ANSI/ASME B16.9-12 Factory made Wrought Steel Buttwelding Fittings.

.5 ANSI/ASME B16.25-12 Buttwelding Ends.

.6 ANSI/ASME B31.1-16 Power Piping.

.1 ANSI/ASME B31.3-16 Process Piping.

.2 Conform to the requirements of TSSA.

.3 American Society for Testing and Materials International (ASTM)

.1 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

.2 ASTM A181/A181M-14, Standard Specification for Carbon Steel Forgings for General Purpose Piping.

.4 Canadian Standards Association (CSA International)

.1 CSA B51-14, Boiler, Pressure Vessel, and Pressure Piping Code.

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00

.2 Co-ordinate submittal requirements and provide submittals required by Section 01 47 15.

.3 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.

.4 Shop Drawings:

.1 Submit shop drawings to indicate project layout including layout, dimensions and extent of piping system.

.1 Vertical and horizontal piping locations and elevations and connections details.

.2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.4 Instructions: submit manufacturer's installation instructions.

.5 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00.

1.4 QUALITY ASSURANCE

.1 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:

.1 In accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 PIPING (COMPRESSED AIR, VACUUM, NITROGEN, OXYGEN)

.1 Pipes shall be seamless Type K A.S.T.M. B-88) hard temper copper tubing or standard weight (Schedule 40) brass pipe, cleaned for oxygen service. Soft temper copper tubing shall be used underground.

.2 Fittings shall be wrought copper, brass or bronze for solder or brazed connections for copper tubing and screw type brass, or bronze, or copper brazing type fittings for brass pipe. Any system in excess of 15 psig and larger than 19 mm (3/4 inch) shall meet the requirements of TSSA. Soldered joints are not acceptable and shall be brazed.

2.2 BALL VALVES

.1 In-line valve assemblies shall be located as shown and as required by code, and shall be full flow, double seal, ball type

with bronze body, Buna-N seals and O ring packing, chrome plated brass ball and designed for working pressures up to 2070 kPa (300 psig). Only one quarter turn of the handle shall be required to operate the valve from the open to closed position. Valves shall be screwed type. All valves shall be serviceable in the line and supplied clean and prepared for service. Colour coded gas identification labels shall be provided for each valve.

.2 Valves to be lockable type.

2.3 COUPLERS/CONNECTORS

.1 Industrial interchange series, full-bore.

.2 Maximum inlet pressure: 1700kPa.

.3 Valve seat: moulded nylon.

.4 Body: zinc plated steel.

.5 Threads: NPT.

2.4 PRESSURE GAUAGES

.1 Only certified test gauges to be at 125% FS of test pressure.

PART 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 CONNECTIONS AND INSTALLATION

.1 Install flexible connection at piping connection to compressors.

.2 Install shut-off valves at outlets, major branch lines and in locations as indicated.

.3 Install quick-coupler chucks and pressure gauges on drop pipes.

.4 Install unions to permit removal or replacement of equipment.

.5 Install tees in lieu of elbows at changes in direction of piping. Install plug in open ends of tees.

.6 Grade piping at 1% slope minimum.

.7 Install compressed air trap and pressure equalizing pipe at moisture collecting points. Drain pipe to nearest floor drain.

.8 Make branch connections from top of main.

.9 Install compressed air trap at bottom of risers and at low points in mains, piped to nearest drain. Distance between drain points to be 30m maximum.

.10 Provide drain from refrigerated air dryer.

.11 Weld steel piping in accordance with Section 23 05 17and;

.1 To ASME code and requirements of authority having jurisdiction.

.2 Weld concealed and inaccessible piping regardless of size.

3.3 FIELD QUALITY CONTROL

.1 Site Tests/Inspection:

.1 Testing: pressure test in accordance with requirements of Section 21 05 01, for hours minimum, to min of 1100kPa or 110% of working pressure (whichever is greater), with outlets closed and with compressor or vacuum isolated from system. Pressure drop not to exceed 10kPa. Test gas shall be nitrogen.

.2 Any piping that is being repurposed for another service shall be reinspected, retested and the contractor shall apply for TSSA approval for the entire length of piping including for the piping that was installed as part of the previous project.

.3 Testing to be witnessed by the owner and TSSA.

.4 Contractor to be registered with TSSA for the piping systems being tested. Contractor to meet with TSSA before any testing started.

.5 All new piping to be registered with TSSA where applicable.

.2 Manufacturer's Field Services:

.1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its products, and submit written reports, in acceptable format, to verify compliance of work with Contract.

.2 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 Schedule site visits to review work at stages listed:

.1 Twice during progress of work at 50% and 100% complete.

.2 Upon completion of Work, after cleaning is carried out.

3.4 CLEANING

.1 Refer to Section 23 08 01and Section 23 08 02.

.2 Cleaning: blow out piping to clean interior thoroughly of oil and foreign matter.

.3 Check entire installation is approved by authority having jurisdiction.

.4 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 REFERENCE STANDARDS

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

.2 Canadian Standards Association (CSA International)

.1 CSA B139-09 Series-15, Installation Code for Oil Burning Equipment.

.3 Green Seal Environmental Standards (GSES)

.1 Standard GS-11-2015, Edition 3.2, Environmental Standard for Paints and Coatings.

.4 National Research Council Canada (NRC)

.1 National Fire Code of Canada 2015 (NFC).

.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-A2005, Adhesive and Sealant Applications.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product Data:

.1 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 Section with manufacturer's written instructions and 01 61 00.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 MATERIAL

.1 Paint: zinc-rich to CAN/CGSB-1.181.

.2 Sealants: in accordance with Section 07 92 00.

.3 Fire Stopping: in accordance with Section 07 84 00.

PART 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 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.

.3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

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.

.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer without interrupting operation of other system, equipment, components.

3.4 DRAINS

.1 Install piping with grade in direction of flow except as indicated.

.2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.

.3 Pipe each drain valve discharge separately to above floor drain.

.1 Discharge to be visible.

.4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 AIR VENTS

.1 Install automatic air vents at high points as per CSA B139.

.2 Install isolating valve at each automatic air valve.

.3 Install drain piping to approved location and terminate where discharge is visible.

3.6 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.

3.7 PIPEWORK INSTALLATION

.1 Install pipework to CSA B139.

.2 Screwed fittings jointed with Teflon tape.

.3 Protect openings against entry of foreign material.

.4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

.5 Assemble piping using fittings manufactured to ANSI standards.

.6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.

.1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.

.7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.

.8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

.9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.

.10 Install, except where indicated, to permit separate thermal insulation of each pipe.

.11 Group piping wherever possible and as indicated.

.12 Ream pipes, remove scale and other foreign material before assembly.

.13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

.14 Provide for thermal expansion as indicated.

.15 Valves:

.1 Install in accessible locations.

.2 Remove interior parts before soldering.

.3 Install with stems above horizontal position unless indicated.

.4 Valves accessible for maintenance without removing adjacent piping.

.5 Install globe valves in bypass around control valves.

.6 Use gate valves at branch take-offs for isolating purposes except where 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 ball valves for glycol service.

.10 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2400mm above floor in Mechanical Rooms.

.16 Check Valves:

.1 Install silent check valves in vertical pipes with downward flow, and as indicated.

.2 Install swing check valves in horizontal lines, on discharge of pumps, and as indicated.

3.8 SLEEVES

.1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.

.2 Material: schedule 40 black steel pipe.

.3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.

.4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.

.5 Installation:

.1 Concrete, masonry walls, 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:

.1 Provide space for firestopping.

.2 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.

3.9 ESCUTCHEONS

.1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.

.2 Construction: one piece type with set screws.

.1 Chrome or nickel plated brass or type 302 stainless steel..

.3 Sizes: outside diameter to cover opening or sleeve.

.1 Inside diameter to fit around pipe or outside of insulation if so provided.

3.10 PREPARATION FOR FIRE STOPPING

.1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with Section 07 84 00.

.2 Uninsulated unheated pipes not subject to movement: no special preparation.

.3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging fires topping material or installation.

.4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

.1 Flush system in accordance with Section 23 08 02

.2 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

.1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.

.2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.

.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 Departmental Representative.

.6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.

.7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

3.13 CLEANING

.1 Clean in accordance with Section 01 74 11.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: in accordance with Section 01 74 20.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ANSI/ASME)

.1 ASME B31.1-2016, Power Piping.

.2 ASME B31.3-2016, Process Piping.

.3 ASME Boiler and Pressure Vessel Code-2017:

.1 BPVC 2017 Section I: Power Boilers.

.2 BPVC 2017 Section V: Nondestructive Examination.

.3 BPVC 2017 Section IX: Welding and Brazing Qualifications.

.2 American Water Works Association (ANSI/AWWA)

.1 AWWA C206-17, Field Welding of Steel Water Pipe.

.3 American Welding Society (AWS)

.1 AWS C1.1M/C1.1-2000(R2012), Recommended Practices for Resistance Welding.

.2 AWS Z49.1-2012, Safety in Welding, Cutting and Allied Process.

.3 AWS WI-2015, Welding Inspection Handbook..

.4 Canadian Standards Association (CSA International)

.1 CSA W47.2-11(R2015), Certification of Companies for Fusion Welding of Aluminum.

.2 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.

.3 CSA B51-14), Boiler, Pressure Vessel and Pressure Piping Code.

.4 CAN/CSA-W117.2-12(R2017), Safety in Welding, Cutting and Allied Processes.

.5 CSA W178.1-2014, Certification of Welding Inspection Organizations.

.6 CSA W178.2-2014, Certification of Welding Inspectors.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

1.4 QUALITY ASSURANCE

.1 Qualifications:

.1 Welders:

.1 Welding qualifications in accordance with CSA B51.

.2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.

.3 Submit welder's qualifications to Departmental Representative.

.4 Each welder to possess identification symbol issued by authority having jurisdiction.

.5 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.

.2 Inspectors:

.1 Inspectors qualified to CSA W178.2.

.3 Certifications:

.1 Registration of welding procedures in accordance with CSA B51.

.2 Copy of welding procedures available for inspection.

.3 Safety in welding, cutting and allied processes in accordance with CAN/CSA-W117.2.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 ELECTRODES

.1 Electrodes: in accordance with CSA W48 Series.

PART 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 QUALITY OF WORK

.1 Welding: in accordance with ASME B31.1, ASME Boiler and Pressure Vessel Code, Sections I and IX and AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, applicable requirements of authority having jurisdiction.

3.3 INSTALLATION REQUIREMENTS

.1 Identify each weld with welder's identification symbol.

.2 Backing rings:

.1 Where used, fit to minimize gaps between ring and pipe bore.

.2 Do not install at orifice flanges.

.3 Fittings:

.1 NPS 2 and smaller: install welding type sockets.

.2 Branch connections: install welding tees or forged branch outlet fittings.

3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS

.1 Review weld quality requirements and defect limits of applicable codes and standards with Departmental Representative before work is started.

.2 Formulate "Inspection and Test Plan" in co-operation with Departmental Representative.

.3 Do not conceal welds until they have been inspected, tested and approved by inspector.

.4 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

3.5 SPECIALIST EXAMINATIONS AND TESTS

.1 General:

.1 Perform examinations and tests by specialist qualified to CSA W178.1 and CSA W178.2 and approved by Departmental Representative.

.2 To ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.

.2 Hydrostatically test welds to ASME B31.1.

.3 Visual examinations: include entire circumference of weld externally and wherever possibleinternally.

.4 Failure of visual examinations:

.1 Upon failure of welds by visual examination, perform additional testing as directed by Departmental Representative.

3.6 DEFECTS CAUSING REJECTION

.1 As described in ASME B31.1 and ASME Boiler and Pressure Vessels Code.

.2 In addition, chilled water systems:

.1 Undercutting greater than 0.8 mm adjacent to cover bead on outside of pipe.

.2 Undercutting greater than 0.8 mm adjacent to root bead on inside of pipe.

.3 Undercutting greater than 0.8 mm at combination of internal surface and external surface.

.4 Incomplete penetration and incomplete fusion greater than total length of 38 mm in 1500 mm length of weld depth of such defects being greater than 0.8mm.

.5 Repair cracks and defects in excess of 0.8mm in depth.

.6 Repair defects whose depth cannot be determined accurately on basis of visual examination or tests.

3.7 REPAIR OF WELDS WHICH FAILED TESTS

.1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

3.8 CLEANING

.1 Clean in accordance with Section 01 74 11.

.2 Waste Management: in accordance with Section 01 74 20.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B1.20.1-2013, Pipe Threads, General Purpose (Inch).

.2 ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit data for valves specified in this Section.

1.4 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00.

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials/Spare Parts:

.1 Furnish following spare parts:

.1 Valve seats: one for every 10valves each size, minimum 1.

.2 Discs: one for every 10valves, each size. Minimum 1.

.3 Stem packing: one for every 10valves, each size. Minimum 1.

.4 Valve handles: 2of each size.

.5 Gaskets for flanges: one for every 10flanged joints.

.2 Tools:

.1 Furnish special tools for maintenance of systems and equipment.

.2 Include following:

.1 Lubricant gun for expansion joints.

1.6 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.

.3 Packaging Waste Management: in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Valves:

.1 Except for specialty valves, to be single manufacturer.

.2 Products to have CRN registration numbers.

.2 End Connections:

.1 Connection into adjacent piping/tubing:

.1 Steel pipe systems: screwed ends to ASME B1.20.1.

.2 Copper tube systems: screwedto ASME B16.18.

.3 Lockshield Keys:

.1 Where lockshield valves are specified, provide 10keys of each size: malleable iron cadmium plated.

.4 Gate Valves:

.1 NPS 2 and under

.1 (150 psi) WSP or 1380 kPa (200 psi) non-shock WOG with bronze body, rising stem screwed.

.5 Globe Valves:

.1 NPS 2 and under

.1 (150 psi) WSP or 1380 kPa (200 psi) non-shock WOG with bronze body, with screwed to solder adapter and composition disc for water service.

.6 Ball Valves NPS 2 and smaller:

.1 bronze body or forged brass 4137 kPa (600 psi) WOG, virgin Teflon seat, TFE stem packing and thrust washer, 1/4 turn open-closed operation with solid ball, screwed ends.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install rising stem valves in upright position with stem above horizontal.

.2 Remove internal parts before soldering.

.3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

.4 Butterfly valves may be used in lieu of gate valves in size 65 mm (2-1/2 in.) and over in systems 1380 kPa (200 psi) and less. Where specifically shown on drawings, butterfly valves must be used. Install between 860 kPa (125 psi) flanges.

.1 Valves shall have iron body, one piece or split alloy steel shaft, top and bottom bearings, bronze disc or iron disc with stainless steel trim and resilient elastomer

replaceable seat with integral reinforcing ring or keyed to body.

.2 Body shall have threaded lugs.

.3 Valve shall have bubble tight shut-off to 1035 kPa (150 psi) pressure in either direction when the piping and connecting flange is removed from one side of the valve.

.4 Valves 100 mm (4 in.) and smaller shall have lever operator with lock.

.5 Valves larger than 100 mm (4 in.) shall have worm gear manual operator with indication of valve opening.

3.2 CLEANING

.1 Clean in accordance with Section 01 74 11.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials in accordance with Section 01 74 20.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B16.1-15, Cast Iron Pipe Flanges and Flanged Fittings: Classes 25, 125 and 250.

.2 ASTM International Inc.

.1 ASTM A49-12, Standard Specification for Heat-Treated Carbon Steel Joint Bars.

.2 ASTM A126-04(2014), Standard Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings.

.3 ASTM A536-84(2014), Standard Specification for Ductile Iron Castings.

.4 ASTM B61-15, Standard Specification for Steam or Valve Bronze Castings.

.5 ASTM B62-17, Standard Specification for Composition Bronze or Ounce Metal Castings.

.6 ASTM B85/B85M-14, Standard Specification for Aluminum-Alloy Die Castings.

.7 ASTM B209-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.3 Underwriters Laboratories of Canada

.1 ULC ORD-C262-1992 Gate Valves for Fire Protection Service

.4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)

.1 MSS SP-70-11, Grey Iron Gate Valves, Flanged and Threaded Ends.

.2 MSS SP-71-11, Grey Iron Swing Check Valves, Flanged and Threaded Ends.

.3 MSS SP-82-1992, Valve Pressure Testing Methods.

.4 MSS SP-85-2011, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product Data:

.1 Provide manufacturer's printed product literature, specifications and datasheets for valves and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

.1 Submit maintenance data for incorporation into manual specified in Section 01 78 00.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 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.

.3 Packaging Waste Management: in accordance with Section 01 74 20.

1.6 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials/Spare Parts:

.2 Furnish following spare parts:

.1 Valve seats: one for every 10 valves each size, minimum 1.

.2 Discs: one for every 10 valves, each size, minimum 1.

.3 Stem packing: one for every 10 valves, each size, minimum 1.

.4 Valve handles: 2 of each size.

.5 Gaskets for flanges: one for every 10 flanged joints.

.3 Tools:

.1 Furnish special tools for maintenance of systems and equipment.

.2 Include following:

.1 Lubricant gun for expansion joints.

PART 2 - PRODUCTS

2.1 MATERIAL

.1 Valves:

.1 Except for specialty valves, to be of single manufacturer.

.2 Standard specifications:

.1 Gate valves: MSS SP-70.

.2 Globe valves: MSS SP-85.

.3 Check valves: MSS SP-71.

.3 Requirements common to valves, unless specified otherwise:

.1 Body, bonnet: cast iron to ASTM B209 Class B.

.2 Connections: flanged ends to ASME B16.1.

.3 Inspection and pressure testing: to MSS SP-82.

.4 Bonnet gasket: non-asbestos.

.5 Stem: to have precision-machined 60 degrees V threads, top screwed for handwheel nut.

.6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.

.7 Gland packing: non-asbestos.

.8 Handwheel: die-cast aluminum alloy to ASTM B85/B85M or malleable iron to ASTM A49. Nut of bronze to ASTM B62.

.9 Identification tag: with catalogue number, size, other pertinent data.

.4 All products to have CRN registration numbers.

2.2 GATE VALVES

.1 NPS 2 1/2-8, outside screw and yoke (OS& Y), bronze mounted, solid wedge disc:

.1 Body and multiple-bolted bonnet: with full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.

.2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.

.3 Seat rings: renewable bronze screwed into body.

2.3 UNDERWRITERS APPROVED GATE VALVE

.1 NPS 2 1/2 - 14, OS& Y:

.1 Approvals: UL and FM approved for fire service.

.2 UL and FM Label: on valve yoke.

.3 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses to ANSI B16.1 and ULC C-262 (B).

.4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.

.5 Packing gland: bronze.

.6 Stem: manganese bronze. Diameter to ULC C-262 (B) or Brass, ASTM B16.

.7 Stuffing box dimensions, gland bolt diameter: to ULC C-262 (B).

.8 Bosses for bypass valve, drain: on NPS 4 and over.

.9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: EPDM coated cast iron with bronze disc rings.

.10 Disc seat ring: self-aligning, Milwood undercut on NPS 3 - 12.

.11 Pressure rating:

.1 NPS 2-1/2 - 12: 1.7 Mpa CWP.

.2 NPS 14-1.2: 1.2 MPa CWP.

.12 Operator: handwheel.

2.4 GLOBE VALVES

.1 NPS 2 1/2 - 10, OSY:

.1 Body: bolted bonnet.

.2 Bonnet-yoke gasket: non-asbestos.

.3 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.

.4 Seat ring: renewable, regrindable, screwed into body.

.5 Stem: bronze to ASTM B62.

.6 Operator: handwheel.

2.5 BYPASSES FOR GATE AND GLOBE VALVES

.1 Locations: as indicated, refer to details.

.2 Size of bypass valve:

.1 Main valve up to NPS 8: NPS 3/4.

.2 Main valve NPS 10 and over: NPS 1.

.3 Type of bypass valves:

.1 On gate valve: globe, with bronzedisc, bronzetrim, to Section 23 05 23.01. Pressure rating to match main valve.

.2 On globe valve: globe, with bronzedisc, bronzetrim, to Section 23 05 23.01. Pressure rating to match main valve.

2.6 VALVE OPERATORS

.1 Install valve operators as follows:

.1 Handwheel: on valves except as specified.

.2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in mechanical equipment rooms.

2.7 CHECK VALVES

.1 Swing check valves, Class 150:

.1 ANSI Class 150, 1030 kPa (150 psi) WSP, dual flapper retainerless design with carbon steel body and stainless steel check, renewable disc and seat for flanged installation

.2 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Grooved or flanged ends: plain faced with smooth finish.

.1 Up to NPS 16: cast iron to ASTM A126 Class B.

.2 .

.3 Disc: rotating for extended life.

.1 Up to NPS 6: stainless steel type 316.

.2 NPS 8 and over: bronze-faced cast iron.

.4 Seat rings: renewable bronze to ASTM B62 screwed into body.

.5 Hinge pin, bushings: renewable bronze to ASTM B62.

.6 Identification tag: fastened to cover.

.7 Hinge: stainless steel.

.2 Swing check valves, NPS 2 1/2 - 8 Class 250:

.1 Body and bolted cover: cast iron to ASTM A126 Class B with tapped and plugged opening on each side for hinge pin.

.2 Flanged ends: 2 mm raised face with serrated finish.

.3 Disc: rotating for extended life.

.1 Up to NPS 3: bronze to ASTM B61.

.2 NPS 4 - 8: iron faced with ASTM B61 bronze.

.4 Seat rings: renewable bronze to ASTM B61, screwed into body.

.5 Hinge pin, bushings: renewable, bronze to ASTM B61.

.6 Hinge: galvanized malleable iron.

.7 Identification tag: fastened to cover.

2.8 STRAINERS

.1 Strainers 65 mm (2-1/2 in.) and larger, cast iron 1720 kPa (250 psi) WSP flanged.

.2 Strainers 50 mm (2 in.) and smaller, cast iron 1720 kPa (250 psi) WSP, threaded.

2.9 BUTTERFLY VALVES

.1 Butterfly valves maybe used as an alternative to gate valves only and shall be iron body, one-piece alloy steel shaft, top and bottom bearings, bronze disc or iron disc with stainless steel trim, resilient elastomer replaceable seat with integral reinforcing ring or keyed to body. Body with threaded lugs. Bubble-tight shut-off to 1035 kPa (150 psi) pressure in either direction when the piping and connecting flange is removed from one side of the valve.

.2 Valves 100 mm (4 in.) and smaller with lever operator with lock.

.3 Valves 150 mm (6 in.) and larger with worm gear manual operator with indication of valve opening.

2.10 SILENT CHECK VALVES

.1 Construction:

.1 Body: carbon steel with integral seat.

.2 Pressure rating: Class 125, WP = 860 kPa.

.3 Connections: grooved ends.

.4 Disc: stainless steel renewable rotating disc.

.5 Seat: renewable, EPDM.

.6 Stainless steel spring, heavy duty.

2.11 OTHER VALVES

.1 Float type eliminators, designed for a minimum of 1035 kPa (150 psi) water pressure with steel or cast iron body having removable flanged top, stainless steel or copper float and stainless steel valve and level mechanism.

.2 As an alternative on vertical in-line pumps suction elbow may be combination elbow and strainer. Strainer perforations shall be as specified for Y strainers. Blow-off valves shall be provide in all sizes. Sizes of elbow strainer shall suit the pump suction size. Elbow shall be cast iron. Elbow shall be sized to suit pipe.

.3 Flow balancing valves shall have meter connection for attaching to a portable meter. Each connection shall have positive shut-off valves. Each valve shall be capable of precise flow measurement, accurate flow balancing and positive shut-off. Adjustment shall be by multiple turns of the handle for Vernier type setting and shall have a hidden memory feature for tamper-proof setting. All valves 65 mm (2-1/2 in.) and larger shall be

flanged or grooved, valves 50 mm (2 in.) and smaller shall be screwed.

.1 Provide a portable flow measuring meter, complete with hoses and carrying case to suit each size of valve provided. Meter shall be computerized, differential pressure type for direct reading of flow rate in either G.P.M. or L/s.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install rising stem valves in upright position with stem above horizontal.

3.2 CLEANING

.1 Clean in accordance with Section 01 74 11.

.2 Clean installed products in accordance to manufacturer's recommendation.

.3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 20.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 REFERENCE STANDARDS

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B31.1-16, Power Piping.

.2 ASTM International

.1 ASTM A125-1996(2013)e1, Standard Specification for Steel Springs, Helical, Heat-Treated.

.2 ASTM A307-14e1, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.3 ASTM A563-15, Standard Specification for Carbon and Alloy Steel Nuts.

.3 Factory Mutual (FM)

.4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)

.1 MSS SP-58-2009, Pipe Hangers and Supports - Materials, Design and Manufacture.

.5 National Research Council Canada (NRC)

.1 National Plumbing Code of Canada 2015(NPC).

.6 Underwriter's Laboratories of Canada (ULC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit shop drawings for:

.1 Bases, hangers and supports.

.2 Connections to equipment and structure.

.3 Structural assemblies.

.4 Certificates:

.1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Manufacturers' Instructions:

.1 Provide manufacturer's installation instructions.

1.4 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00.

1.5 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.

.3 Packaging Waste Management: in accordance with Section 01 74 20.
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PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

.1 Design Requirements:

.1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.

.2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP-58.

.3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.

.4 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.

.5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP-58.

2.2 GENERAL

.1 Piping and equipment shall be complete with all necessary supports and hangers required for a safe and workmanlike installation.

.2 Hangers, supports, anchors, guides, and restraints shall be selected to withstand all static and dynamic loading conditions which act upon the piping system and associated equipment. Prepare detailed shop drawings showing all anchors and guides for all systems with the potential for thermal expansion/contraction and/or loads due to weight or thrust. The drawings shall bear the signed seal of a Professional Engineer licensed to practice in the appropriate discipline and place of work. The drawings shall include all details of construction, static and dynamic forces at points of attachment, etc. necessary for review and acceptance by the Departmental Representative. Make adjustments as necessary to satisfy the requirements of the Departmental Representative. No anchor points shall be permitted without reviewed shop drawings and, where installed prior to review,

shall be removed and replaced to the satisfaction of the Departmental Representative.

.3 Fabricate hangers, supports and sway braces in accordance with MSS SP-58 and ANSI B31.1.

.4 Use components for intended design purpose only. Do not use for rigging or erection purposes.

.5 All hangers, supports, brackets and other devices installed exterior to the building shall be galvanized to prevent failure from environmental corrosion. If galvanized components cannot be used submit samples of proposed substitute for review prior to installation.

2.3 PIPE HANGERS

.1 Finishes:

.1 Pipe hangers and supports: galvanizedafter manufacture.

.2 Ensure steel hangers in contact with copper piping are epoxy coated or copper plated.

.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 carbon steel retaining clip.

.2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, MSS SP-58.

.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, to MSS SP69.

.2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut.

.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 6mm minimum greater than rod diameter.

.2 Concrete inserts: wedge shaped body with knockout protector plate to MSS SP-58.

.5 Hanger rods: threaded rod material to MSS SP58:

.1 Ensure that hanger rods are subject to tensile loading only.

.2 Provide linkages where lateral or axial movement of pipework is anticipated.

.3 Do not use 22mm or 28mm rod.

.6 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 hot pipework.

.4 Oversize pipe hangers and supports.

.7 Adjustable clevis: material to MSS SP-58, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.

.1 Ensure "U" has hole in bottom for rivetting to insulation shields.

.8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP-58.

.9 U-bolts: carbon steel to MSS SP69 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.

.10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.4 RISER CLAMPS

.1 Steel or cast iron pipe: galvanized carbon steel to MSS SP-58, type 42.

.2 Copper pipe: carbon steel copper plated to MSS SP-58, type 42.

.3 Bolts: to ASTM A307.

.4 Nuts: to ASTM A563.

2.5 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:

.1 64 kg/m3density insulation plus insulation protection shield to: MSS SP-58, galvanized sheet carbon steel. Length designed for maximum 3 m span.

.2 Insulated hot piping:

.1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP-58.

2.6 CONSTANT SUPPORT SPRING HANGERS

.1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).

.2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.

.3 Provide upper and lower factory set travel stops.

.4 Provide load adjustment scale for field adjustments.

.5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.

.6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.7 VARIABLE SUPPORT SPRING HANGERS

.1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.

.2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2springs in series in single casing.

.3 Variable spring hanger complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.

.4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.8 EQUIPMENT SUPPORTS

.1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 12 23. Submit calculations with shop drawings.

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.10 HOUSE-KEEPING PADS

.1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50mm larger than equipment; chamfer pad edges.

.2 Concrete: to Section 03 30 00.

2.11 OTHER EQUIPMENT SUPPORTS

.1 Fabricate equipment supports from structural grade steel meeting requirements of Section 05 12 23.

.2 Submit structural calculations with shop drawings.

PART 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 Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent undue stress to building structural components.

.2 Suspending one hanger from another shall not be permitted.

.3 Install in accordance with:

.1 Manufacturer's instructions and recommendations.

.4 Vibration Control Devices:

.1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.

.5 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.

.6 Clevis plates:

.1 Attach to concrete with 4minimum concrete inserts, oneat each corner.

.7 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

.8 Use approved constant support type hangers where:

.1 Vertical movement of pipework is 13 mm or more,

.2 Transfer of load to adjacent hangers or connected equipment is not permitted.

.9 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.

.10 For special equipment supports refer to equipment sections. Where no support method is identified secure wall mounted equipment to metal framing or masonry, with steel toggle or expansion fasteners, machine screws or sheet metal screws as applicable. Plastic, fibre or soft metal inserts shall not be acceptable. Wall mounted equipment shall not exceed 45.5 Kg (100 lbs) in weight or 250mm (10”) in depth unless reviewed or detailed by the Engineer’s Representative. Where framing does not permit direct attachment, provide metal strut sub-framing or minimum 19mm (3/4 in.) fire retardant treated plywood backboards, unpainted, attached to the framing. Provide attachments for backboards at 600mm (24 in.) on centres with no less than 4 attachments.

3.3 HANGER SPACING

.1 Plumbing piping: to National Plumbing Code of Canada (NPC) or Ontario Building Code, whichever is more stringent.

.2 Fire protection: to Ontario fire code.

.3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.

.4 Copper piping: up to NPS 1/2: every 1.5 m.

.5 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.

.6 Within 300mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

.7 Pipework greater than NPS 12: to MSS SP-58.

3.4 HANGER INSTALLATION

.1 Install hanger so that rod is vertical under operating conditions.

.2 Adjust hangers to equalize load.

.3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

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, 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 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.2 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 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.8 CLEANING

.1 Clean in accordance with Section 01 74 11.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: in accordance with Section 01 74 20.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 REFERENCE STANDARDS

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.2 National Fire Protection Association (NFPA)

.1 NFPA 13-2016, Standard for the Installation of Sprinkler Systems.

.3 National Research Council Canada (NRC)

.1 National Building Code of Canada 2015(NBC).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00. Include product characteristics, performance criteria, and limitations.

.2 Submit shop drawings in accordance with Section 01 33 00.

.1 Provide system shop drawingscomplete with performance and product data.

.3 Quality assurance submittals: submit following in accordance with Section 01 33 00.

.1 Instructions: submit manufacturer's installation instructions.

1.4 PERFORMANCE REQUIREMENTS

.1 Adequately isolate all equipment to maintain acceptable noise levels in the occupied area of the building as specified below. Take noise measurements over the complete audible frequency range in each of the occupied zones under, above and beside Mechanical Equipment Rooms, and where indicated by the Departmental Representative. Noise levels due to mechanical equipment, ductwork, grilles, registers, terminal devices, diffusers, etc, shall not exceed sound pressure levels in all 8 octave bands corresponding to the NC levels per ASHRAE handbook as indicated.

AREAS	N.C. LEVELS
General Offices	35
Meeting Rooms	35
Duct distribution system	35
Storage Rooms	40
Entrance Halls	40
Laboratories	50

Outdoors	45 dBA

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 GENERAL

.1 Size and shape of bases type and performance of vibration isolation as indicated.

.2 All equipment provided for vibration isolation or noise control shall be new and manufactured specifically for the purpose intended.

.3 Provide silencers in accordance with the Silencer Schedule.

.4 Type EP (Elastomeric Pad)

.1 Type EP shall be 8mm thick ribbed or waffle neoprene pads. Isolator pads shall be selected for less than 80% maximum rated load.

.2 If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve shall be installed under the bolt head between the steel washer and the base plate.

.5 Type MEP

.1 Type MEP shall consist of two 8mm thick ribbed or waffle neoprene pads bonded to each side of a 16-gauge stainless or galvanized steel shim plate. Isolator pads shall be selected for less than 80% maximum rated load.

.2 If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve shall be installed under the bolt head between the steel washer and the base plate.

.6 Type DDNM (Double Deflection Neoprene Mounts)

.1 Type DDNM shall be laterally stable, double deflecting, molded neoprene isolators. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed and bolt holes shall be provided in the base. The mounts shall have leveling bolts rigidly secured to the equipment.

.2 DDNM mounts shall be selected for a static deflection of 9.5mm unless specified otherwise.

.7 Type DDNH (Double Deflection Neoprene Hangers)

.1 Type DDNH shall consist of a molded neoprene isolating element in a steel hanger box. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel. The diameter of the clear hole in the hanger box shall be at least 19mm larger than the diameter of the hanger rod and permit the hanger rod to swing through a 30 degree arc. When installed the hanger box shall be allowed to rotate through a full 360 degrees without encountering an obstructions.

.2 Unless otherwise specified the static deflection of DDNH hangers shall be 8mm.

.8 Type SPNM (Spring and Neoprene Mounts)

.1 Type SPNM shall have a free standing and laterally stable steel spring without any housing, and two type WP isolation pads sandwiching a 16 gauge stainless or galvanized steel separator plate shall be bonded to the isolator base plate. Springs shall be designed so that the ratio of the horizontal to vertical spring constant is between one and two. The spring diameter shall not be less than 80% of the compressed height of the spring at rated load. Loaded springs shall have a minimum additional travel to solid equal to 50% of the specified static deflection.

.2 Unless otherwise specified the minimum static deflection of SPNM isolators under actual load conditions for equipment mounted on grade slabs shall be 25 mm (1 in.), and 50 mm (2 in.) for equipment mounted above grade level.

.3 Unless otherwise specified, isolators need not be bolted to the floor for indoor installations. If base plates are bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 602/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.

.9 Type SPH (Spring Hangers)

.1 Type SPH shall consist of a steel spring and welded steel housing. Spring diameter and hanger box hole shall be large enough to permit the hanger rod to swing through a 30 degree arc. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 19 mm (3/4 in.) larger than the diameter of the hanger rod. When installed, the spring element shall not be cocked, and the hanger box shall be allowed to rotate through a full 360 degree arc without encountering any obstructions.

.2 Unless otherwise specified, the static deflection of SPH hangers under actual load conditions shall be 50 mm (2 in.).

.10 Type SPNH (Spring and Neoprene Hangers)

.1 Type SPNH shall be as above with the addition of a neoprene element in series with the spring. The neoprene element shall have a deflection of not less than 9mm with a strain not exceeding 15%. Unless otherwise specified, the static deflection of SPNH hangers under actual load conditions shall be 50 mm (2 in.).

.11 Type CSNM (Constrained Spring and Neoprene Mounts)

.1 Type CSNM shall be a spring and neoprene mount that incorporates a housing which contains unrestrained stable springs with built-in leveling device and resilient vertical limit stops to prevent spring elongation when partial load is removed and limits the movement of equipment when it is subjected to wind loading.

.2 A minimum clearance of 25 mm (1 in.) shall be maintained around the restraining bolts and between the housing and the spring so as not to interfere with the spring operation. Limit stops shall provide minimum 6 mm (1/4 in.) clearance under normal operation, and a neoprene washer shall be installed beneath the bolt head/washer used to restrain the isolator.

.3 For Installations subject to wind load, provide tapped hole in top and bottom plates for bolting to equipment and the roof or supporting structure with a neoprene sleeve.

.4 Provide minimum 6mm thick neoprene acoustical base pad on the underside of the mount unless designated otherwise.

.5 Mount shall be capable of supporting equipment at a fixed elevation during equipment erection. Installed and operating heights shall be identical.

.6 Unless specified otherwise, the minimum static deflection for Type CSNM mounts under actual load conditions shall be 50 mm (2 in.).

.12 Type SB (Steel Base)

.1 Type SB inertia base which shall be a structural steel base frame with clearance holes located to correspond to the mounting bolt holes of the equipment mounted on the base. Fan bases shall have built-in motor slide rails, and shall be reinforced as necessary to withstand belt pull without drive misalignment or base distortion.

.2 The bases shall be constructed with deep angle steel sections with a minimum vertical angle leg of 100 mm (4 in.) for motors of 7.5 hp or less, 125 mm (5 in.) for motors between 7.5 hp and 20 hp, and 150 mm (6 in.) for motors over 20 hp.

.3 Structural steel base frames shall be prime-painted (galvanized).

.13 Type CB (Concrete Base)

.1 Type CB inertia base shall have an integral rectangular structural steel form to which concrete is poured.

.2 Perimeter members shall be beams of depth equal to 10% of the longest span of the base, but not more than 300 mm (12 in.) or less than 150 mm (6 in.) deep. Forms shall include

motor slide base and all reinforcing steel. Where anchor bolt locations fall in concrete, the reinforcing steel shall include drilled members with sleeves welded below the steel to accept the anchor bolts. Height saving steel brackets shall be used in all mounting locations.

.3 When the concrete base is T-shaped, isolators shall be located under the projections as well as under the main body in order to prevent cantilever distortion.

.4 Inertia bases for pumps shall be of sufficient size to accommodate supports for pipe elbows at pump suction and discharge connections.

.5 Height saving brackets or welded steel pockets shall be incorporated in ensure a 50 mm (2 in.) minimum clearance under each inertia base.

.6 The weight of each inertia base shall be sufficient to lower the centre of gravity to or below the isolator support plane.

.7 The structural perimeter frame, mounting templates, height saving brackets, and spring system shall be provided as an assembly by the vibration control vendor.

.8 Structural perimeter frames shall be prime-painted (galvanized).

.14 All spring mounts shall be complete with levelling devices 6 mm (1/4 in.) thick ribbed neoprene sound pads and completely colour coded stable springs.

.15 Where steel spring isolation systems are described in the specifications, the mounting assemblies shall utilize bare springs with the spring diameter not less than 80% of the loaded operating height of the spring. Each spring isolator shall be designed and installed so that the ends of the spring remain parallel during and after spring installation.

.16 All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer, and must be linear over a deflection range of not less than 50% above the design deflection.

.17 All vibration isolators shall have either known undeflected heights of calibration markings to that, after adjustment, verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to design.

.18 All mounts installed outdoors or exposed to high humidity conditions shall have two coats of rust resisting paint and springs shall be cadmium plated and neoprene coated. Nuts and bolts shall be cadmium plated. All metal parts of mountings (except springs and hardware) shall be hot dip galvanized.

.19 Grout: Non-shrink, self-levelling grout having ability to withstand thermal, vibratory and impact stresses.

.20 Acoustic Sealant: Non-hardening, non-skinning permanently flexible, to CAN/CGSB-19.21-M87.

2.2 ACOUSTICAL DUCT AND PIPE LAGGING

.1 The barrier shall be constructed of a 2 mm (1/16 in.) thick barium sulphate loaded limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side. The barrier shall have a nominal density of 4.8 kg/m^3 (1 lbs/ft^3) and shall have a minimum STC rating of 28.

.2 The barrier shall have a minimum thermal conductivity "K" value of 0.29 and a rated service temperature range of -40 Deg. C. (-40 Deg. F.) to 105 Deg. C. (220 Deg. F.).

.3 The barrier shall have a Flame Spread Index of no more than 25 and a Smoke Development Index of no more than 50 when tested for Surface Burning Characteristics per ASTM E84.

.4 The decoupling layer shall be a combination of 25 mm (1 in.) or 50 mm (2 in.) as shown, fibreglass batting, non woven porous scrim-coated glass cloth, quilted together in a matrix of diamond stitch pattern which encapsulates the glass fibres. The composite material shall be fabricated to include a nominal 152 mm (6 in.) wide barrier overlap tab extending beyond the quilted fibreglass to facilitate a leak-tight seal around field joints.

2.3 SILENCERS

.1 Factory-Built Silencers shall be completely pre-fabricated of incombustible materials and shall have a minimum insertion loss and a maximum air pressure drop as shown in Silencer Schedule. Submitted silencer performance shall be according to ASTM E477-06a “Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers”

.2 Media filled silencers shall contain acoustic media type as indicated on the Silencer Schedule, either acoustic quality, shot free glass fibre insulation with long, resilient fibres bonded with a thermosetting resin, or 100% natural cotton fibres treated with an EPA registered, non-toxic borate solution, “flash dried” to provide resistance to mould, mildew and fungi. Media shall not cause or accelerate corrosion of aluminum or steel. Glass fibre, and rockwool will not be permitted as a substitute for cotton fibre media.

.3 Acoustic media in media filled silencers shall have density as required to provide specified performance, packed under 15 percent compression and protected from air erosion by perforated sheet metal, gauge as specified below.

.4 Acoustic media filled silencers with internal air velocities above 22.9 m/s (4500 fpm) shall have acoustic media wrapped with glass fibre cloth for additional erosion protection. Where indicated on the Silencer Schedule silencers shall have acoustic media wrapped in Tedlar film liner to help prevent shedding, erosion and impregnation of the acoustic media.

.5 No-media silencers shall contain no absorptive media of any kind. Attenuation shall be achieved with controlled impedance membranes and broadly tuned resonators.

.6 Silencer materials, including acoustic media and Tedlar film, shall have the following combustion ratings when tested in

accordance with ASTM E84-17: maximum Flamespread Classification 25, maximum Smoke Development Rating 50.

.7 Rectangular type silencers for duct systems operating less than 4 in. WG and designated as Class 1 on the Silencer Schedule shall be constructed with a minimum 22 gauge (0.78 mm) lock formed galvanized steel outer casing and 26 gauge (0.47 mm) galvanized perforated steel liner.

.8 Rectangular type silencers for duct systems operating greater than 4 in. WG and less than 8 in. WG and designated as Class 2 on the Silencer Schedule shall be constructed with a minimum 18 gauge (1.18 mm) Pittsburgh lock formed galvanized steel outer casing and 22 gauge (0.78 mm) galvanized perforated steel liner.

.9 Rectangular type elbow silencers shall have minimum Class 2 construction, 18 gauge (1.18 mm) Pittsburgh lock formed galvanized steel outer casing and 22 gauge (0.78 mm) galvanized perforated steel liner, unless indicated as Class 3 on the Silencer Schedule. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 1200 mm (48 in.) shall have at least two half splitters and one full splitter.

.10 Silencers shall be complete with high transmission loss (HTL) casing where indicated on the silencer schedule. HTL walls shall consist of media, airspace, mass and outer protective metal skin as required to obtain specified room noise criteria. Standard acoustic panels will not be accepted as HTL walls. Where requested by the Engineer’s Representative, provide breakout noise calculations for each air handling and fan system with silencer submittal to insure compliance with the room noise criteria. Breakout noise calculations shall be based on the sound power levels of the specified equipment and calculation methods in accordance with ASHRAE HVAC Applications handbook.

PART 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 Obtain one copy of all Shop Drawings of equipment to be isolated showing weights, shaft centres and all dimensions.

.2 On system start-up, inspect the complete installation and provide a report in writing.

.3 Furnish concrete bases, including concrete fill, on springs or other vibration isolation materials for mechanical isolation.

.4 All floor mounted equipment shall be erected on concrete housekeeping pads, with thickness as identified, over the complete floor area of the equipment, unless shown or specified otherwise. Wherever vibration eliminating devices and/or concrete inertia pads are specified, these items shall be mounted on concrete housekeeping pads.

.5 Furnish and install neoprene mounting sleeves for hold-down bolts to prevent any metal to metal contact.

.6 All equipment shall be provided with lateral restraining isolators as required to limit horizontal motion to 6mm maximum, under all operating conditions. Lateral restraining isolators shall have the same static deflection as equipment being isolated.

.7 Unless otherwise indicated, all equipment mounted on vibration isolators shall have a minimum operating clearance of 50 mm (2 in.) between the bottom of the equipment or inertia base (and height-saving bracket) and the concrete housekeeping pad (or bolt heads) beneath the equipment. The clearance shall be checked by the Contractor to ensure that no material has been left to short- circuit the vibration isolators. There shall be a minimum 100 mm (4 in.) clearance between isolated equipment and the walls, ceiling, floors, columns and any other equipment not installed on vibration isolators.

.8 Piping, ductwork, conduit or mechanical equipment shall be supported from building structure, not hung from or supported on other equipment, pipes, or ductwork.

.9 Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping, and blocked-up with temporary shims to final operating height. When the system is assembled and fluid is added, the isolators shall be adjusted to allow removal of the shims.

.10 All mechanical equipment not specifically identified in this Section that contains rotating or vibrating elements, and any associated electrical apparatus installed by this Division that contains transformers or inductors shall be installed on Type DDNM, MEP, or EP isolators as appropriate.

.11 All wiring connections to mechanical equipment on isolators shall be made with a minimum long flexible conduit installed in a slack “U” shape.

.12 Elastomeric isolators that will be exposed to temperatures below 0 deg. C. (32 deg. F.) shall be fabricated from natural rubber instead of neoprene.

.13 Springs shall be designed and installed so that ends of springs remain parallel and all springs installed with adjustment bolts.

.14 Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.

.15 Fans and air handling units shall be levelled with fans operating before the flexible connectors are attached.

.16 All fan bases and isolators shall be sized so that thrust restraints (which would act against turning moment caused by static pressure) are not required.

.17 Any conflicts with other trades which result in rigid contact with the equipment or piping due to inadequate space or other unforeseen conditions should be brought to the Departmental Representative's attention prior to installation. If not brought to the attention of the Departmental Representative prior to installation corrective work necessitated by conflicts shall be at the Contractor's expense.

.18 Locate isolation hangers with the housing a minimum of 50 mm (2 in.) below but as close as possible to the structure. Where isolator hangers would be concealed by a non-accessible acoustical sub-ceiling, install the hangers immediately below the sub-ceiling for access.

.19 Except as noted elsewhere in this specification, outside the Mechanical Room all HVAC, compressed air, and domestic hot and cold water pipes with an inner diameter less than or equal to 50 mm (2 in.) shall be isolated from the structure with sponge neoprene, felt or glass /mineral fibre sleeves between the pipe and pipe clamp or with Type WP pads between the clamp and the structure. When compressed, the sleeve shall be not less than 3 mm (1/8 in.) in thickness.

.20 All piping outside the Mechanical Room with inner diameter greater than 50 mm (2 in.) shall be supported on Type SPNM isolators or suspended by Type SPNH isolators. Where piping is ganged on a trapeze the piping shall rest on the trapeze, which shall be isolated from the structure by the appropriate isolators. Neoprene pipe riser guides shall be used where lateral restraint is required.

.21 Any pipe crossing an acoustical joint shall have a twin-sphere neoprene flexible connector at the joint, with the exception of piping associated with fire protection, natural gas and compressed gases, and shall be suspended by Type SPNH isolators as follows:

.1 Pipes with inner diameters less than 50 mm (2 in.) shall be suspended by Type DDNH isolators for a minimum distance of 6m on each side of the joint.

.2 Pipes with an inner diameter of 50 mm (2 in.) or greater shall be suspended on Type SPNH isolators for a minimum distance of 6m on the non-isolated structure and for the entire pipe length on the isolated structure.

.22 Where pipes rise in a vertical chase and are supported from a structure with type SPNH or DDNH isolators and require lateral bracing, neoprene riser guides shall be mounted around the pipe to limit lateral movement and to prevent direct contact with the supporting structure.

.23 Ducts shall be connected to fans, fan casings and fan plenums by means of flexible connectors. Flexible connectors shall be installed to prevent metal-to-metal contact across flexible connection. Flexible duct connectors shall not be used outside the Mechanical Room unless expressly shown on the Drawings.

.24 After installation, manufacturer shall verify that the vibration isolation systems are installed and operating properly, and shall submit a certificate so stating. Verify that the isolators are adjusted, with springs perpendicular to bases or housings, adjustment bolts are tightened up on equipment mountings, and hangers are not cocked.

3.3 SILENCERS

.1 Where silencers are to be installed in stainless steel or aluminum ductwork, the silencer shall be all stainless steel or aluminum construction to match the ductwork gauges used.

.2 Silencers for all variable air volume boxes, and fan powered variable volume boxes shall be as scheduled in the Silencer Schedule. Refer to Drawings for specific number required. The Silencer Schedule only indicates type. Receive from VAV box manufacturer dimension and sound data. Adjust silencers as required to match box discharge size. Adjust silencer as required to ensure insertion loss necessary to meet the room noise criteria.

.3 Silencers shall have outside dimensions that match the connecting duct size unless indicated otherwise.

.4 Submittals shall include certified test data on dynamic insertion loss, self-noise power levels, and pressure drop for reverse or forward flow. Silencer performance must have been substantiated by laboratory testing according to ASTM E477-06a and so certified when submitted for approval. The aero-acoustic laboratory must be NVLAP accredited for the ASTM E477-06a test standard. A copy of the accreditation certificate must be included with the submittals. Data from non-NVLAP accredited test facilities will not be accepted. Shop Drawings submitted without proper certifications will be rejected.

.5 The certification of the pressure drop, insertion loss and generated noise data shall be based upon tests of the same silencer for all measurements.

.6 For specific silencers indicated on the Silencer Schedule, the manufacturer shall provide acoustic analysis for approval showing that this silencer will reduce mechanical fan noise to acceptable levels in the occupied space. Use sound power levels of actual equipment to be installed on project. Analysis shall include breakout noise calculations.

3.4 FIELD QUALITY CONTROL

.1 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 After delivery and storage of Products.

.2 After preparatory work is complete but before installation commences.

.3 Twice during the installation, at 25% and 60% completion stages.

.4 Upon completion of installation.

.3 Submit manufacturer's reports to Departmental Representativewithin 3days of manufacturer representative's review.

.4 Make adjustments and corrections in accordance with written report.

.2 Inspection and Certification:

.1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systemsafter start up and TAB of systems to Section 23 05 93.

.2 Provide Departmental Representative with notice 24hours in advance of commencement of tests.

.3 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).

.4 Submit complete report of test results including sound curves.

3.5 CLEANING

.1 Proceed in accordance with Section 01 74 11.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA)

.1 CSA B149.1-15, Natural Gas and Propane Installation Code.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.

.2 CAN/CGSB-24.3-92, Identification of Piping Systems.

.3 National Fire Protection Association (NFPA)

.1 NFPA 13-2016, Standard for the Installation of Sprinkler Systems.

.2 NFPA 14-2016, Standard for the Installation of Standpipe and Hose Systems.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.2 Submittals: in accordance with Section 01 33 00.

.3 Product data to include paint colour chips, other products specified in this section.

.4 Samples:

.1 Submit samples in accordance with Section 01 33 00.

.2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.4 QUALITY ASSURANCE

.1 Quality assurance submittals: submit following in accordance with Section 01 33 00.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 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.

2.2 SYSTEM NAMEPLATES

.1 Colours:

.1 Hazardous: red letters, white background.

.2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

.2 Construction:

.1 3 mm thick white anodized aluminum or laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to following table:

Size # mm	Sizes (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.

.4 Locations:

.1 Terminal cabinets, control panels: use size # 5.

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

2.3 PIPING SYSTEMS GOVERNED BY CODES

.1 Identification:

.1 Natural gas: to authority having jurisdiction and CSA/CGA B149.1.

.2 Sprinklers: to NFPA 13.

.3 Standpipe and hose systems: to NFPA 14.

2.4 IDENTIFICATION OF PIPING SYSTEMS

.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 Pictograms:

.1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.

.3 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB-24.3.

.4 Arrows showing direction of flow:

.1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.

.2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.

.3 Use double-headed arrows where flow is reversible.

.5 Extent of background colour marking:

.1 To full circumference of pipe or insulation.

.2 Length to accommodate pictogram, full length of legend and arrows.

.6 Materials for background colour marking, legend, arrows:

.1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.

.2 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.

.7 Colours and Legends:

.1 Where not listed, obtain direction from Departmental Representative.

.2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

.3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
Softened water	Green	SOFTENED WATER
RO Water	Green	RO WATER
Condenser water supply	Green	COND. WTR. SUPPLY
Condenser water return	Green	COND. WTR. RETURN
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Make-up water	Yellow	MAKE-UP WTR
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS

Non Potable cold water supply	Yellow	NON POTABLE CWS
Non Potable hot water supply	Yellow	NON POTABLE HW SUPPLY
Non Potable HWS recirculation	Yellow	NON POTABLE HW CIRC
Acid Drainage	Yellow	LABORATORY DRAINAGE
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
Natural gas	To Code	NAT. GAS
Nitrogen	Yellow	NITROGEN
Oxygen	Yellow	OXYGEN
Laboratory Compressed air	Green	LAB COMP. AIR
Vacuum	Green	VACUUM
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS

2.5 IDENTIFICATION DUCTWORK SYSTEMS

.1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.

.2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

2.6 VALVES, CONTROLLERS

.1 Brass tags with 12 mm stamped identification data filled with black paint.

.2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.7 CONTROLS COMPONENTS IDENTIFICATION

.1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.

.2 Inscriptions to include function and (where appropriate) fail-safe position.

2.8 LANGUAGE

.1 Identification in English.

.2 Use one nameplate and label for both languages each language.

PART 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 TIMING

.1 Provide identification only after painting has been completed.

3.3 INSTALLATION

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

3.4 NAMEPLATES

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

.1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m 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 Adjacent to each change in direction.

.3 At least once in each small room through which piping or ductwork passes.

.4 On both sides of visual obstruction or where run is difficult to follow.

.5 On both sides of separations such as walls, floors, partitions.

.6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.

.7 At beginning and end points of each run and at each piece of equipment in run.

.8 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 easily and accurately readable from usual operating areas and from access points.

.1 Position of identification approximately at right angles to 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.

3.6 VALVES, CONTROLLERS

.1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.

.2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Departmental Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.

.3 Number valves in each system consecutively.

3.7 CLEANING

.1 Proceed in accordance with Section 01 74 11

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 QUALIFICATIONS OF TAB PERSONNEL

.1 Submit names of personnel to perform TAB to Departmental Representativewithin 30days of award of contract.

.2 Provide documentation confirming qualifications, successful experience.

.3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:

.1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2017, 7th Edition.

.2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) 1780, HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.

.4 Recommendations and suggested practices contained in the TAB Standard: mandatory.

.5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.

.6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.

.7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

.8 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 TAB Specialist.

.2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

.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.

1.4 EXCEPTIONS

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

1.5 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.

1.6 PRE-TAB REVIEW

.1 Review Contract Documents before project construction is startedconfirm in writing to Departmental Representativeadequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to Departmental Representativein writing proposed procedures which vary from standard.

.3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 START-UP

.1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

.2 Follow special start-up procedures specified elsewhere in Division 23.

1.8 OPERATION OF SYSTEMS DURING TAB

.1 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.

1.9 START OF TAB

.1 Notify Departmental Representative 7 days prior to start of TAB.

.2 Start TAB when building is essentially completed, including:

.3 Installation of ceilings, doors, windows, other construction affecting TAB.

.4 Application of weatherstripping, sealing, and caulking.

.5 Pressure, leakage, other tests specified elsewhere Division 23.

.6 Provisions for TAB installed and operational.

.7 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 Fire, smoke, volume control dampers installed and open.

.6 Coil fins combed, clean.

.7 Access doors, installed, closed.

.8 Outlets installed, volume control dampers open.

.3 Liquid systems:

.1 Flushed, filled, vented.

.2 Correct pump rotation.

.3 Strainers in place, baskets clean.

.4 Isolating and balancing valves installed, open.

.5 Calibrated balancing valves installed, at factory settings.

.6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

.1 LaboratoryHVAC systems: plus 10%, minus 0%.

.2 Other HVAC systems: plus 5%, minus 5%.

.3 Hydronic systems: plus or minus 10%.

1.11 ACCURACY TOLERANCES

.1 Measured values accurate to within plus or minus 2% of actual values.

1.12 INSTRUMENTS

.1 Prior to TAB, submit to Departmental Representative list of instruments used together with serial numbers.

.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.

1.13 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit, prior to commencement of TAB:

.2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 PRELIMINARY TAB REPORT

.1 Submit for checking and approval of Departmental Representative, 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 Summaries.

1.15 TAB REPORT

.1 Format report for clarity. Hand written reports will not be accepted.

.2 TAB report to show results in SI and IP units and to include:

.1 Project record drawings.

.2 System schematics.

.3 Submit 3 copies of TAB Report to Departmental Representativefor verification and approval, Englishin D-ring binders, complete with index tabs.

1.16 VERIFICATION

.1 Reported results subject to verification by Departmental Representative.

.2 Provide personnel and instrumentation to verify up to 30% of reported results.

.3 Number and location of verified results as directed by Departmental Representative.

.4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

1.17 SETTINGS

.1 After TAB is completed to satisfaction of Departmental Representative, 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.

1.18 COMPLETION OF TAB

.1 TAB considered complete when final TAB Report received and approved by Departmental Representative.

1.19 AIR SYSTEMS

.1 Standard: TAB to most stringent of TAB standards of AABC, ASHRAE, or SMACNA.

.2 The following systems shall be tested and balanced:

.1 Air conditioning, ventilation and heating systems

.2 Miscellaneous ventilation or exhaust systems

.3 Air distribution (supply, return and exhaust)

.4 Chillers and chilled water distribution

.5 Life safety and fire protection systems

.6 Plumbing systems

.7 All process piping including gas, air nitrogen and vacuum

.3 Qualifications: personnel performing TAB qualified and current member in good standing of AABC or NEBB.

.4 Quality assurance: perform TAB under direction of supervisor qualified to standards of NEBB or AABC.

.5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

.6 Locations of equipment measurements: to include as appropriate:

.1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.

.2 At controllers, controlled device.

.7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 OTHER TAB REQUIREMENTS

.1 Duct traverse readings shall be taken through the access ports provided. Where no access ports have been provided new holes shall be made as required. These holes shall be resealed after final readings with sheet metal cover plates and sealant. Duct tape is not acceptable.

.2 Where insulation is damaged it shall be repaired including the vapour barrier in an approved manner. Duct tape is not acceptable.

.3 In all cases where measurements show failure to comply with the Drawings and Specifications, the Contractor shall change fan sheaves, etc., as required, and new TAB measurements shall be made.

.4 Following final acceptance of the certified reports by the Departmental Representative, permanently mark the settings of all valves, dampers, splitters and other adjustable devices so that balance set position can be restored if disturbed at any time. Do not mark such devices until after final acceptance.

.5 General requirements applicable to work specified this paragraph:

.1 Qualifications of TAB personnel: as for air systems specified this section.

.2 Quality assurance: as for air systems specified this section.

.6 Building pressure conditions:

.1 Adjust HVAC systems, equipment, controls to ensure building has overall positive pressure condition.

.7 Zone pressure differences:

.1 Adjust HVAC systems, equipment, controls to establish indicated air pressure differentials, with systems in every possible combinations of normal operating modes.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not used.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 REFERENCE STANDARDS

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)

.1 SMACNA HVAC Air Duct Leakage Test Manual, 1985.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00.

.2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:

.1 Submit proposed report form and test report format to Departmental Representative for approval at least three months before proposed date of first series of tests. Do not start tests until approval received in writing from Departmental Representative.

.2 Prepare report of results and submit to Departmental Representative within 24 hours of completion of tests. Include:

.1 Schematic of entire system.

.2 Schematic of section under test showing test site.

.3 Required and achieved static pressures.

.4 Orifice differential pressure at test sites.

.5 Permissible and actual leakage flow rate (L/s) for test sites.

.6 Witnessed certification of results.

.3 Include test reports in final TAB report.

.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 Manufacturer's field reports specified.

1.4 QUALITY ASSURANCE

.1 Pre-Installation Meetings:

.1 Convene pre-installation meeting oneweek prior to beginning work of this Section.

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building subtrades.

.4 Review manufacturer's installation instructions and warranty requirements.

PART 2 - PRODUCTS

2.1 TEST INSTRUMENTS

.1 Test apparatus to include:

.1 Fan capable of producing required static pressure.

.2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.

.3 Flow measuring instrument compatible with the orifice plate.

.4 Calibration curves for orifice plates used.

.5 Flexible duct for connecting to ductwork under test.

.6 Smoke bombs for visual inspections.

.2 Test apparatus: accurate to within +/- 3% of flow rate and pressure.

.3 Submit details of test instruments to be used to Departmental Representative at least three months before anticipated start date.

.4 Test instruments: calibrated and certificate of calibration deposited with Departmental Representative no more than 28 days before start of tests.

.5 Re-calibrated every six months thereafter.

PART 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 TEST PROCEDURES

.1 Test for leakage in accordance with all SMACNA Manuals and Standards, all ductwork except downstream of variable air volume boxes or other pressure reducing devices. Seal ducts at all equipment connections.

.2 Lengths of ducts to be tested consistent with capacity of test equipment.

.3 Section of duct to be tested to include:

.1 Fittings, branch ducts, tap-ins.

.4 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.

.5 Base partial system leakage calculations on SMACNA HVAC Air Duct Leakage Test Manual.

.6 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

3.3 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.

.1 Small duct systems up to 250 Pa: leakage 2%.

.2 VAV box and duct on downstream side of VAV box: leakage 2%.

.3 Large low pressure duct systems up to 500 Pa: leakage 2%.

.4 HP duct systems up to 1000 Pa pressure classification, including upstream side of VAV boxes: leakage 1.

.3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 TESTING

.1 Test ducts before installation of insulation or other forms of concealment.

.2 Test after seals have cured.

.3 Test when ambient temperature will not affect effectiveness of seals, and gaskets.

.4 Flexible connections to VAV boxes.

3.5 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services.

.1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.

.2 Manufacturer's Field Services: 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 Schedule site visits, to review Work, at stages listed:

.1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.

.2 Twice during progress of Work at 25% and 60% complete.

.3 Upon completion of the Work, after cleaning is carried out.

.4 Obtain reports, within 3 days of review, and submit, immediately, to Departmental Representative.

.2 Performance Verification:

.1 Departmental Representative to witness tests and to verify reported results.

.2 To be certified by same TAB agency approved by Departmental Representative to undertake TAB on this project.

3.6 CLEANING

.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

.2 Section 23 05 29

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.1 ANSI/ASHRAE/IESNA 90.1-16, SI Edition; Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 ASTM International Inc.

.1 ASTM B209M-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

.2 ASTM C335/335M-17, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.

.3 ASTM C411-17, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.4 ASTM 07(2013) Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.5 ASTM C547-17, Standard Specification for Mineral Fiber Pipe Insulation.

.6 ASTM C553-13, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.7 ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.8 ASTM C921-10(2015), Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.

.5 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102.3-07, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.3 DEFINITIONS

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED" - means "not concealed" as previously defined.

.3 Insulation systems - insulation material, fasteners, jackets, and other accessories.

.2 TIAC Codes:

.1 CRD: Code Round Ductwork,

.2 CRF: Code Rectangular Finish.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.

.1 Description of equipment giving manufacturer's name, type, model, year and capacity.

.2 Details of operation, servicing and maintenance.

.3 Recommended spare parts list.

.3 Samples:

.1 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.

.2 Mount sample on 12 mm plywood board.

.3 Affix typewritten label beneath sample indicating service.

.4 Manufacturers' Instructions:

.1 Provide manufacture's written duct insulation jointing recommendations and special handling criteria, installation sequence, cleaning procedures.

1.5 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.

.3 Packaging Waste Management: in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 FIRE AND SMOKE RATING

.1 To CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).

.4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).

.1 Mineral fibre: to ASTM C553.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to ASTM C553.

2.3 JACKETS

.1 Canvas:

.1 220gm/m2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: compatible with insulation.

.3 Aluminum:

.1 To ASTM B209 with moisture barrier as scheduled in PART 3 of this section.

.2 Thickness: 0.50mm sheet.

.3 Finish: Corrugated.

.4 Jacket banding and mechanical seals: 19mm wide, 0.5 mm thick stainless steel.

2.4 ACCESSORIES

.1 Indoor Jacketing:

.1 UL Listed, Zero permeability, puncture and tear resistant, temperature range of -70 to 120C, 6um thick, self-adhesive.

.2 Colour: Standard to suit Departmental Representative

.2 Outdoor Jacketing:

.1 UL Listed, Zero permeability, Acrylic, puncture and tear resistant, temperature range of -70 to 120C, 6um thick, self-adhesive.

.2 Colour: Standard to suit Departmental Representative

.3 Tape: self-adhesive, aluminum, reinforced, 75mm wide minimum.

.4 Contact adhesive: quick-setting

.5 Canvas adhesive: washable.

.6 Tie wire: 1.5mm stainless steel.

.7 Banding: 19mm wide, 0.5mm thick stainless steel.

.8 Facing: 25mm stainless steel hexagonal wire mesh stitched on one face of insulation.

.9 Fasteners: pins withclips, length to suit thickness of insulation.

PART 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 PRE-INSTALLATION REQUIREMENTS

.1 Pressure test ductwork systems complete, witness and certify.

.2 Ensure surfaces are clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply jacket on all exposed ductwork throughout the building and outdoors.

.3 Apply materials in accordance with manufacturer’s instructions and as indicated.

.4 Use 2layers with staggered joints when required nominal thickness exceeds 75 mm.

.5 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Ensure hangers, and supports are outside vapour retarder jacket.

.6 Hangers and supports in accordance with Section 23 05 29.

.1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.

.7 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2rows each side.

.8 Coordinate to ensure duct insulation is applied prior to ductwork being installed to underside of slabs, beams or other services or behind other duct risers and shafts.

3.4 DUCTWORK INSULATION SCHEDULE

.1 Insulation types and thicknesses: conform to following table:

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	[C-1]	[yes]	[50]

Round cold and dual temperature supply air ducts	[C-2]	[yes]	[50]
Rectangular warm air ducts	[C-1]	[no]	[25]
Round warm air ducts	[C-1]	[no]	[25]
Supply, return and exhaust ducts exposed in space being served	[none]		
Outside air ducts to mixing plenum	[C-1]	[yes]	[25]
Mixing plenums	[C-1]	[yes]	[25]
Exhaust duct between dampers and louvres	[C-1]	[no]	[25]
Rectangular ducts outside	[C-1]	[special]	[50]
Round ducts outside	[C-1]	[special]	[50]
Acoustically lined ducts	[none]		

.2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

.1 Use TIAC code C-1 insulation, scored to suit diameter of duct.

.1 Finishes: conform to following table:

	Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed within mechanical room	Jacket(match existing)	Jacket(match existing)
Indoor, exposed elsewhere	Jacket (match existing)	Jacket(match existing)

3.5 CLEANING

.1 Clean in accordance with Section 01 74 11.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: in accordance with Section 01 74 20

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.1 ASHRAE 90.1-16, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM B209M-14, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.

.2 ASTM C335/335M-17, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.3 ASTM C411-17, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.4 ASTM C449-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.5 ASTM C533-2017, Calcium Silicate Block and Pipe Thermal Insulation.

.6 ASTM C547-2017, Mineral Fiber Pipe Insulation.

.7 ASTM C795-08(2013), Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.8 ASTM C921-10(2015), Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.4 Department of Justice Canada (Jus)

.1 Canadian Environmental Assessment Act (CEAA), 1999, c. 37.

.2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

.3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.6 Manufacturer's Trade Associations

.1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.

.7 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC-S102-10, Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701-11, Thermal Insulation, Polystyrene, Boards and Pipe Covering.

.3 CAN/ULC-S702-14, Thermal Insulation, Mineral Fibre, for Buildings

.4 CAN/ULC-S702.2-15, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 DEFINITIONS

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED" - will mean "not concealed" as specified.

.2 TIAC:

.1 CRF: Code Rectangular Finish.

.2 CPF: Code Piping Finish.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section01 33 00. Include product characteristics, performance criteria, and limitations.

.1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00.

.3 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00.

.4 Samples:

.1 Submit samples in accordance with Section 01 33 00.

.2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix label beneath sample indicating service.

.5 Quality assurance submittals: submit following in accordance with Section 01 33 00.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

.1 Qualifications:

.2 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.2 Storage and Protection:

.1 Protect from weather, construction traffic.

.2 Protect against damage.

.3 Store at temperatures and conditions required by manufacturer.

.3 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102.

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre specified includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335/C335M.

.3 TIAC Code A-1: rigid moulded mineral fibre with factory applied all-service jacket.

.1 Mineral fibre: to CAN/ULC-S702.

.2 Maximum "k" factor: to CAN/ULC-S702.

.4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to CAN/ULC-S702.

.5 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to CAN/ULC-S702.

.6 TIAC Code A-6: flexible unicellular tubular elastomer.

.1 Insulation: 13mm, exterior piping covered with vapour retarder jacket.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

.7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.

.1 Insulation: 50mm thick to ASTM C533.

.2 Joints: Staggered

.3 Jacket: Aluminum

.4 Design to permit periodic removal and re-installation.

2.3 INSULATION SECUREMENT

.1 Tape: self-adhesive, aluminum, reinforced, 50mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5mm diameter stainless steel.

.5 Bands: stainless steel, 19mm wide, 0.5mm thick.

2.4 CEMENT

.1 Thermal insulating and finishing cement:

.1 As recommended by insulation manufacturer

2.5 VAPOUR RETARDER LAP ADHESIVE

.1 Water based, fire retardant type, compatible with insulation.

2.6 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 OUTDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: fibrous glass, untreated 305 g/m2.

2.8 JACKETS

.1 Polyvinyl Chloride (PVC):

.1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.

.2 Colours: white.

.3 Minimum service temperatures: -20 degrees C.

.4 Maximum service temperature: 65 degrees C.

.5 Moisture vapour transmission: 0.02 perm.

.6 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.7 Special requirements:

.1 Outdoor: UV rated material at least 0.5 mm thick.

.2 ABS Plastic:

.1 One-piece moulded type and sheet with pre-formed shapes as required.

.2 Colours: white

.3 Minimum service temperatures: -40 degrees C.

.4 Maximum service temperature: 82 degrees C.

.5 Moisture vapour transmission: 0.012 perm.

.6 Thickness: 0.75mm.

.7 Fastenings:

.1 Solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.8 Locations:

.1 For outdoor use ONLY.

.3 Canvas:

.1 220 gm/m2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: compatible with insulation.

.4 Aluminum:

.1 To ASTM B209.

.2 Thickness: 0.50mm sheet.

.3 Finish: stucco embossed.

.4 Joining: longitudinal and circumferential slip joints with 50mm laps.

.5 Fittings: 0.5mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19mm wide, 0.5mm thick at 300mm spacing.

2.9 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

.1 Caulking to: Section 07 90 00.

PART 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 PRE-INSTALLATION REQUIREMENT

.1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturers instructions and this specification.

.3 Use two layers with staggered joints when required nominal wall thickness exceeds 38 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Install hangers, supports outside vapour retarder jacket.

.5 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

.6 Terminate insulation on pipes passing through fire rated walls or floors, and fit tight to the fire stop material.

.7 Irregular shaped objects such as strainers, pipe system filters, cyclone separators, blowdown valves and other accessories requiring servicing, on insulated piping, shall be insulated with removable caps or sections. All edges shall be sealed between pipe and vapour barrier and held in place with stainless steel straps. Finish all insulation smooth, making the outline of pipe insulation a true circular and concentric shape. Shape the outline of fitted insulation to blend with adjacent covering.

.8 On cold water service valves, water meters, drain valves, vent connections, thermometer wells, pressure gauges and other irregular shaped objects, apply flexible elastomeric sheet insulation, thickness to suit service, cut and mitre as necessary, and attach with adhesive and stainless steel banding. Bond and seal edges of insulation to the adjacent surfaces, provide vapour retarder.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: at expansion joints, valves, primary flow measuring elements, flanges and unions at equipment.

.2 Design: to permit periodic removal and replacement without damage to adjacent insulation.

.3 Insulation:

.1 Insulation, fastenings and finishes: same as system.

.2 Jacket: provide material as required for temperature of system: PVC, aluminum, high temperature fabric, ABS.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

.1 Insulation to remain dry. Overlaps to manufacturer's instructions. Ensure tight joints.

.2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 TIAC Code: A-1.

.1 Securements: wire at 300 mm on centre.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code 1501-H.

.3 TIAC Code: A-3.

.1 Securements: SS bands at 300mm on centre.

.2 Protection: sheet steel shields at each hanger or support

.3 Seals: VR lap seal adhesive, VR lagging adhesive.

.4 Installation: TIAC Code: 1501-C.

.4 TIAC Code: A-6.

.1 Securements: Adhesive applied to both joining surfaces

.2 Seals: lap seal adhesive, lagging adhesive.

.5 TIAC Code: C-2 with all service jacket.

.1 Securements: wire at 300 mm on centre.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code: 1501-C.

.6 TIAC Code: A-2.

.1 Securements: 0.045mm SS tie wire 300 mm on centre.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code: 1501-H.

.7 Thickness of insulation as listed in following table.

.1 Run-outs to individual units and equipment not exceeding 4000 mm long.

.2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)		
Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8 & over

Condensate Return	60 - 94	[A-1]	25	38	38
Hot Water Heating	60 - 94	[A-1]	25	38	38
Hot Water Heating	up to 59	[A-1]	25	25	25
Glycol Heating	60 - 94	[A-1]	25	38	38
Glycol Heating	up to 59	[A-1]	25	25	25
Domestic HWS	[A-1]	25	25	25	38
Chilled Water	4 - 13	[A-3]	25	25	25
Chilled Glycol	below 4	[A-3]	25	25	38
Chilled Water Pump Casing	[A-3]	25	25	25	25
First 4500mm of sprinkler main	[A-3]	25	25	25	25
Condenser Water	[A-3]	25	25	25	25
Refrigerated Drinking Water	[A-3]	25	25	25	25
Domestic CWS	[A-3]	25	25	25	25
Refrigerant[suction] [liquid] [hot gas]	4 - 13	[A-6]	25	25	25
Refrigerant[hot gas] [liquid] [suction]	below 4	[A-6]	25	25	38
RWL and RWP	[C-2]	25	25	25	25
Cooling Coil cond. drain	[C-2]	25	25	25	25
Diesel generator exhaust system	[A-2]	38	65	65	75

.8 Finishes:

.1 Exposed indoors: PVC jacket.

.2 Exposed in mechanical rooms: PVC or aluminum jacket.

.3 Concealed, indoors: canvas.

.4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.

.5 Outdoors: water-proof ABS or aluminum jacket.

.6 Finish attachments: SS bands at 150mm on centre. Seals: closed.

.7 Installation: to appropriate TIAC code CRF/1 through CPF/5.

.9 Drainage piping:

.1 Cover cast iron bell and spigot drainage pipe 75 mm (3 in.) and smaller with 12 mm (1/2 in.) preformed glass fibre pipe insulation, and finish with vapour barrier jacket. Cover the bell and spigot joint with a 12 mm (1/2 in.) thick flexible elastomeric insulation band that overlaps the fibreglass insulation 300 mm (12 in.) beyond joint in each direction. Seal band to the fibreglass insulation. Apply 25 mm (1 in.) thick insulation for all larger pipes.

.2 Storm Drainage piping to be insulated:

.1 Roof drain sump

.2 All horizontal or sloping storm piping

.3 All elbows connecting the horizontal storm drainage piping to the vertical leaders

.4 Where the roof drain is less than 3000 mm (10 ft.) from the vertical leader, insulate the first 3000 mm (10 ft.) of pipe closest to the roof drain and the exposed portion of the roof drain.

.3 Sanitary drainage piping to be insulated:

.1 Sanitary drainage pipes from urinals

.2 Direct and indirect drains from drinking fountains

.3 Floor drains from air conditioning apparatus

.4 Carrying chilled condensate to closest branch or main.

.5 All piping passing through high humidity area

.6 Sanitary drainage pipe from barrier free lavatories

3.7 CLEANING

.1 Proceed in accordance with Section 01 74 11.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 REFERENCE STANDARDS

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM E202-12, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

.1 In accordance with Section 23 08 02.

1.4 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

.1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.

.2 When systems are operational, perform following tests:

.1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.

.2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.

.1 Pump operation.

.2 Boiler and/or chiller operation.

.3 Pressure bypass open/closed.

.4 Control pressure failure.

.5 Maximum heating demand.

.6 Maximum cooling demand.

.7 Boiler and/or chiller failure.

.8 Cooling tower (and/or industrial fluid cooler) fan failure.

.9 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

1.5 HYDRONIC SYSTEM CAPACITY TEST

.1 Perform hydronic system capacity tests after:

.1 TAB has been completed

.2 Verification of operating, limit, safety controls.

.3 Verification of primary and secondary pump flow rates.

.4 Verification of accuracy of temperature and pressure sensors and gauges.

.2 Calculate system capacity at test conditions.

.3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.

.4 When capacity test is completed, return controls and equipment status to normal operating conditions.

.5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.

.6 Heating system capacity test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or

.2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.

.2 Test procedures:

.1 Open fully heat exchanger, heating coil and radiation control valves.

.2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.

.3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.

.7 Chilled water system capacity test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.1 Adding heat from building heating system or;

.2 Raising space temperature by turning off cooling and air systems for sufficient period of time before starting testing and pre-heating building to summer design space temperature (occupied) or above. Set OAD and RAD for minimum outside air if OAT is near outside design temperature or to maximum recirculation if RAT is greater that OAT. RAT to be at least 23 degrees C minimum.

.2 Test procedures:

.1 Open fully cooling coil control valves.

.2 Set thermostats on associated AHU's for maximum cooling.

.3 Set AHU's for design maximum air flow rates.

.4 Set load or demand limiters on chillers to 100%.

.5 After system has stabilized, record chilled water, and condenser water flow rates and supply and return temperatures simultaneously.

1.6 GASEOUS FUEL SYSTEMS

.1 Operation tests:

.1 Measure gas pressure at gas metre outlet and at burner manifold.

.2 Verify details of temperature and pressure compensation at meter.

.3 Verify settings, operation, venting of high and low pressure cut-outs, alarms.

.4 Check terminals of vents for gas pressure regulators.

1.7 POTABLE WATER SYSTEMS

.1 When cleaning is completed and system filled:

.1 Verify performance of equipment and systems as specified elsewhere in Division 23.

.2 Check for proper operation of water hammer arrestors. Run oneoutlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.

.3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

1.8 WET AND DRY PIPE SPRINKLER SYSTEM, STANDPIPE AND HOSE SYSTEMS

.1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Division 23.

.2 Verification of controls, detection devices, alarm devices is specified Division 26.

.3 Demonstrate that fire hose will reach to most remote location regardless of partitions, and obstructions.

.4 Verify operation of interlocks between HVAC systems and fire alarm systems.

1.9 SANITARY AND STORM DRAINAGE SYSTEMS

.1 Buried systems: perform tests prior to back-filling. Perform hydraulic tests to verify grades and freedom from obstructions.

.2 Ensure that traps are fully and permanently primed.

.3 Ensure that fixtures are properly anchored, connected to system.

.4 Operate flush valves, tank and operate each fixture to verify drainage and no leakage.

.5 Cleanouts: refer to Section 22 42 00.

.6 Roof drains:

.1 Refer to Section 22 42 00.

.2 Remove caps as required.

1.10 REPORTS

.1 Provide reports for all tests.

1.11 TRAINING

.1 In accordance with Section 01 91 13: Training of O&M Personnel.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 REFERENCE STANDARDS

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM E202-12, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00. Include product characteristics, performance criteria, and limitations.

1.4 QUALITY ASSURANCE

.1 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 CLEANING SOLUTIONS

.1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.

.2 Sodium carbonate: 0.40 kg per 100 L water in system.

.3 Low-foaming detergent: 0.01 kg per 100 L water in system.

PART 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 CLEANING HYDRONICSYSTEMS

.1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.

.2 Cleaning Agency:

.1 Retain qualified water treatment specialist to perform system cleaning.

.3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.

.4 Cleaning procedures:

.1 Provide detailed report outlining proposed cleaning procedures at least 4weeks prior to proposed starting date. Report to include:

.1 Cleaning procedures, flow rates, elapsed time.

.2 Chemicals and concentrations used.

.3 Inhibitors and concentrations.

.4 Specific requirements for completion of work.

.5 Special precautions for protecting piping system materials and components.

.6 Complete analysis of water used to ensure water will not damage systems or equipment.

.5 Conditions at time of cleaning of systems:

.1 Systems: free from construction debris, dirt and other foreign material.

.2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.

.3 Strainers: clean prior to initial fill.

.4 Install temporary filters on pumps not equipped with permanent filters.

.5 Install pressure gauges on strainers to detect plugging.

.6 Report on Completion of Cleaning:

.1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

.7 Hydronic Systems:

.1 Fill system with water, ensure air is vented from system.

.2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).

.3 Use water metre to record volume of water in system to +/- 0.5%.

.4 Add chemicals under direct supervision of chemical treatment supplier.

.5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.

.6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.

.7 Add chemical solution to system.

.8 Establish circulation, raise temperature slowly to maximum design. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 hours at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

.8 Glycol Systems:

.1 In addition to procedures specified above perform specified procedures.

.2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.

3.3 START-UP OF HYDRONIC SYSTEMS

.1 After cleaning is completed and system is filled:

.1 Establish circulation and expansion tank level, set pressure controls.

.2 Ensure air is removed.

.3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.

.4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.

.5 Clean out strainers repeatedly until system is clean.

.6 Commission water treatment systems as specified in Section 23 25 00.

.7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.

.8 Repeat with water at design temperature.

.9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.

.10 Bring system up to design temperature and pressure slowly over a 24 hour period.

.11 Perform TAB as specified in Section 23 05 93.

.12 Adjust pipe supports, hangers, springs as necessary.

.13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.

.14 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

.15 Check operation of drain valves.

.16 Adjust valve stem packings as systems settle down.

.17 Fully open balancing valves (except those that are factory-set).

.18 Check operation of over-temperature protection devices on circulating pumps.

.19 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01.

.2 SECTION 23 09 63.

1.2 SYSTEM DESCRIPTION

.1 Furnish completely integrated laboratory air flow and control systems.

.2 A number of the lab air valves will be provided under a different division as part of the lab bench package. These valves are indicated on the drawings. These valves shall be fully integrated into the existing control system. Integration shall include, but not be limited to, all wiring from lab air valves supplied by others, update of graphics, updating of sequencing of existing lab air vlaves.

.3 Integrated laboratory room air flow control system shall respond to full scale air flow change commands within less than 1 second.

.4 Laboratory control system shall be provided such that future fume hood controls (sash sensor, alarm contacts, etc) can be added at a later date and tie into the system with no proprietary issues.

.5 Make-up/supply air control system shall maintain the ventilation rate that is the greater of temperature control, minimum ventilation level or that level driven by the exhaust to maintain space pressure and air flow balance under all operating conditions.

.6 Integrated laboratory air flow control system shall include make-up/supply air controllers; closed loop variable frequency drives for dedicated exhaust fume hoods (VSCFH); variable frequency drives for supply and/or exhaust fans (VSC); exhaust fan stability/capacity control systems; enhanced discharge plume exhaust fans; supply, exhaust, constant volume and general purpose air flow control valves plus on-site start-up and commissioning to result in a completely operational system.

.7 All control components shall be strictly electronic.

1.3 ACTION AND INFORMATION SUBMITTALS

.1 Submit manufacturer’s literature and data for all components in accordance with requirements of SECTION 21 05 01.00, including the following:

.1 Schematics of control piping and wiring of all air valves, fume hood and make-up air controllers generated specifically for this project.

.2 Schematics of all termination points within each Make-up Air Controller (MAC).

.3 Controllable Air Flow Venturi (CAFV) schedule listing CAFV minimum and maximum as well as operating minimum and maximum as well as operating minimum and maximum air flows, air valve sizes, and room differential offsets.

.4 Catalog cut sheets of all components used, including fume hood monitors, sash sensors, make-up air controllers, power supplies, CAFV's and the life.

.5 Noise data for CAFV's and exhaust fans.

.6 Furnish UL913 Certificates for all sash position sensors.

.2 Dimensions of all CAFV's, SPS, FHC and other equipment supplied.

.1 Control system interconnection wiring diagram showing all tie-in point signal pick-up for other building systems such as DDC systems.

.2 Point-to-point wiring diagrams of the specified control systems.

.3 As-Built Documentation

.1 Submit data in accordance with requirements of Section 01 78 00 - CLOSEOUT SUBMITTALS.

.2 Submit CAFV calibration data on computer diskette in ASCII format and in hard copy printout to be included with as-built documentation.

.4 Pre-Bid Submittals

.1 Where manufacturer's products other than those specified herein are proposed for use on this Project, submit in writing, at least 10 business days prior to Bid Closing Date, the following information.

.1 Complete technical Specifications of products and services proposed, showing compliance to every clause of these Specifications. If the proposed product deviates from any clause, the proposal shall clearly outline the extent of the deviation, and its impact on safety, reliability, system stability, operating energy costs, and maintenance.

.2 A list of 5 successful installations of an integrated laboratory air flow control systems, comparable in scope to that specified herein, within a 100 km radius of the location of this project, complete with names, addresses, and telephone numbers of contact personnel. Each project must have been in operation for at least 3 years.

.5 Spare Parts

.1 Include 10% extra gaskets of each valve size on the job for valves supplied under this Section, and hand over in labelled containers to the departmental representative for maintenance use.

PART 2 - PRODUCTS

2.1 CONTROLLABLE AIR FLOW VENTURI (CAFV) - GENERAL

.1 Basis of Design: Phoenix Valves

.2 CAFV shall utilize a venturi section into which a cone shaped element slides to create a smoothly varying, annular orifice. CAFV shall be constructed such that the venturi body's shape logarithmically necks down to the orifice area and then

logarithmically re-expands to full valve inlet size to ensure a static regain with minimal pressure loss. CAFV shall have an Equal Percentage flow characteristic to provide accurate control at low flow values. Butterfly, opposed blade, bladder type dampers, or VAV boxes are not acceptable.

.3 CAFV shall be pressure independent over a differential pressure range of 15 mm to 75 mm (0.6 in. to 3.0 in.) WC across the valve. Integral pressure independent assembly shall respond and maintain specific air flow within one second of a change in duct static pressure.

.4 CAFV air flow accuracy shall be +/-5% of reading (not full scale) regardless of inlet or exit duct configuration over an air flow turndown range of no less than 8 to 1. No entrance or exit duct diameter restrictions shall limit the specified speed of response, accuracy, or pressure independence.

.5 If the available length of straight duct runs either before and/or after the sensing element of separate air flow sensors falls outside of that recommended by the sensor manufacturer, furnish air flow straightening stations to ensure specified performance.

.6 Any electronic (hot wire, thermistor, velocity pressure, etc.) air flow sensor or transducer having electronic parts exposed to fume hood, canopy, snorkel, etc. exhaust air flow shall be UL listed under the UL913 Class 1, Division 1 Standard for Intrinsically Safe Equipment used in Hazardous Locations. Single point sensors are not acceptable.

.7 CAFV shall be constructed for horizontal application and of one of the following three types:

.1 Make-up, supply and general exhaust air CAFV bodies shall be constructed of 1.29 mm (0.0508 in. - 16 B&S Ga) aluminum or 1.56 mm (0.0614 in. - 16 GSG) galvanized steel. All bearing surfaces shall be made of a composite Teflon or Teflon infused (versus coated) aluminum. The CAFV’s shaft, pivot arm, shaft support brackets, and internal mounting hardware shall be made of Type 316L stainless steel.

.2 Fume hood, canopy, articulating canopy, snorkel, bio-safety cabinet exhaust CAFV bodies, shaft and cone assemblies shall have two baked on coats of a corrosion resistant phenolic coating (Heresite P403 or Phenoflex 957) or shall be constructed entirely of Type 316L stainless steel, with two additional baked on coats of corrosion resistant phenolic coating. The pivot arm, shaft support brackets, and internal mounting hardware shall be made of Type 316L stainless steel. Uncoated shafts and general 300 Series stainless steel materials are unacceptable. All bearing surfaces shall be made of a Teflon or Teflon infused (versus coated) aluminum. Fumehood and snorkel exhaust valves shall be capable of full shut off.

.8 CAFV shall use electronic based closed loop position feedback and control to regulate air volume linearly proportional to a 0 to 10 volt electronic control signal. CAFV shall generate a 0 to 10 volt feedback signal linearly proportional to CAFV air flow for internal volume control, monitoring, or air flow tracking

control. Signal shall be factory calibrated to a stated cfm per volt scale factor using NIST traceable instrumentation directly from the CAFV's control arm or shaft position.

.9 CAFV shall achieve 90% of its commanded volume within one second of being commanded to its new volume set-point (regardless of system stability) with less than a 5% undershoot or overshoot.

.10 Singular CAFV's shall incorporate a circular bolt pattern flange on each end of the CAFV for ease of installation and removal. Flange shall be factory butt welded or spun onto the CAFV. Each flange shall be drilled with a hole pattern and size suitable for the application. Two closed cell neoprene gaskets cut to the correct size bolt pattern shall be included with each CAFV.

.11 Seal all CAFV body penetrations, including, but not limited to the actuator arm, to ensure a leakage rate of less than 0.15% if maximum air flow.

.12 Venturi valves and actuators located within Class 1 Zone 2 spaces shall have full explosion proof enclosure.

2.2 EXHAUST AND MAKE-UP AIR CAFV

.1 Linear exhaust air flow control CAFV shall be provided to linearly control the exhaust air flow out a laboratory fume hood, and/or the general exhaust/return air out of a laboratory space.

.2 CAFV shall use electronic based closed loop position feedback and control to regulate air volume linearly proportional to a 0 to 10 volt electronic control signal. CAFV shall generate a 0 to 10 volt feedback signal linearly proportional to CAFV air flow for internal volume control, monitoring, or air flow tracking control. Signal shall be factory calibrated to a stated cfm per volt scale factor using NIST traceable instrumentation directly from the CAFV's control arm or shaft position.

.3 CAFV shall achieve 90% of its commanded volume within one second of being commanded to its new volume set-point (regardless of system stability) with less than a 5% undershoot or overshoot.

.4 A static pressure switch pre-mounted to a fume hood exhaust CAFV shall sense and alarm an air flow of approximately 20% below the setpoint. The switch shall operate by measuring the pressure drop across the CAFV's variable orifice venturi.

.5 Venturi valves and actuators located within Class 1 Zone 2 spaces shall have full explosion proof enclosure.

2.3 LABORATORY CONTROL PANEL (LCP)

.1 Provide a LCP to control the air flow balance of the Laboratory Room. The LCP shall be panel or CAFV mounted. Provide one LCP per laboratory pressurization zone.

.2 The LCP shall be of electronic design with analog signal inputs and outputs. The LCP shall accept 0 to 10 volt input signals proportional to fume hood, canopy, snorkel, bio-safety cabinet exhaust, and office supply air flows.

.3 The LCP output shall control supply CAFV's, general exhaust/return air CAFV's and/or VSCFHs with 0 to 10 volt signals linearly proportional to the desired supply or exhaust volumes.

.4 Provide integral field adjustable trimpots for all required calibration and scaling adjustments.

.5 The LCP shall maintain a specified constant adjustable offset between the sum of the room's total exhaust and the make-up/supply air volumes for "leaky" labs without air locks. This offset shall be independent of the exhaust volume magnitude and represent the volume of air that will infiltrate the room from the corridor or other areas. For "bottle tight" high containment facilities having air locks, the offset shall be reset from a differential pressure transmitter signal according to a predetermined schedule dependent on the room "leakage" rate. Refer to the Sequence of Operation for details.

.6 The LCP shall generate 0 to 10 volt analog signals linearly proportional to all air flow sources, sash sensors, and flow alarms (0 or 12 v alarm). These signals shall be available for direct connection to the facility's DDC/Energy Management System. As a minimum, the following signals (points) shall be available:

.1 Individual Fume Hood Exhaust Flow (cfm, 0-10v)

.2 Supply/make-up air flow (cfm, 0-10v)

.3 General exhaust flow (cfm, 0-10v)

.4 Total lab exhaust flow (cfm, 0-10v)

.5 Total lab supply flow (cfm, 0-10v)

.6 Room offset (cfm, 0-10v)

.7 Fume hood exhaust low flow alarm (digital 0 or 12v)

.8 Fume hood sash position (0-10v)

.9 Common fume hood low flow alarm (digital contact)

.10 Common fume hood emergency exhaust alarm (digital contact)

.7 The LCP shall also accept direct input signals from the facility's DDC/Energy Management System. As a minimum, the following inputs shall be available:

.1 Emergency exhaust override (digital contact)

.2 Remote room offset adjustment (0-10v)

.3 Electronic temperature override (0-10v)

.8 Provide an integral power supply for the LCP to power the complete laboratory air flow control system from one dedicated 120VAC line connection. In cases where a LCP is wired to an MCP, it shall obtain its power from it.

.9 Provide a liquid crystal digital display to read out directly in cfm for panel mounted LCP's to indicate the magnitude of all exhaust and supply air flow signals specified above.

2.4 SUPPLY/EXHAUST TRACKING CONTROLLER (STC)

.1 Provide a STC to provide proper room pressurization and air flow balance where only one exhaust or return air source is used in conjunction with one make-up/supply air source.

.2 The STC shall accept one input and produce one output signal. The input signal shall be a 0 to 10 volt analog signal from a linear pressure independent fume hood exhaust CAFV, fume hood exhaust variable speed VSCFH, or laboratory office supply CAFV. The output signal shall be a 0 to 10 volt analog signal capable of proportionally controlling a linear pressure independent supply/make-up air CAFV or general exhaust CAFV.

.3 The STC shall maintain a constant, adjustable offset between the room's exhaust and make-up/supply volumes. This offset shall be independent of the exhaust volume magnitude.

.4 Trimpot adjustments shall be used to accurately calibrate and scale the input signal. Both the minimum and maximum level of the supply or exhaust air flow shall be separately adjustable.

2.5 REHEAT COIL TRANSITION BOXES

.1 Provide acoustically lined transition boxes to adapt the circular cross section CAFV's to rectangular reheat coils for all makeup CAFV's, constructed as detailed. The Transition Boxes shall be provided wherever a CAFV is shown attached to a single or multiple reheat coils.

.2 Each transition box shall include a factory installed reheat coil with capacity as specified, completely encased by the box including the supply and return coil headers to minimize air leakage below 0.2% at a pressure up to 500 Pa (75 psi). The boil shall be easily removable by simply removing the sealed and gasketed access plate and sliding the coil out of the box. Pipe connections shall be either suitable for soldering or threaded.

.3 The downstream method of connecting the duct to the box shall be flanged and gasketed using C type slip and drive cleats, or as otherwise specified. Gasketing supplied by separate Section.

.4 The length of the plenum chamber upstream of the coil, shall be a minimum of 1.5 times the nominal diameter of the sum of the attached CAFV's. All inside surfaces shall be lined with a minimum of 25 mm (1 in.) fiberglass insulation.

.5 The upstream side of the box shall have circular cut-outs equal to the inside diameter of the connected CAFV(s), complete with "weldnuts" attached to the inside of the plenum to match the bolts of the CAFV's for ease of on-site assembly by the sheet metal Contractor. Furnish CAFV flange bolts for the transition side of the connection only.

.6 The box shall be constructed of heavy gauge steel for rigidity and to minimize leakage when subjected to the design duct pressures. Refer to Drawings for details.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Perform all wiring and make necessary electrical connections, and install all equipment specified under this Section, unless otherwise specified.

.2 All low voltage wire used for the interconnection of control components specified in this section, shall be provided by the installing Contractor at his expense and be of the type recommended by this supplier.

.3 Install SPSV and its cable in a concealed manner in the right hand service cavity of the fume hood, and make accessible from the top of the hood for field servicing. Affix SPSH sensor bars to the top of the individual sash panels, with the connecting wiring smoothly following the sash movements, without catching on hood structural members.

.4 Install CAFV's horizontally to insure factory calibrated performance, unless specifically ordered for vertical installation. Vertical CAFV's shall be so marked on the plans as well as on the product.

.5 Provide clean and dry instrument quality compressed air at 138 Pa (20 psi) pressure.

3.2 DDC SYSTEM TIE-INS

.1 Provide the following information for quantity of future tie-in signals and/or dry contacts to the DDC system under this section:

Dry contacts or low voltage signals for status or alarm:

Hood flow alarm	1 binary signal per hood (2 per lab module)
Sash open	1 binary signal per hood (2 per lab module)

3.3 INSTALLATION

.1 Install CAFV's horizontally, unless specified otherwise.

3.4 ON-SITE COMMISSIONING, CALIBRATION, START UP AND OTHER SERVICES

.1 Include as part of this Work, the on-site services of a factory-trained, qualified technician to assist in the set up air flow control systems specified herein, start-up, calibration and commissioning services. The technician shall have at least 5 years' experience in set-up of such systems, and shall include the following:

.1 The setting of fume hood face velocities, fume hood air flows, and the setting of exhaust and supply CAFV air flows, as specified.

.2 Include a second trip to the jobsite, not longer than 3 months after the project has been completed and taken over by the , to instruct s' personnel in the proper care and maintenance of the systems.

.3 Include a third trip to the jobsite, not longer than 3 months after the completion of the project, to instruct the users in the correct operation of the system.

.4 Not longer than 3 months after the completion of the project, submit a preventative maintenance service proposal to the to check the operation and calibration of the

systems and perform the recommended maintenance at the beginning of the second year of operation.

PART 1 - GENERAL

1.1 WORK INCLUDED

.1 Conform to Section 21 05 00.

.2 Conform to SECTION 23 09 63.

1.2 SYSTEM DESCRIPTION

.1 This Work consists of providing necessary hardware and custom written software required to integrate and control all equipment specified under Section 23 09 63.00. Provide detailed coordination with both this Section and Section 23 09 63.00, and other Sections performing isolated and essential parts of the work which form part of the overall Laboratory Controls.

.2 Provide complete, integrated laboratory air flow and control systems, fully responsible to full scale air flow change commands within less than 1 second.

.3 Become intimately knowledgeable with the functioning and capabilities of each and every piece of equipment forming part of the system and/or sub-system.

.4 Laboratory Fume Hood Control Systems shall maintain a constant average face velocity of air entering the fume hood regardless of the position of the sash. This system shall respond to sash movements from fully closed to fully open, and vice versa, to re-establish the set face velocity to within +/-5% of setpoint, within less than 1 second.

.5 Make-up/Supply Air Control System shall maintain the ventilation rate that is the greater of temperature control, minimum ventilation level or that level driven by the exhaust to maintain space pressure and air flow balance under all operating conditions.

.6 Integrated Laboratory Air Flow Control System shall include fume hood control systems: make-up/supply air controllers; closed loop variable frequency drives for dedicated exhaust fume hoods (VSCFH); variable frequency drives for supply and/or exhaust fans (VSC); exhaust fan stability/capacity control systems; enhanced discharge plume exhaust fans; supply, exhaust, constant volume and general purpose air flow control valves plus on-site start-up and commissioning to result in a completely operational system.

.7 All control components except for pneumatic actuators shall be strictly electronic.

1.3 ACTION AND INFORMATION SUBMITTALS

.1 Shop Drawings and Manufacturer’s Literature: Submit shop drawings and data in accordance with Section 01 33 23. Submittals shall include manufacturer’s literature and data for all components including the following:

.1 Schematics of control piping and wiring of all air valves, fume hood and make-up air controllers generated specifically for this project.

.2 Schematics of all termination points within each Make-up Air Controller (MAC). Controllable Air Flow Venturi (CAFV) schedule listing CAFV minimum and maximum, operating minimum and maximum air flows, air valve sizes, and room differential offsets.

.3 Catalog cut sheets of all components used, including fume hood monitors, sash sensors, make-up air controllers, power supplies, CAFV's.

.4 Noise data for CAFV's and exhaust fans.

.2 Pre-Bid Submittals:

.1 All specialists other than those listed in Article 1.5 that intend to submit a bid based on these Specifications, shall submit in writing, at least 10 business days prior to bid closing, the following information.

.1 Complete technical Specifications of its products and services proposed for this project, showing compliance to every clause of these Specifications. If the proposed product deviates from any clause, the prospective bidder shall clearly outline the extent of the deviation, and its impact on safety, reliability, system stability, operating energy costs, and maintenance.

.2 A list of 5 successful installations of an integrated laboratory air flow control system, comparable in scope to that specified herein, within a 300 km radius of the location of this project, complete with names, addresses, and telephone numbers of contact personnel. Each project must have been in operation for at least 3 years.

1.4 CAFV CALIBRATION

.1 Each CAFV valve shall be factory calibrated to the job specific air flows as detailed on Drawings and in Specifications. Valve shall be electronically calibrated/characterized at the factory by certified NIST traceable air stations. The valve's characterization shall be determined at 8 unique air flows including a test of the valve's pressure independence at 3 different static pressures. A total of 19 air flow checks shall be performed and recorded for each air valve.

.2 Field adjustments shall not be required other than minor changes as required by the balancing Contractor. Accuracy and performance shall be guaranteed as specified regardless of field conditions such as CAFV duct entry and exit configurations.

.3 Each CAFV shall be individually marked with valve specific factory calibration data. As a minimum, it should include valve tag number, serial number, model number, eight point valve characterization information, and quality control inspection numbers. All information shall be stored on computer diskette in ASCII format for future retrieval or for hard copy printout to be included with as-built documentation where so specified.

1.5 ON-SITE COMMISSIONING AND START UP

.1 Include under this Section for the services of a qualified technician to assist the Contractor to set up the air flow control systems specified herein, on the jobsite. The technician shall have at least 5 years' experience in such systems.

1.6 QUALITY ASSURANCE

.1 Qualifications of Laboratory Airflow Sequence Controls Specialists: Work of this Section is restricted for following specialists.

.2 The qualified technician providing on-site assistance and setting up the air flow control systems shall have at least 5 years' experience in such systems.

1.7 WARRANTY

.1 Contractor hereby warrants the airflow set-up in accordance with General Conditions, and the accuracy and performance of airflow shall meet the specified criteria, regardless of the field conditions, including variables such as the CAFV duct entry and exit configurations.

.2 Further to the Warranty requirements of the General Conditions, the response to warranty callback shall be a maximum of 4 hours from the time of notification.

PART 2 - PRODUCTS

2.1 SEQUENCES OF OPERATION

.1 Fume Hood Face Velocity Control

.1 SPS shall modulate a CAFV or VSCFH to vary the hood exhaust to maintain a constant average face velocity of 100 fpm (0.5 m/s) regardless of the sash position. The air flow control device shall provide a scaled signal proportional to exhaust air flow for pressurization control.

.2 In the absence of alarms registered on the FHC, the GREEN SYSTEM NORMAL pilot light shall illuminate.

.3 Whenever the feedback hood exhaust air flow does not meet the commanded flow, an audible and visual low FLOW ALARM sequence shall be initiated and the GREEN SYSTEM NORMAL pilot light shall extinguish. Upon actuation of the MUTE push button, the audible alarm shall cease to sound; however, the pilot light shall not extinguish until the fault has been cleared. A signal shall be made available at the MAC for central alarm purposes and record keeping.

.4 Whenever the EMERGENCY EXHAUST push button is pushed, the FHC shall command maximum hood exhaust air flow, overriding the SPS.

.5 The fume hood shall always operate with the face velocity control system in operation, in both DAY and NIGHT modes. The set points shall not be readjustable remotely, nor shall the hood ever be shut off.

.6 The FHC shall monitor the dual condition of a raised sash and the ambient lighting conditions. If the user leaves the lab at night, turns the lights off, but leaves the sash

open, an ENERGY WASTE ALERT audible and visual alarm shall be initiated. This alarm is cancelled by lowering the sash or muted by actuating the MUTE push button.

.7 The above sequence is typical for every hood, including horizontal sash and walk-in hoods.

.8 Double sided entry fume hoods installed in the wall separating two adjoining labs, shall be fitted with a SPS, FHC and CAFV on each sash. The SPS shall control the CAFV through FHC on each side, and the common air flow signal, summed from the air flow through both CAFV's shall modulate the speed of the exhaust fan through VSCFH. The signal from each CAFV shall be used by the MAC in the lab from which the open sash is Drawing air, for lab room pressurization control.

.9 The fume hood face velocity control system shall be monitored by the DDC control system, as specified.

.2 Day-Night Setback Control Sequence

.1 A DAY-NIGHT contact wired to the MAC, shall give ability to reduce the laboratory ventilation levels when switched to the NIGHT mode.

.2 The minimum night ventilation level shall be realized by adjusting the supply and general exhaust air flow with all hood sashes at minimum position.

.3 An OPEN contact shall represent DAY conditions and a CLOSED contact shall represent NIGHT conditions.

.3 Laboratory Room Pressurization Control Sequence

.1 The MAC shall maintain the desired room pressurization levels by commanding a supply air flow at a constant shortfall of total lab exhaust under all operating conditions.

.2 In general, a neutral room pressurization level shall require the MAC to command the supply CAFV to introduce an amount of supply air equal to the total instantaneous exhaust air flow.

.3 A negative pressurization level shall require the MAC to command the supply CAFV to introduce a total supply air flow equal to 90% of total lab exhaust air flow. The supply air shortfall shall be constant under all operating conditions.

.4 A positive pressurization level shall require the MAC to command the supply CAFV to introduce a total supply air flow equal to 110% of total lab exhaust air flow from the lab. The supply air surplus shall be constant under all operating conditions.

.5 The speed of response of the complete control system shall be less than 1 second over the complete capacity range of the system. This time span shall be measured from the time of occurrence of the input command signal (step input) to the time the new air flow is achieved within less than +/- 5%.

.6 For high containment level labs, the surplus or shortfall of makeup air shall be varied according to a schedule from a differential pressure signal. The schedule shall allow

an adjustable variation of +/- 50% of the constant shortfall.

.4 Corridor Pressurization Control Sequence

.1 The MAC's in each lab room adjoining the corridor in question shall provide a measurement of the amount of make up air to be introduced into the corridor that is equal to the algebraic sum of the volumetric offsets of the individual lab rooms adjoining the corridor. This amount shall then be introduced into the corridors to provide air balance in the buildings as a whole.

.2 This control sequence shall be typical for each corridor.

.3 In cases where certain Laboratory Rooms have switch selectable pressurization control, the corridor pressurization control sequence shall be modified to incorporate this effect, by subtracting the amount of volumetric offset of the positively pressurized rooms from the sum of the volumetric offset of the negatively pressurized rooms, and introduce this amount into the corridors. This operation shall be performed automatically from the room pressurization selection switches.

.5 Alarm Annunciation Sequence

.1 The ALARM ANNUNCIATION PANEL (AAP), and excess exhaust air panel (EAP) located as shown on Drawings shall each flash a pilot light and initiate an audible alarm sequence upon sensing an alarm condition.

.2 The alarm initiating contact shall either close or open to alarm as specified for fail-safe reasons.

.3 Upon actuation of MUTE push-button, the visual indicator of an alarming channel shall illuminate steadily and the audible annunciator shall revert to steady illumination.

.4 The alarm circuit shall be reset to receive the next alarm. When the alarm initiating contact reverts to normal, the pilot light shall extinguish.

.5 The above sequence shall be typical for every alarm specified.

.6 Fan Stability Sequence of Control

.1 Where so shown on the plans or specified in the Sequence of Operations, the MAC in each laboratory, or a MSC shall provide a 0-10 VDC, or 20-103 kPa (3-15 psi) output control signal, to modulate a capacity control device installed on the variable volume exhaust fans not fitted with variable speed drives, to provide stable fan operation under large turndown ratios.

.2 The Zero and Span of this signal shall be individually adjustable to suit system operation.

.3 Where the capacity control system is for a Tri-Stack enhanced discharge plume exhaust fan, factory mount all capacity control devices and controllers.

.7 Space Temperature Control Sequence

.1 A 20-103 kPa (3-15 psi) temperature controller output signal, shall be provided by the DDC system supplier and

connected to the pneumatic reheat coil valve to maintain space temperature control.

.2 To maintain tight temperature control tolerances, the MAC shall assure that the supply air flow does not change unless the room ventilation levels are commanded to change.

.3 Where so specified, the temperature controller output shall command a sequencing of the pneumatic reheat coil valve with additional ducted supply air for cooling. In this case, the DDC system supplier shall provide a pneumatic temperature controller output signal as stated above, and a 1-10 VDC or 4-20 maDC signal wired to the MAC. The MAC shall scale this signal, and command the supply CAFV to provide additional supply air to satisfy the cooling requirement above that required for ventilation, and to increase the general exhaust air flow to maintain room pressurization at the specified level.

.4 The speed of response of the complete control system over the specified capacity range of the integrated fume hood exhaust, LFC exhaust, general exhaust, and make up air flow control system, shall be less than 1 second. All control system cycling shall have diminished to within 5% of set point within this time span.

.8 Variable Speed Controller (VSC) Sequence of Operation

.1 If the HAND-OFF-AUTO switch is in the HAND position, and the VSC-BYPASS switch is in the VSC position, power shall be applied to each VSC to provide a soft motor start.

.2 When the supply fan HAND-OFF-AUTO switch is in the AUTO position, and the VSC-BYPASS switch is in the VSC position, power shall be applied to the supply fan VSC and the soft start circuit, when the remote or automatically controlled contact wired to the designated MCP terminal is closed.

.3 When the return fan HAND-OFF-AUTO switch is in the AUTO position, and the VSC-BYPASS switch is in the VSC position, power shall be applied to the return fan VSC and the soft start circuit, when the supply fan interlock contact wired to the designated MCP terminal is closed.

.4 When the VSC-BYPASS switch is in the BYPASS position, then the bypass starter shall start the motor to allow it to operate at maximum speed.

.5 When the supply fan MANUAL-AUTO switch is in the AUTO position, the motor shall accelerate at a rate determined by the fan stability feature until the speed controller set point has been attained and the fan capacity satisfies the speed controller set point.

.6 When the exhaust fan MANUAL-AUTO switch is in the AUTO position, the motor shall accelerate at a rate determined by the fan stability feature until the speed controller set point has been attained. In this mode, the exhaust fan capacity shall match the supply fan capacity.

.7 When any fan MANUAL-AUTO switch is in the MANUAL position, speed control for that fan shall be transferred to the VSC manual speed control potentiometer.

.8 Each speed control potentiometer shall control the motor speed from minimum to the full motor nameplate speed, unless specified otherwise.

.9 Upon loss of power at the VSC input terminals or upon sensing a fault condition, the VSC shall advance to an orderly shutdown. Upon resumption of power at the same input terminals, the VSC shall advance to an orderly automatic restart sequence and provide a soft start for the motor.

.10 Upon sensing a short circuit or ground fault anywhere in the motor circuit, the short circuit protection circuit shall interrupt the current flow.

.11 The VSC shall provide a dry contact whenever it is READY and is operational, or it has TRIPPED on a fault. Each contact shall be wired to a marked set of terminals for tie-in to the monitoring system.

.12 Upon sensing an abnormal condition, the high temperature protection thermostat shall actuate a set of dry contacts wired to shut down both the supply and exhaust fan motors, de-energize the controls, and close the outside air intake and exhaust dampers.

.13 Upon sensing an abnormal condition, the LOW TEMPERATURE protection thermostat shall actuate a set of dry contacts to shut down both the supply and exhaust fan motors, de-energize the controls, and close the outside air intake and exhaust dampers.

.9 Fail-Safe Operation

.1 In the event of a compressed air or local power failure, or a break in the wiring carrying the control signals, all exhaust CAFV’s shall revert to their maximum air flow positions. Under these abnormal conditions, each CAFV shall maintain maximum specified air flows, independent of duct pressure fluctuations.

.2 In the event of a compressed air or local power failure, or a break in the wiring carrying the control signals, all supply CAFVs shall revert to their minimum air flow positions. Under these abnormal conditions, each CAFV shall maintain specified minimum air flows, independent of duct pressure fluctuations.

.3 The maximum and minimum air flows under loss of power or compressed air conditions, shall be as follows, unless specified otherwise:

CAFV Size	Minimum Air Flow		Maximum Air Flow	
	cfm	L/s	cfm	L/s
150 mm (6 in.)	30	15	250	118
250 mm (10 in.)	60	29	900	425
300 mm (1 ft.)	165	78	1400	660
2x250 mm (10 in.)	120	58	1800	850
2x300 mm (1 ft.)	330	156	2800	1320
3x300 mm (1 ft.)	495	235	4200	1980

4x300 mm (1 ft.)	660	312	5600	2640

2.2 TWO POSITION EXHAUST CAFV

.1 A two position exhaust air flow control CAFV equal to the EXV-SLV series CAFV offered by Phoenix Controls shall be supplied to control the exhaust flow from a laboratory canopy hood, snorkel, bio-safety cabinet or fume hood, where so specified.

.2 Two position CAFV shall maintain two fixed (minimum/maximum) air flow set points based on a switched 0-20 psi pneumatic signal. CAFV shall generate a 0-10 volt feed back signal linearly proportional to the CAFV air flow for monitoring or air flow tracking purposes. Feedback signal shall be determined directly from the CAFV's control arm and be factory calibrated by NIST traceable instrumentation to a stated cfm per volt scale factor.

.3 The two position CAFV shall be capable of accepting additional circuit boards through field modification to provide full variable volume exhaust control. Removal of the CAFV will not be required. Existing airflow tracking controllers shall accommodate variable volume operation without modification.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Controllable Air Flow Venturis (CAFV)

.1 The CAFV's are manufactured in the following capacity ranges:

CAFV Sizes	Minimum Air Flow		Maximum Air Flow	
	cfm	L/s	cfm	L/s
150 mm (6 in.)	30	15	250	118
250 mm (10 in.)	60	29	900	425
300 mm (1 ft.)	165	78	1400	660
2x250 mm (10 in.)	120	58	1800	850
2x300 mm (1 ft.)	330	156	2800	1320
3x300 mm (1 ft.)	495	235	4200	1980
4x300 mm (1 ft.)	660	312	5600	2640

.2 Please assure that the CAFV's are specified to be installed by the sheet metal Contractor in a manner that would leave the valve accessible for removal or replacement, and the electronics box accessible for calibration. The CAFV shall be installed in such a manner that body penetrations such as screws are not at the bottom. If there are condensates in the exhaust air stream, these condensates could leak through the body penetrations onto the electronics or onto the floor. Either is undesirable.

.3 Please assure that the differential pressure across each CAFV is within the range of 0.6 in. to 3.0 in. W.C. If the differential pressure falls outside of this window, the valve with become pressure dependent and not provide the correct air flow, resulting in nuisance alarms at the least, and possibly unsafe conditions at worst, depending on the application.

.4 CAFV's must be specified for horizontal or vertical mounting at the time of ordering. If a CAFV is delivered for the wrong orientation, it must be returned. The CAFV orientation cannot be changed in the field.

.5 The fail-safe operation of the CAFV must be specified. Normally, make up CAFV's are specified to be Normally Closed (NC) and exhaust CAFV's Normally Open (NO).

.6 For negatively pressurized rooms, it is usually a good idea to specify the supply CAFV's to be NC, while the exhaust CAFV's are specified to be NO. In case of compressed air failure or loss of control signal, the CAFV's fail to the specified minimum supply air flows and specified maximum exhaust air flows, to maintain a negative room pressurization, even under this abnormal condition. The opposite is true for positively pressurized rooms.

.7 The CAFV's require a 20 psi supply of instrument quality compressed air for the actuator. Air consumption is small, typically about 10 SCIM. In fact, the CAFV's only require air when the actuator is extending. No air is consumed when the actuator retracts or when it is not doing anything. The compressed air connection is normally provided by the controls Contractor.

3.2 ELECTRICAL POWER REQUIREMENTS

.1 Provide fume hood termination kit terminal box for future installation of all controls on the fume hood.

.2 The remaining wiring is the low voltage interconnecting wiring.

.3 All power to the laboratory ventilation system, including, but not limited to 3 phase line voltage and 115 VSC single phase control power, shall be distributed from a locked distribution panel that is adequately marked. A key should be make available to the laboratory user personnel, in case the breaker ever trips and must be reset.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for electric and electronic control system for HVAC and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect electric and electronic control systems from damage

.3 Replace defective or damaged materials with new.

1.4 THERMOSTAT (LOW VOLTAGE)

.1 Low voltage wall thermostat:

.1 For use on 24 V circuit at 1.5 A capacity.

.2 With heat anticipator adjustable 0.1 to 1.2A.

.3 Temperature setting range: 10 degrees C to 25 degrees C.

.4 Without sub-base.

1.5 THERMOSTAT (REMOTE BULB)

.1 Line voltage remote bulb type thermostat with:

.1 8A rating on 120V.

.2 3m copper capillary tube.

.3 Moisture and dust-resistant enclosure.

1.6 THERMOSTAT GUARDS

.1 Thermostat guards: lockable, opaque, cast metal. Slots for air circulation to thermostat.

1.7 LOW LIMIT TEMPERATURE ALARM

.1 Low limit temperature alarm with:

.1 Rating: 10.2 A at 120 V.

.2 Sensing bulb and long capillary tube.

.3 Switching action: manual.

.4 Temperature setting range: 0 degrees C to 15 degrees C.

1.8 HIGH LIMIT TEMPERATURE ALARM

.1 High limit temperature alarm with:

.1 Rating 10 A at 120 V.

.2 Positive lock-out.

.3 Manual reset only after 14 degrees C drop-in temperature.

.4 Cutout setting: 50 degrees C.

1.9 SAIL SWITCH

.1 Sail switch, [mercury bulb]type with [stainless steel]sail, adjustable range set for 120V. Maximum ambient temperature: 100 degrees C.

1.10 FLOW SWITCH

.1 Flow switch for pipe size as indicated, CSA Enclosure. Maximum liquid temperature: 121 degrees C. Maximum liquid gauge pressure of 1034 kPa ambient temperature range 16 degrees C to 120 degrees C.

1.11 PRESSURE SWITCH

.1 Pressure switch for water or air with reset, contacts auto on rise. Full load 1.2A at 16V. ULC rated.

PART 2 - EXECUTION

2.1 INSTALLATION

.1 Install control devices.

.2 On outside wall, mount thermostats on bracket or insulated pad [25]mm from exterior wall.

.3 Install remote sensing device and capillary tube in metallic conduit. Conduit enclosing capillary tube must not touch heater or heating cable.

.4 CLEANING

.5 Progress Cleaning: clean in accordance with Section 01 74 11-Cleaning.

.6 Leave Work area clean at end of each day.

.7 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

.8 Waste Management: in accordance with Section 01 74 20.

.9 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01.

.2 Section 23 05 23.01.

.3 Section 23 05 23.02.

.4 Section 23 08 02.

.5 Section 23 05 93

1.2 REFERENCE STANDARDS

.1 American National Standards Institute/American Water Works Association (ANSI/AWWA)

.1 ANSI/AWWA C111/A21.11-17, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.2 American Society of Mechanical Engineers (ASME)

.1 ASME B16.1-15, Grey Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

.2 ASME B16.3-16, Malleable Iron Threaded Fittings: Classes 150 and 300.

.3 ASME B16.5-17, Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.

.4 ASME B16.9-12, Factory-Made Wrought Buttwelding Fittings.

.5 ASME B18.2.1-12, Square Hex, Heavy Hex and Askew Head Bolts and Hex, Heavy Hex, Hex Flange. Loded Head and Lag Screws (Inch Series).

.6 ASME B18.2.2-15, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).

.3 ASTM International

.1 ASTM A47/A47M-99(2014), Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

.3 ASTM A181/A181M-14, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping

.4 ASTM A536-84(2014), Standard Specification for Ductile Iron Castings.

.5 ASTM B61-15, Standard Specification for Steam or Valve Bronze Castings.

.6 ASTM B62-17, Standard Specification for Composition Bronze or Ounce Metal Castings.

.7 ASTM E202-12, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.

.4 CSA International

.1 CSA B242-15, Groove and Shoulder Type Mechanical Pipe Couplings.

.2 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.

.5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS)

.1 MSS-SP-67-2017, Butterfly Valves.

.2 MSS-SP-70-2011, Grey Iron Gate Valves, Flanged and Threaded Ends.

.3 MSS-SP-71-2011, Grey Iron Swing Check Valves Flanged and Threaded Ends.

.4 MSS-SP-80-2013, Bronze Gate, Globe, Angle and Check Valves.

.5 MSS-SP-85-2011, Grey Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for hydronic systemsand include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate on drawings:

.1 Components and accessories.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00.

.2 Operation and Maintenance Data: submit operation and maintenance data for hydronic systemsfor incorporation into manual.

.1 Include special servicing requirements.

1.5 EXTRA STOCK MATERIALS

.1 Supply spare parts as follows:

.1 Valve seats: 1minimum for every ten valves, each size. Minimum one.

.2 Discs: 1minimum for every ten valves, each size. Minimum one.

.3 Stem packing: 1minimum for every ten valves, each size. Minimum one.

.4 Valve handles: 2minimum of each size.

.5 Gaskets for flanges: 1minimum for every ten flanges.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials in dry location, off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect hydronic systemsfrom damage.

.3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 PIPE

.1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:

.1 To NPS 6: Schedule 40.

.2 NPS 8 and over, 10.

.3 NPS 12 and over, 10 mm wall thickness.

2.2 PIPE JOINTS

.1 NPS 2 and under:screwed fittings.

.2 NPS 2-1/2 and over:welding fittings and flanges to CSA W48.

.3 Roll grooved: standardcoupling to CSA B242.

.4 Flanges: forged steel ASTM A181, 1035 kPa (150 psi) WSP, ANSI B16.1. Use only weld neck flanges with butterfly valves.

.5 Orifice flanges: slip-on raised face, 2100 kPa.

.6 Flange gaskets: to ANSI/AWWA C111/A21.11.

.7 Pipe thread: taper.

.1 Bolts and nuts: square head machine with hexagonal nut, steel ASTM A307, ANSI B18.2.

.8 Roll grooved coupling gaskets: type EPDM.

2.3 FITTINGS

.1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.

.2 Pipe flanges and flanged fittings:

.1 Cast iron: to ASME B16.1, Class 125.

.2 Steel: to ASME B16.5.

.3 Butt-welding fittings: steel, to ASME B16.9.

.4 Unions: malleable iron, to ASME B16.3.

.5 Fittings for roll grooved piping: ductile iron to ASTM A536.

2.4 VALVES

.1 Connections:

.1 NPS 2 and smaller: screwed ends.

.2 NPS 2-1/2 and larger: flangedends.

.2 Gate valves: application: isolating equipment, control valves, pipelines:

.1 NPS 2 and under:

.1 Mechanical Rooms: Class 125, rising stem, splitwedge disc, as specified Section 23 05 23.01.

.2 Elsewhere:Class 125, non-rising stem, solidwedge disc, as specified Section 23 05 23.01.

.2 NPS 2-1/2 and over:

.1 Mechanical Rooms: rising stem, splitwedge disc, bronzetrim, as specified Section 23 05 23.02.

.1 Operators: manual.

.2 Elsewhere: non-rising stem, solidwedge disc, bronzetrim, as specified Section 23 05 23.02.

.1 Operators: Manual

.3 Butterfly valves: application: isolating cells or section of multiple component equipment (i.e. multi-section coils, multi-cell cooling towers):

.1 NPS 2-1/2 and over: as specified Section 23 05 23.02.

.4 Globe valves: to application: throttling, flow control, emergency bypass:

.1 NPS 2 and under:

.1 Mechanical Rooms:withPTFEdisc, as specified Section 23 05 23.01.

.2 Elsewhere: globe, with compositiondisc, as specified Section 23 05 23.01.

.2 NPS 2-1/2 and over:

.1 With bronzedisc, bronzetrim, as specified Section 23 05 23.02.

.5 Balancing, for TAB:

.1 Sizes: calibrated balancing valves, as specified this section.

.2 NPS 2 and under:

.1 Mechanical Rooms: globe, with plugdisc as specified Section 23 05 23.01.

.2 Elsewhere: globe, with plug disc as specified Section 23 05 23.01.

.6 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01.

.7 Swing check valves:

.1 NPS 2 and under:

.1 Class 125, swing, with compositiondisc, as specified Section 23 05 23.01.

.2 NPS 2-1/2 and over:

.1 Flanged ends: as specified Section 23 05 23.02.

.8 Silent check valves:

.1 NPS 2 and under:

.1 As specified Section 23 05 23.01.

.2 NPS 2-1/2 and over:

.1 Flanged ends: as specified Section 23 05 23.02.

.9 Ball valves:

.1 NPS 2 and under: as specified Section 23 05 23.01.

.10 Lubricated Plug Valves

.1 NPS 2-1/2 and over:

.1 As specified Section 23 05 23.02.

PART 3 - EXECUTION

3.1 PIPING AND VALVE INSTALLATION

.1 Install pipework in accordance with Section 23 05 05.

.2 For pipe 65 mm (2-1/2 in.) and larger, use flanges, and for smaller pipe, use unions at all valves and equipment.

.3 Flare connections may be used on soft copper tubing where one end of the flare connection is an integral part of the equipment or valve.

.4 Provide automatic air eliminators at all high points on piping mains for hot and chilled water systems. Where venting a horizontal pipe, grade pipe up in direction of flow with vent at high point. Provide gate valve at the float inlet. Pipe outlets to drain using copper pipe. Drain pipe shall be run such that its route is visible.

.5 Provide manual air vents on all hot water heating units where air may be trapped. Use screw-driver operated vents of chrome plated brass. Vents shall be accessible without removing cover of heating unit.

.6 Install drain valves at all low points for draining and locate where easily accessible. In order to achieve this, install remote from system where necessary, clearly marked. Typical marking similar to the following:

.1 Heating system.

.2 Danger, authorized personnel only.

.7 Carefully ream threaded joints and join with compound on the male thread only. Re-tighten flanged connections after the installation has been brought up to its service. Following testing, apply insulation. Take care not to overstress the material during construction.

.8 Pipe welding operations shall be performed by welders Provincial Certification for the class of piping to be welded. Ensure the internal opening of pipes and fittings are not restricted by superfluous material.

.9 When welding or cutting with a torch, take precautions to prevent fire by maintaining fully charged 4.5 kg (10 lbs.) carbon dioxide extinguisher immediately adjacent to the operation. Protect wooden structure with fire retardant blankets.

.10 Arrange piping to permit ease of equipment removal. Provide flanges or unions on all pipe connections to each piece of equipment.

.11 Connect all multi-row water coils in counter flow.

.12 Drains from packaged air handling unit drain pans shall be of same size as connection on unit. Provide traps on all drains and deep seal traps on both sides of the fan and coil sections.

.13 Connect bases of all pumps with packed glands to drain with 12 mm (1/2 in.) O.D. copper tubing.

.14 Provide on the discharge line of each spray pump, a 12 mm (1/2 in.) valved bleed-off. Connect to discharge line above sump water level and run to drain.

.15 Provide strainers upstream of each pump suction and where shown.

.16 Provide butterfly valves where shown; these are permitted in lieu of gate valves in sizes 65 mm (2-1/2 in.) and larger.

.17 Provide gate, globe and check valves in all piping systems as shown and as required for satisfactory operation and control of equipment. Provide shut-off valves wherever piping is connected to all equipment. Provide one flow balancing valve and one shut-off valve on water coils.

.18 Provide for the expansion and Contraction of all pipes. Install with sufficient flexibility to prevent end-thrust and movements caused by thermal expansion or Contraction causing detrimental distortion or damage of connection equipment. Provide offsets between mains and equipment of sufficient length to safety absorb the expansion of the main.

.19 Install all control devices, valves and any other appurtenances as directed by the controls and/or BAS trades.

.20 Make connections between copper and steel with brass or bronze fittings.

.21 Ball valves may be used in low temperature and/or pressure systems only in lieu of gate valves in 50 mm (2 in.) and smaller. Provide union downstream of ball valves for servicing if ball valve is not a three piece design.

.22 For grooved piping ensure ends are clean and free from indentations, projections, and roll marks in the area from the pipe end to the groove for proper gasket sealing.

.23 Install all grooved products as per manufacturers latest recommended instructions. The Contractor is responsible to establish training for proper pipe end preparation and assembly by the manufacturer.

3.2 CIRCUIT BALANCING VALVES

.1 Install flow measuring stations and flow balancing valves as indicated.

.2 Remove handwheel after installation and when TAB is complete.

.3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

.4 Install flow balancing valves in sections of straight pipe as recommended by the manufacturer, but in no case with less than 10 pipe diameters upstream of the valve.

.5 Install flow balancing valves in the following locations:

.1 at each heating, chilled or condenser water riser, or main floor branch.

.2 each heating water and cooling water coils including unit heaters, fan coils and force flow heaters.

.3 Each heat exchanger.

.4 Each wall fin, radiant ceiling or similar heating device.

.5 Each heat pump.

.6 Each pump pressure differential line.

.7 Each main building or secondary heating or cooling circuit.

.8 And where shown.

3.3 CLEANING, FLUSHING AND START-UP

.1 In accordance with Section 23 08 02.

3.4 TESTING

.1 Test system in accordance with Section 21 05 01.

3.5 BALANCING

.1 Balance water systems to within plus or minus 5% of design output.

.2 In accordance with Section 23 05 93for applicable procedures.

3.6 PERFORMANCE VERIFICATION

.1 In accordance with Section 23 08 01.

3.7 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

.3 Waste Management:in accordance with Section 01 74 20.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.8 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by hydronic systems installation.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01.

1.2 REFERENCE STANDARDS

.1 ASME

.1 ASME Boiler and Pressure Vessel Code (BPVC), Section VIII-2017.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for HVAC water treatment systemsand include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit 2copies of WHMIS MSDS

.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00.

.2 Operation and Maintenance Data: submit operation and maintenance data for HVAC water treatment systemsfor incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Replace defective or damaged materials with new.

.4 Packaging Waste Management: in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 MANUFACTURER

.1 Equipment, chemicals, and service provided by one supplier.

PART 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 CLEANING OF MECHANICAL SYSTEM

.1 Provide copy of recommended cleaning procedures and chemicals for approval by Departmental Representative.

.2 Flush mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Use chemicals to inhibit corrosion of various system materials that are safe to handle and use.

.3 Examine and clean filters and screens, periodically during circulation of cleaning solution, and monitor changes in pressure drop across equipment.

.4 Drain and flush systemsuntil alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.

.5 Disposal of cleaning solutions approved by authority having jurisdiction.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

.3 Waste Management: in accordance with Section 01 74 20.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01.

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

.2 ASTM International

.1 ASTM A480/A480M-17, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.2 ASTM A635/A635M-15, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.

.3 ASTM A653/A653M-17, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.3 National Fire Protection Association (NFPA)

.1 NFPA 90A-18, Standard for the Installation of Air-Conditioning and Ventilating Systems.

.2 NFPA 90B-18, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

.3 NFPA 96-17, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005

.2 SMACNA HVAC Air Duct Leakage Test Manual.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Test and Evaluation Reports:

.1 Certification of Ratings:

.1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in dry location, off ground and in clean, dry, well-ventilated area.

.2 Store and protect metal ducts from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

LOW PRESSURE DUCT CONSTRUCTION

MAX. DUCT DIMENSION	SHEET METAL US GAUGE	TRANSVERSE JOINT CONNECTION AND BRACING
Up to 300 mm (12 in.)	26	Flat drive or flat ‘S’ no bracing
325 mm to 425 mm (13 in. to 18 in.)	24	Flat drive or flat ‘S’ no bracing
475 mm to 750 mm (19 in. to 30 in.)	24	25 mm (1 in.) standing ‘T’ bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
775 mm to 1050 mm (31 in. to 42 in.)	22	25 mm (1 in.) standing ‘T’ bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
1075 mm to 1200 mm (43 in. to 48 in.)	22	38 mm (1-1/2 in.) standing ‘T; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
1225 mm to 1350 mm (49 in. to 54 in.)	22	38 mm (1-1/2 in.) standing ‘T; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
1375 mm to 1500 mm (55 in. to 60 in.)	20	38 mm (1-1/2 in.) standing ‘T; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
1525 mm to 2100 mm (61 in. to 84 in.)	20	38 mm (1-1/2 in.) standing ‘T; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.

2125 mm to 2400 mm (85 in. to 96 in.)	18	50 mm (2 in.) standing 'T' bracing 38 mm x 38 mm x 5 mm (1-1/2 in. x 1-1/2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.
2425 mm to 3000 mm (97 in. to 120 in.)	18	50 mm (2 in.) standing 'T' bracing 50 mm x 50 mm x 6 mm (2 in. x 2 in. x 1/4 in.) at maximum 600 mm (24 in.) centres.
3025 mm and over (121 in. and over)	18	As above with addition of tie rods at 300 mm (120 in.) centres for joint bracing.

.1 Bracing spacing shown is maximum spacing between two bracings or between bracing and joint.

.2 Locate bracings mid-way between joints.

.3 Make longitudinal joints Pittsburgh lock seam at edge of duct, and grooved seam on face of duct.

2.2 SEALANT

.1 Sustainability Characteristics:

.1 Adhesives and sealants: in accordance with Section 07 90 00, and 01 33 29.

.2 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.3 TAPE

.1 Tape: polyvinyl treated, open weave fiberglass tape, 50mm wide.

2.4 DUCT LEAKAGE

.1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.5 FITTINGS

.1 Fabrication: to ASHRAE.

.2 Radiused elbows:

.1 Rectangular: short radius with single thickness turning vanes or standard radius centreline radius: 1.5 times width of duct.

.2 Round: smooth radius, centreline radius: 1.5 times diameter.

.3 Mitred elbows, rectangular:

.1 To 400mm: with double thickness turning vanes.

.2 Over 400mm: with double thickness turning vanes.

.4 Branches:

.1 Rectangular main and branch: with radius on branch 1.5 times width of duct.

.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.

.4 Main duct branches: with splitter damper.

.5 Transitions:

.1 Diverging: 20 degrees maximum included angle.

.2 Converging: 30 degrees maximum included angle.

.6 Offsets:

.1 Full radiused elbows.

.7 Obstruction deflectors: maintain full cross-sectional area.

.1 Maximum included angles: as for transitions.

2.6 FIRE STOPPING

.1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00.

.2 Fire stopping material and installation must not distort duct.

2.7 GALVANIZED STEEL

.1 Lock forming quality: to ASTM A653/A653M, Z275 zinc coating.

.2 Thickness, fabrication and reinforcement: to SMACNA.

.3 Joints: per above table.

2.8 STAINLESS STEEL

.1 For all laboratory exhaust ductwork

.2 To ASTM A480/A480M, Type 304.

.3 Finish: number 4.

.4 Thickness, fabrication and reinforcement: to ASHRAE.

.5 Joints: to be continuous inert gas welded.

2.9 HANGERS AND SUPPORTS

.1 Hangers and Supports: in accordance with Section 23 05 29.

.1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.

.1 Maximum size duct supported by strap hanger: 500.

.2 Hanger configuration: to SMACNA.

.3 Hangers: galvanized steel angle with galvanized steel rods to SMACNA or the following table, whichever is more stringent:

Duct Size	Angle Size	Rod Size
(mm)	(mm)	(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

.4 Upper hanger attachments:

.1 For concrete: manufactured concrete inserts.

.2 For steel beams: manufactured beam clamps:

PART 3 - EXECUTION

3.1 GENERAL

.1 Make all laps in the direction of air flow. Use no sheet metal screws in the duct where it is possible to use rivets and bolts. Hammer down all edges and slips so as to leave smooth finished surface inside the ducts.

.2 Brace and stiffen all ducts, and make tight so that they will not breathe, rattle, vibrate or sag. Cross-break all rectangular ducts with heights or widths of 300 mm (12 in.) or larger.

.3 Where rectangular ducts are shown, round ducts may be substituted at the Contractor’s option, provided there is sufficient room. Conversion from rectangular to round duct, sizing shall be as shown on charts in ASHRAE.

.4 Do work in accordance with NFPA 90A.

.5 Do not break continuity of insulation vapour barrier with hangers or rods.

.6 Ensure diffuser is fully seated, Insulate strap hangers 100 mm beyond insulated duct.

.7 Provide splitter dampers as shown on Standard Details.

.8 Support risers in accordance with SMACNA.

.9 Install breakaway joints in ductwork on sides of fire separation.

.10 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.2 HANGERS

.1 All round duct or diffuser hangers in exposed ceilings in finished spaces shall be wire cable type hangers, installed to manufacturer requirements.

.2 Strap hangers: install in accordance with SMACNA.

.3 Angle hangers: complete with locking nuts and washers.

.4 Hanger spacing: in accordance with SMACNA:

Duct Size (mm)	Spacing (mm)
to 1500	3000
1501 and over	2500

3.3 WATERTIGHT DUCT

.1 Provide watertight duct for:

.1 Fresh air intake.

.2 Minimum 3000 mm from duct mounted humidifier in all directions.

.3 As indicated.

.2 Form bottom of horizontal duct without longitudinal seams.

.1 Weld joints of bottom and side sheets.

.2 Seal other joints with duct sealer.

.3 Slope horizontal branch ductwork down towards fume hoods served.

.1 Slope header ducts down toward risers.

.4 Fit base of riser with 150 mm deep drain sump and 32mm drain connected, with deep seal trap and valve and discharging to open funnel drain.

3.4 SEALING AND TAPING

.1 Apply sealant in accordance with SMACNA.

.2 Bed tape in sealant and recoat with minimum of 1 coat of sealant to manufacturers recommendations.

3.5 LEAKAGE TESTS

.1 Refer to Section 23 05 94.

.2 In accordance with SMACNA HVAC Duct Leakage Test Manual.

.3 Do leakage tests in sections.

.4 Make trial leakage tests as instructed to demonstrate workmanship.

.5 Do not install additional ductwork until trial test has been passed.

.6 Test section minimum of 30m long with not less than three branch takeoffs and two 90 degrees elbows.

.7 Complete test before performance insulation or concealment Work.

3.6 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

Waste Management: in accordance with Section 01 74 20.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01.

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

.2 ASTM International

.1 ASTM A653/A653M-17, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.3 Sheet Metal Air Conditioning Contractors' National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005.

.2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.

.3 SMACNA IAQ Guideline for Occupied Buildings Under Construction.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for ductwork and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Test and Evaluation Reports:

.1 Certification of Ratings:

.1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground in clean, dry, well-ventilated area.

.2 Store and protect metal ducts from damage.

.3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 DUCTWORK

.1 Material:

.1 Galvanized steel with Z275 designation zinc coating lock forming quality: to ASTM A653/A653M.

.2 Thickness: as indicated in table below.

.2 Construction: round and oval.

.1 Ducts: factory fabricated, spiral wound, with matching fittings and specials to SMACNA.

.2 Transverse joints up to 900mm: slip type with tape and sealants.

.3 Transverse joints over 900mm: Vanstone.

.4 Fittings:

.1 Elbows: 3 piece (for 45 degrees) 5 piece (for 90 degrees). Centreline radius: 1.5x diameter.

.2 Branches: conical transition with conical branch at 45 degrees and 45 degrees elbow. pressure systems.

.3 Construction: rectangular:

.1 Ducts: to SMACNA.

.2 Transverse joints: welded or SMACNA seal Class A and B

.3 Fittings:

.1 Elbows: smooth radius; centreline radius 1.5x width of duct. No vanes.

.2 Branches: with conical branch at 45 degrees and 45 degrees elbow.

.4 Fire stopping:

.1 50 x 50 x 3 mm retaining angles around duct, on both sides of fire separation.

.2 Fire stopping material must not distort duct.

2.2 DUCT CONSTRUCTION

.1 Medium pressure rectangular ducts are required for all smoke exhaust systems and in the following areas. Construct medium pressure rectangular ducts as follows:

MEDIUM PRESSURE RECTANGULAR DUCT CONSTRUCTION

MAX. DUCT DIMENSION	SHEET METAL US GAUGE	TRANSVERSE JOINT CONNECTION & BRACING
Up to 300 mm (12 in.)	24	25 mm (1 in.) standing seam, 16 mm (5/8 in.) welded flange 25 mm (1 in.) pocket lock, no bracing.
325 mm to 425 mm (13 in. to 18 in.)	24	25 mm (1 in.) standing seam, 22 mm (7/8 in.) welded flange, 25 mm (1 in.) pocket lock, bracing 25 mm x 25 mm x 16 gauge (1 in. x 1 in. x 16 UG gauge) at 1200 mm (48 in.) centres.
475 mm to 600 mm (19 in. to 24 in.)	22	32 mm (1-1/4 in.) standing seam, 35 mm (1-3/8 in.) welded flange, 30 mm (1-1/8 in.) pocket lock, bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 120 mm (48 in.) centres.
625 mm to 900 mm (25 in. to 36 in.)	22	38 mm (1-1/2 in.) standing seam, 38 mm (1/2 in.) pocket lock, bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 120 mm (48 in.) centres.
925 mm to 1200 mm (37 in. to 48 in.)	22	50 mm (2 in.) standing seam or 50 mm (2 in.) flanged joint, bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 750 mm (30 in.) centres.
1125 mm to 1500 mm (49 in. to 60 in.)	20	38 mm (1-1/2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 50 mm x 50 mm x 3 mm (2 in. x 2 in. x 1/8 in.) at maximum 600 mm (24 in.) centres.
1525 mm to 1800 mm (61 in. to 72 in.)	20	38 mm (1-1/2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 50 mm x 50 mm x 3 mm (2 in. x 2 in. x 1/8 in.) at maximum 600 mm (24 in.) centres.
1825 mm to 2100 mm (73 in. to 84 in)	18	50 mm (2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 65 mm x 65 mm x 5 mm (2-1/2 in. x 2-1/2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.
2425 mm and over (96 in. and over)	18	50 mm (2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 65 mm x 65 mm x 5 mm (2-1/2 in. x 2-1/2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.

.1 Bracing spacing shown above is maximum spacing between two bracings or between bracing and joint. Locate bracing mid-way between joints.

.2 Make longitudinal joints Pittsburgh lock seam at edge of duct, and grooved seam on face of duct.

.2 Medium and high pressure round ducts up to 750 mm (30 in.) dia. shall be factory fabricated, helically wound galvanized iron strips with spiral lock seam as follows:

MEDIUM AND HIGH PRESSURE ROUND DUCT CONSTRUCTION

DIAMETER	STRIP METAL US GAUGE	STRIP JOINT	GIRTH JOINT
Up to 200 mm (8 in.)	26	100 mm (4 in.)	50 mm (2 in.) long slip
225 mm to 550 mm (9 in. to 22 in.)	24	100 mm (4 in.)	50 mm (2 in.) long slip
575 mm to 750 mm (23 in. to 30 in.)	22	150 mm (6 in.)	100 mm (4 in.) long slip

.3 Join with galvanized iron coupling sleeves or conduit fittings of welded construction.

US GAUGE	SHEET METAL US GAUGE	REINFORCING	GIRTH JOINT
775 mm to 900 mm (31 in. to 36 in.)	20	None	100 mm (4 in.) long slip
925 mm to 1500 mm (37 in. to 60 in.)	18	32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) angle on max 1800 mm (72 in.) centres	32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in. angle flanged.

.4 Construct larger ductwork as follows with longitudinal lock or butt welded seams:

2.3 SEALANT

.1 Sustainability Characteristics:

.1 Adhesives and sealants: in accordance with Section 07 90 00, and 01 33 29.

.2 Oil resistant, water-borne polymer type flame resistant high velocity duct sealing compound.

.1 Temperature range of minus 30 degrees C to plus 93 degrees C.

2.4 TAPE

.1 Tape: polyvinyl treated, open weave fibre glass, 50 mm wide.

2.5 HANGERS AND SUPPORTS

.1 Hangers and supports: in accordance with Section 23 05 29.

.1 Pre-manufactured cable hangers – for all exposed ductwork in occupied spaces.

.2 Band hangers: use on round and oval ducts up to 500 mm diameter, of same material as duct but next sheet metal thickness heavier than duct.

.3 Trapeze hangers: ducts over 500mm diameter or longest side, to ASHRAE.

.4 Hangers: galvanized steel angle with galvanized steel rods to 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

PART 3 - EXECUTION

3.1 GENERAL

.1 Do work in accordance with SMACNA.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

.1 Insulate band hangers 100 mm beyond insulated duct.

.2 Ensure diffuser is fully seated.

.3 Support risers in accordance with SMACNA.

.4 Install breakaway joints in ductwork on sides of fire separation.

3.2 HANGERS

.1 Band hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 cable hangers: per manufacturer’s guidelines

.4 Hanger spacing: as follows:

Duct Size (mm)	Spacing (mm)
to 1500	2400
1501 to 3000	2400
3000 to 6000	1200

3.3 SEALING AND TAPING

.1 Apply sealant in accordance with SMACNA.

.2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturer's recommendations.

3.4 LEAKAGE TESTS

.1 Refer to Section 23 05 94.

.2 In accordance with SMACNA HVAC Duct Leakage Test Manual.

.3 Perform leakage tests in sections.

.4 Perform trial leakage tests, as instructed to demonstrate quality of work.

.5 Do not install additional ductwork until trial tests have been achieved.

.6 Test section minimum of 30m long with not less than 3branch takeoffs and two 90 degrees elbows.

.7 Complete tests before performing insulation or concealment Work.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

.3 Waste Management: in accordance with Section 01 74 20.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01.

1.2 REFERENCE STANDARDS

.1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, 2005.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for air duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Indicate:

.1 Flexible connections.

.2 Duct access doors.

.3 Turning vanes.

.4 Instrument test ports.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00. Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect air duct accessories from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 GENERAL

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

2.2 FLEXIBLE CONNECTIONS

.1 Frame: galvanized sheet metal frame.

.2 Material:

.1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3kg/m2.

2.3 ACCESS DOORS IN DUCTS

.1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.

.2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.

.3 Gaskets: neoprene.

.4 Hardware:

.1 Up to 300 x 300mm: two sash locks complete with safety chain.

.2 301 to 450mm: four sash locks complete with safety chain.

.3 451 to 1000mm: piano hinge and minimum two sash locks.

.4 Doors over 1000mm: piano hinge and two handles operable from both sides.

.5 Hold open devices.

.6 300 x 300 mm glass viewing panels.

2.4 TURNING VANES

.1 Factory or shop fabricated single thickness to recommendations of SMACNA and as indicated.

2.5 INSTRUMENT TEST

.1 1.6mm thick steel zinc plated after manufacture.

.2 Cam lock handles with neoprene expansion plug and handle chain.

.3 28 mm minimum inside diameter. Length to suit insulation thickness.

.4 Neoprene mounting gasket.

2.6 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.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Flexible Connections:

.1 Install in 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 Length of connection: 100 mm.

.3 Minimum distance between metal parts when system in operation: 75 mm.

.4 Install in accordance with recommendations of SMACNA.

.5 When fan is running:

.1 Ducting on sides of flexible connection to be in alignment.

.2 Ensure slack material in flexible connection.

.2 Access Doors and Viewing Panels:

.1 Size:

.1 Min 450mmx450mm

.2 As indicated.

.2 Locations:

.1 Fire and smoke dampers.

.2 Control dampers.

.3 Devices requiring maintenance.

.4 Required by code.

.5 Reheat coils.

.6 Elsewhere as indicated.

.3 Instrument Test Ports:

.1 General:

.1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.2 Locate to permit easy manipulation of instruments.

.3 Install insulation port extensions as required.

.4 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 And as indicated.

.5 For temperature readings:

.1 At outside air intakes.

.2 In mixed air applications in locations as approved by Departmental Representative.

.3 At inlet and outlet of coils.

.4 Downstream of junctions of two converging air streams of different temperatures.

.5 And as indicated.

.4 Turning Vanes:

.1 Install in accordance with recommendations of SMACNA and as indicated.

3.2 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

.3 Waste Management: in accordance with Section 01 74 20.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01.

1.2 REFERENCE STANDARDS

.1 Sheet Metal and Air Conditioning National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-2013.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for dampersand include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00.

.2 Operation and Maintenance Data: submit operation and maintenance data for dampersfor incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect dampersfrom nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 GENERAL

.1 Manufacture to SMACNA standards.

2.2 SPLITTER DAMPERS

.1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.

.2 Doublethickness construction.

.3 Control rod with locking device and position indicator.

.4 Rod configuration to prevent end from entering duct.

.5 Pivot: piano hinge.

.6 Folded leading edge.

2.3 SINGLE BLADE DAMPERS

.1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.

.2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm.

.3 Locking quadrant with shaft extension to accommodate insulation thickness.

.4 Inside and outside bronze or nylonend bearings.

.5 Channel frame of same material as adjacent duct, complete with angle stop.

2.4 MULTI-BLADED DAMPERS

.1 Factory manufactured of material compatible with duct.

.2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.

.3 Maximum blade height: 100mm.

.4 Bearings: self-lubricating nylon or pin in bronze bushings.

.5 Linkage: shaft extension with locking quadrant.

.6 Channel frame of same material as adjacent duct, complete with angle stop.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install where indicated.

.2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.

.4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.

.5 Dampers: vibration free.

.6 Ensure damper operators are observable and accessible.

.7 Corrections and adjustments conducted by Departmental Representative.

3.2 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11

.3 Waste Management:in accordance with Section 01 74 20.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01.

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)

.2 National Fire Protection Association (NFPA)

.1 NFPA 90A-18, Standard for the Installation of Air-Conditioning and Ventilating Systems.

.2 NFPA 90B-18, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.

.3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, 2005.

.2 SMACNA IAQ Guideline for Occupied Buildings under Construction,2008.

.4 Underwriters' Laboratories (UL)

.1 UL 181-2013, Standard for Factory-Made Air Ducts and Air Connectors.

.5 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC-S110-2013, Standard Methods of Tests for Air Ducts.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for flexible ductsand include product characteristics, performance criteria, physical size, finish and limitations.

.2 Indicate:

.1 Thermal properties.

.2 Friction loss.

.3 Acoustical loss.

.4 Leakage.

.5 Fire rating.

.3 Test and Evaluation Reports:

.1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions 01 61 00

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect flexible ductsfrom damage.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management:in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 GENERAL

.1 Factory fabricated to CAN/ULC-S110.

.2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.

.3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.2 METALLIC - UNINSULATED

.1 spiral wound flexible aluminum, as indicated.

.2 Performance:

.1 Factory tested to 2.5kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

2.3 METALLIC - INSULATED

.1 spiral wound flexible aluminum with factory applied, 37mm thick flexible glass fibre thermal insulation with vapour barrier and aluminumjacket, as indicated.

.2 Performance:

.1 Factory tested to 2.5kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

2.4 NON-METALLIC - ACOUSTIC INSULATED

.1 non-collapsible, coated mineral base perforated fabric type helically supported by and mechanically bonded to wire with factory applied flexible mineral fibre acoustic insulation and encased in aluminum foil/mylar laminate vapour barrier, as indicated.

.2 Performance:

.1 Factory tested to 2.5kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

.3 Acoustical performance: Minimum attenuation (dB/m) to following table:

Frequency (Hz)					
Duct Diam:	125	250	500	1000	2000
100	0.6	3	12	27	0
150	1.2	3	12	22	27
200	2.0	5	12	19	20
300	2.4	5	12	16	15

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

.1 Install in accordance with: SMACNA.

.2 Ensure installed lengths of flexible ductwork shall be no longer than 1.5m (5 ft.) when fully stretched.

.3 Flexible ductwork may be used under the following conditions:

.1 Flexible ductwork shall be used where shown to allow easy location of diffusers.

.2 Flexible ductwork shall not pass through floors or fire walls,

.3 Flexible ductwork shall be a single section of duct (no joints). In the event that building construction requires connection between lengths of flexible duct use a rigid section of duct as the joint. Flexible duct shall be secure to the rigid section using ties and sealant.

.4 Provide durable elbow support where flexible ducts bend as an elbow.

3.2 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

.3 Waste Management: in accordance with Section 01 74 20.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01.

1.2 REFERENCE STANDARDS

.1 ASTM International

.1 ASTM C423-17, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

.2 ASTM C916-14, Standard Specification for Adhesives for Duct Thermal Insulation.

.3 ASTM C1071-16, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

.4 ASTM C1338-14, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.

.5 ASTM G21-15, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

.2 National Fire Protection Association (NFPA)

.1 NFPA 90A-18, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 NFPA 90B-18, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

.3 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)

.1 SMACNA, HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition -2005.

.2 SMACNA IAQ Guideline for Occupied Buildings Under Construction-2008.

.4 Underwriter's Laboratories of Canada (ULC)

.1 CAN/ULC-S102-11, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for duct linersand include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00.

.2 Operation and Maintenance Data: submit operation and maintenance data for duct linersfor incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect duct linersfrom damage.

.3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 DUCT LINER

.1 General:

.1 Mineral Fibre duct liner: air surface coated mat facing.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102.

.3 Recycled Content: with minimum 35 by weight recycled content.

.4 Fungi resistant

.2 Flexible:

.1 Use on

.1 All return air transfer ductwork.

.2 All ductwork specifically identified on the Drawings.

.2 Duct liner shall comply with the requirements of NFPA 90A and the “Duct Liner Materials Standard” of the Thermal Insulation Manufacturer’s Association.

.3 Sizes shown on the Drawing are free area dimensions (after the installation of duct liner). Duct liner shall be a minimum of 25 mm (1 in.) unless shown otherwise.

.4 All acoustical duct lining shall incorporate means to prevent fiber entrainment in the air stream.

.5 Fibrous glass blanket duct liner.

.6 Density: 24 kg/m3minimum.

.7 Thermal resistance to be minimum 0.74 (m2.degrees C)/W for 25 mm thickness when tested in accordance with ASTM C177, at 24 degrees C mean temperature.

2.2 ADHESIVE

.1 Adhesive: to ASTM C916.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 degrees C to plus 93 degrees C.

.3 Water-based fire retardanttype.

2.3 FASTENERS

.1 Weld pins 2.0mm diameter, length to suit thickness of insulation. Metal retaining clips, 32mm square.

2.4 JOINT TAPE

.1 Poly-Vinyl treated open weave fiberglass membrane 50mm wide.

2.5 SEALER

.1 Meet requirements of NFPA 90A.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 degrees C to plus 93 degrees C.

PART 3 - EXECUTION

3.1 GENERAL

.1 Do work in accordance with SMACNA HVAC Duct Construction Standard except as specified otherwise.

.2 Line inside of ducts where indicated.

.3 Duct dimensions, as indicated, are clear inside duct lining.

3.2 DUCT LINER

.1 Install in accordance with manufacturer's recommendations, and as follows:

.1 Fasten to interior sheet metal surface with 90% coverage of adhesive to ASTM C916.

.1 Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.

.2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres to compress duct liner sufficiently to hold it firmly in place.

.1 Spacing of mechanical fasteners in accordance with SMACNA HVAC Duct Construction Standard.

.2 In systems, where air velocities exceeds 20.3m/s, install galvanized sheet metal noising to leading edges of duct liner.

.3 Ducts, except where noted otherwise, shall be acoustically lined internally, from the fan connection to the terminal. Both supply and return systems shall be lined unless otherwise specified. Exhaust ducts shall be internally lined where shown on the Drawings to reduce sound transmission.

.4 Other ductwork shall be acoustically lined where shown on the Drawings.

.5 Acoustical duct lining shall be 50 mm (2 in.) thick in ducts within Mechanical Rooms, in plenums, and where expressly shown on the Drawings. Acoustical duct lining shall be 25 mm (1 in.) thick in all other internally lined sheet metal ducts, unless otherwise specified or shown on the Drawings.

.6 The acoustical liner shall be fixed to the duct with a minimum of 50% coverage of a fire-resistant adhesive. Where the duct width exceeds 300 mm (12 in.) or the height 600 mm (24 in.), the liner shall be additionally secured with mechanical fastening on maximum 450 mm (18 in.) centers on all sides. Mechanical fasteners that pierce the duct are unacceptable. All ends of the liner shall be coated with a fire resistant cementing material to prevent delamination, leakage or erosion. All joints shall be firmly butted and ends coated with an adhesive to ensure that the lining is smooth across all joints.

.7 Where acoustical duct lining is installed, the dimensions of the sheet metal shall be increased to include the thickness of the lining material. Dimensions shown on the Mechanical Drawings are the clear internal dimensions after the liner has been installed.

3.3 JOINTS

.1 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:

.1 Bed tape in sealer.

.2 Apply 2coats of sealer over tape.

.2 Replace damaged areas of liner at discretion of Departmental Representative.

.3 Protect leading and trailingedges of duct sections with sheet metal nosing having 15mm overlap and fastened to duct.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

.3 Waste Management:in accordance with Section 01 74 20.

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes.

.1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) and includes:

.1 Start-up testing and verification of systems.

.2 Check out demonstration or proper operation of components.

.3 On-site operational tests.

1.2 RELATED REQUIREMENTS

.1 Section 21 05 01

1.3 DEFINITIONS

.1 For additional acronyms and definitions refer to Section 25 05 01.

.2 AEL: ratio between total test period less any system downtime accumulated within that period and test period.

.3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:

.1 Outage of main power supply in excess of back-up power sources, provided that:

.1 Automatic initiation of back-up was accomplished.

.2 Automatic shut-down and re-start of components was as specified.

.2 Failure of communications link, provided that:

.1 Controller automatically and correctly operated in stand-alone mode.

.2 Failure was not due to failure of any specified EMCS equipment.

.3 Functional failure resulting from individual sensor inputs or output devices, provided that:

.1 System recorded said fault.

.2 Equipment defaulted to fail-safe mode.

.3 AEL of total of all input sensors and output devices is at least 99% during test period.

1.4 DESIGN REQUIREMENTS

.1 Confirm with Departmental Representative that Design Criteria and Design Intents are still applicable.

.2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 30.

.2 Final Report: submit report to Departmental Representative.

.1 Include measurements, final settings and certified test results.

.2 Bear signature of commissioning technician and supervisor

.3 Report format to be approved by Departmental Representative before commissioning is started.

.4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Departmental Representative in accordance with Section 01 78 00.

.5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.6 CLOSEOUT SUBMITTALS

.1 Provide documentation, O&M Manuals, and training of O&M personnel for review of Departmental Representative before interim acceptance in accordance with Section 01 78 00.

1.7 COMMISSIONING

.1 Carry out commissioning under direction of Departmental Representative and in presence of Departmental Representative.

.2 Inform, and obtain approval from, Departmental Representative in writing at least 14days prior to commissioning or each test. Indicate:

.1 Location and part of system to be tested or commissioned.

.2 Testing/commissioning procedures, anticipated results.

.3 Names of testing/commissioning personnel.

.3 Correct deficiencies, re-test in presence of Departmental Representative until satisfactory performance is obtained.

.4 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.

.5 Load system with project software.

.6 Perform tests as required.

1.8 COMPLETION OF COMMISSIONING

.1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Departmental Representative.

1.9 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

.1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

PART 2 - PRODUCTS

2.1 EQUIPMENT

.1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.

.2 Instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.

.3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than 2 months prior to tests.

.4 Locations to be approved, readily accessible and readable.

.5 Application: to conform to normal industry standards.

PART 3 - EXECUTION

3.1 PROCEDURES

.1 Test each system independently and then in unison with other related systems.

.2 Commission each system using procedures prescribed by the Commissioning Manager.

.3 Debug system software.

.4 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.

.5 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

3.2 FIELD QUALITY CONTROL

.1 Pre-Installation Testing.

.1 General: consists of field tests of equipment just prior to installation.

.2 Testing may be on site or at Contractor's premises as approved by Departmental Representative.

.3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU's, and TCU's.

.4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).

.5 Additional instruments to include:

.1 DP transmitters.

.2 VAV supply duct SP transmitters.

.3 DP switches used for dirty filter indication and fan status.

.6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0and 500Pa, to hold steady at any setting and with direct output to milli-amp metre at source and to BECC.

.7 After setting, test zero and span in 10% increments through entire range while both increasing and decreasing pressure.

.8 Transmitters above 0.5% error will be rejected.

.9 DP switches to open and close within 2% of setpoint.

.2 Completion Testing.

.1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.

.2 Include following activities:

.1 Test and calibrate field hardware including stand-alone capability of each controller.

.2 Verify each A-to-D convertor.

.3 Test and calibrate each AI using calibrated digital instruments.

.4 Test each DI to ensure proper settings and switching contacts.

.5 Test each DO to ensure proper operation and lag time.

.6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.

.7 Test operating software.

.8 Test application software and provide samples of logs and commands.

.9 Verify each CDL including energy optimization programs.

.10 Debug software.

.11 Blow out flow measuring and static pressure stations with high pressure air at 700kPa.

.12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. This document will be used in final startup testing.

.3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Departmental Representative and provide:

.1 2technical personnel capable of re-calibrating field hardware and modifying software.

.2 Detailed daily schedule showing items to be tested and personnel available.

.3 Commissioning to commence during final startup testing.

.4 O&M personnel to assist in commissioning procedures as part of training.

.5 Commissioning to be supervised by qualified supervisory personnel.

.6 Commission systems considered as life safety systems before affected parts of the facility are occupied.

.7 Operate systems as long as necessary to commission entire project.

.8 Monitor progress and keep detailed records of activities and results.

.4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.

.1 Prior to beginning of 30day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.

.1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.

.2 Test to last at least 30consecutive 24 hour days.

.3 Tests to include:

.1 Demonstration of correct operation of monitored and controlled points.

.2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.

.4 System will be accepted when:

.1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.

.2 Requirements of Contract have been met.

.5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.

.6 Correct defects when they occur and before resuming tests.

.5 Departmental Representative to verify reported results.

3.3 ADJUSTING

.1 Final adjusting: upon completion of commissioning as reviewed by Departmental Representative, set and lock devices in final position and permanently mark settings.

3.4 DEMONSTRATION

Demonstrate to Commissioning Manager operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 79 00.

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for training program, instructors and training materials, for building Energy Monitoring and Control System (EMCS) Work.

1.2 RELATED REQUIREMENTS

.1 Section 21 05 01

.2 Section 25 05 01.

1.3 DEFINITIONS

.1 CDL - Control Description Logic.

.2 For additional acronyms and definitions refer to Section 25 05 01.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00, supplemented and modified by requirements of this Section.

.2 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Departmental Representative 30 days prior to anticipated date of beginning of training.

.1 List name of trainer, and type of visual and audio aids to be used.

.2 Show co-ordinated interface with other EMCS mechanical and electrical training programs.

.3 Submit reports within one week after completion of training program that training has been satisfactorily completed.

1.5 QUALITY ASSURANCE

.1 Provide competent instructors thoroughly familiar with aspects of EMCS installed in facility.

.2 Departmental Representative reserves right to approve instructors.

1.6 INSTRUCTIONS

.1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.

.2 Training to be project-specific.

1.7 TIME FOR TRAINING

.1 Number of days of instruction to be as specified in this section (1 day = 8 hours including two 15 minute breaks and excluding lunch time).

1.8 TRAINING MATERIALS

.1 Provide equipment, visual and audio aids, and materials for classroom training.

.2 Supply manual for each trainee, describing in detail data included in each training program.

.1 Review contents of manual in detail to explain aspects of operation and maintenance (O&M).

1.9 TRAINING PROGRAM

.1 To be in 2 phases over 6 month period.

.2 Phase 1: HALF day program to begin before 30 day test period at time mutually agreeable to Contractor and Departmental Representative.

.1 Train O&M personnel in functional operations and procedures to be employed for system operation.

.2 Supplement with on-the-job training during 30 day test period.

.3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.

.4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.

.3 Phase 2: HALF day program to begin 8 weeks after acceptance for operators, equipment maintenance personnel and programmers.

.1 Provide multiple instructors on pre-arranged schedule. Include at least following:

.1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.

.2 Equipment maintenance training: provide personnel with training in maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.

.3 Programmers: provide personnel with training in following subjects in approximate percentages of total course shown:

Software and architecture: 10%
Application programs: 15%
Controller programming: 50%
Trouble shooting and debugging:10%
Colour graphic generation: 15%

1.10 ADDITIONAL TRAINING

.1 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

1.11 MONITORING OF TRAINING

.1 Departmental Representative to monitor training program and may modify schedule and content.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

.2 Section 25 05 54.

.3 25 05 02

1.2 REFERENCE STANDARDS

.1 The Instrumentation, Systems and Automation Society (ISA).

.1 ISA 5.5-1985, Graphic Symbols for Process Displays.

.2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).

.1 ANSI/IEEE 260.1-1993, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).

.3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.1 ASHRAE 135-R2016, BACNET - Data Communication Protocol for Building Automation and Control Network.

.4 Canadian Standards Association (CSA International).

.1 CAN/CSA-Z234.1-89(R1995), Canadian Metric Practice Guide.

.5 Consumer Technology Association (CTA).

.1 CTA-709.1-B-2014, Control Network Protocol Specification.

.6 Electrical and Electronic Manufacturers Association (EEMAC).

.1 EEMAC 2Y-1-1958, Light Grey Colour for Indoor Switch Gear.

.7 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

.1 Material Safety Data Sheets (MSDS).

1.3 ABBREVIATIONS AND ACRONYMS

.1 Acronyms used in EMCS:

.1 AEL - Average Effectiveness Level
.2 AI - Analog Input
.3 AIT - Agreement on International Trade
.4 AO - Analog Output
.5 BACnet - Building Automation and Control Network.
.6 BC(s) - Building Controller(s).
.7 BECC - Building Environmental Control Centre.
.8 CAD - Computer Aided Design.
.9 CDL - Control Description Logic.
.10 CDS - Control Design Schematic.
.11 COSV - Change of State or Value.

.12 CPU - Central Processing Unit.
.13 DI - Digital Input.
.14 DO - Digital Output.
.15 DP - Differential Pressure.
.16 ECU - Equipment Control Unit.
.17 EMCS - Energy Monitoring and Control System.
.18 HVAC - Heating, Ventilation, Air Conditioning.
.19 IDE - Interface Device Equipment.
.20 I/O - Input/Output.
.21 ISA - Industry Standard Architecture.
.22 LAN - Local Area Network.
.23 LCU - Local Control Unit.
.24 MCU - Master Control Unit.
.25 NAFTA - North American Free Trade Agreement.
.26 NC - Normally Closed.
.27 NO - Normally Open.
.28 OS - Operating System.
.29 O&M - Operation and Maintenance.
.30 OWS - Operator Work Station.
.31 PC - Personal Computer.
.32 PCI - Peripheral Control Interface.
.33 PCMCIA - Personal Computer Micro-Card Interface Adapter.
.34 PID - Proportional, Integral and Derivative.
.35 RAM - Random Access Memory.
.36 SP - Static Pressure.
.37 ROM - Read Only Memory.
.38 TCU - Terminal Control Unit.
.39 USB - Universal Serial Bus.
.40 UPS - Uninterruptible Power Supply.
.41 VAV - Variable Air Volume.

1.4 DEFINITIONS

.1 Point: may be logical or physical.

.1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.

.2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.

.2 Point Name: composed of two parts, point identifier and point expansion.

.1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for

which database to provide 25 character field for each point identifier. "System" is system that point is located on.

.1 Area descriptor: building or part of building where point is located.

.2 System descriptor: system that point is located on.

.3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point" will be shortforms or acronyms. Database must provide 25 character field for each point identifier.

.2 Point expansion: comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide 32 character field for each point expansion.

.3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.

.1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.

.3 Point Object Type: points fall into following object types:

.1 AI (analog input).

.2 AO (analog output).

.3 DI (digital input).

.4 DO (digital output).

.5 Pulse inputs.

.4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.

.1 Printouts: to ANSI/IEEE 260.1.

.2 Refer also to Section 25 05 54.

1.5 SYSTEM DESCRIPTION

.1 Provide all labour, materials, products, equipment and services to supply, install, test and commission Building Automation System (BAS) with Direct Digital Control (DDC) for building mechanical and electrical systems and interface with other microprocessor based building subsystems as indicated on drawings and described herein.

.2 **Fully integrate lab air valves supplied by this division and by others into the existing control system. Update graphics to include all new air valves.**

.3 Provide system architecture based on drawings, sequence of operations.

.4 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:

.1 Development of I/O Points list based on drawings, sequence of operations.

.2 Building Controllers.

.3 Control devices as required by I/O point list.

.4 OWS(s).

.5 Data communications equipment necessary to effect EMCS data transmission system.

.6 Field control devices.

.7 Software/Hardware complete with full documentation.

.8 Complete operating and maintenance manuals.

.9 Training of personnel.

.10 Acceptance tests, technical support during commissioning, full documentation.

.11 Wiring interface co-ordination of equipment supplied by others.

.12 Miscellaneous work as specified in these sections and as indicated.

.5 Design Requirements:

.1 Design and provide conduit and wiring linking elements of system.

.2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Departmental Representative prior to installation.

.3 Location of controllers as reviewed by Departmental Representative prior to installation.

.4 Provide utility power to EMCS and emergency power to EMCS as indicated.

.5 Metric references: in accordance with CAN/CSA Z234.1.

.6 Language Operating Requirements:

.1 Provide English operator selectable access codes.

.2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.

.3 Operating system executive: provide primary hardware-to-software interface with associated documentation to be in English.

.4 System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.

.5 Include, in English:

.1 field related changes, Input and output commands and messages from operator-initiated functions, alarms as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definements).

.2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic

control of specified hardware points. To be in English at specified OWS and to be able to operate one terminal in English and second in French. Point name expansions in both languages.

.3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 25 05 02

.2 Submit for review:

.1 Equipment list, systems manufacturers at time of tender within 10 days after award of contract.

.3 Quality Control:

.1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.

.2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.

.3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02. Label or listing of specified organization is acceptable evidence.

.4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.

.5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

.6 Permits and fees: in accordance with general conditions of contract.

.7 Submit certificate of acceptance from authority having jurisdiction to Departmental Representative.

1.7 QUALITY ASSURANCE

.1 Have local office within 50 km of project staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems,

.2 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.

.3 Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.

.4 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:

.1 Separate waste materials in accordance with Section 01 74 20.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal in appropriate on-site bins for recycling in accordance with Waste Management Plan.

PART 2 - PRODUCTS

2.1 EQUIPMENT

.1 Data Communication Protocol: to CTA 709.1, ASHRAE 135.

.2 Complete list of equipment and materials to be used on project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

2.2 ADAPTORS

.1 Provide adaptors between metric and imperial components.

PART 3 - EXECUTION

3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation: to manufacturer's recommendations.

3.2 PAINTING

.1 Painting: in accordance with Section 09 91 23, supplemented as follows:

.1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.

.2 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.

.3 Clean and prime exposed hangers, racks, fastenings, and other support components.

.4 Paint unfinished equipment installed indoors to EEMAC 2Y-1.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

.2 Section 25 05 01.

.3 Section 25 01 11.

1.2 SUMMARY

.1 Section Includes.

.1 Methods and procedures for shop drawings submittals, preliminary and detailed review process including review meetings, for building Energy Monitoring and Control System (EMCS).

1.3 DEFINITIONS

.1 Acronyms and definitions: refer to Section 25 05 01.

1.4 DESIGN REQUIREMENTS

.1 Preliminary Design Review: to contain following contractor and systems information.

.1 Location of local office.

.2 Description and location of installing and servicing technical staff.

.3 Location and qualifications of programming design and programming support staff.

.4 List of spare parts.

.5 Names of sub-contractors and site-specific key personnel.

.6 Sketch of site-specific system architecture.

.7 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.

.8 Descriptive brochures.

.9 Sample CDL and graphics (systems schematics).

.10 Response time for each type of command and report.

.11 Item-by-item statement of compliance.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 and coordinate with requirements in this Section.

.2 Shop Drawings to consist of 1 soft copy of design documents, shop drawings, product data and software.

1.6 PRELIMINARY SHOP DRAWING REVIEW

.1 Submit preliminary shop drawings within 30 working days of award of contract and include following:

.1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.

.2 Detailed system architecture showing all points associated with each controller.

.3 Spare point capacity of each controller by number and type.

.4 Controller locations.

.5 Auxiliary control cabinet locations.

.6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.

.7 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).

.8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.

.9 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model and range of velocity transmitter.

.10 Sequence of Operation: Provide a complete description of operation to Section 25 90 01. Provide description of operation for interlocks that directly connect to the Work. Indicate references to the system flow diagram by control device designation or point object name.

1.7 DETAILED SHOP DRAWING REVIEW

.1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:

.1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.

.2 Wiring diagrams.

.3 Piping diagrams and hook-ups.

.4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.

.5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:

.1 Sensing element type and location.

.2 Transmitter type and range.

.3 Associated field wiring schematics, schedules and terminations.

.4 Complete Point Name Lists.

.5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.

.6 Software and programming details associated with each point. Manufacturer's recommended installation instructions and procedures.

.7 Input and output signal levels or pressures where new system ties into existing control equipment.

.6 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.

.7 Graphic system schematic displays of air and water systems with point identifiers and textual description of system, and typical floor plans as specified.

.8 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.

.9 Listing and example of specified reports.

.10 Listing of time of day schedules.

.11 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.

.12 Type and size of memory with statement of spare memory capacity.

.13 Full description of software programs provided.

.14 Sample of "Operating Instructions Manual" to be used for training purposes.

.15 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11.

1.8 QUALITY ASSURANCE

.1 Preliminary Design Review Meeting: Convene meeting within 45 working days of award of contract to:

.1 Undertake functional review of preliminary design documents, resolve inconsistencies.

.2 Resolve conflicts between Contract Document requirements and actual items (e.g.: points list inconsistencies).

.3 Review interface requirements of materials supplied by others.

.4 Review "Sequence of Operations".

.2 Contractor's programmer to attend meeting.

.3 Departmental Representative retains right to revise sequence or subsequent CDL prior to software finalization without cost.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

Not Used.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

.2 Section 25 05 02

.3 Section 25 01 11.

1.2 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for final control diagrams and operation and maintenance (O&M) manual, for building Energy Monitoring and Control System (EMCS) Work.

1.3 DEFINITIONS

.1 BECC - Building Environmental Control Centre.

.2 OWS - Operator Work Station.

.3 For additional acronyms and definitions refer to Section 25 05 01.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 78 00, supplemented and modified by requirements of this Section.

.2 Submit Operation and Maintenance Manual & As-built drawings to Departmental Representative in English.

.3 Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.

.1 Binders to be 2/3 maximum full.

.2 Provide index to full volume in each binder.

.3 Identify contents of each manual on cover and spine.

.4 Provide Table of Contents in each manual.

.5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

1.5 AS-BUILTS

.1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 and include:

.1 Changes to Contract Documents as well as addenda and contract extras.

.2 Changes to interface wiring.

.3 Routing of conduit, wiring and control air lines associated with EMCS installation.

.4 Locations of obscure devices to be indicated on drawings.

.5 Listing of alarm messages.

.6 Panel/circuit breaker number for sources of normal/emergency power.

.7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.

.8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11.

.9 Basic system design and full documentation on system configuration.

.2 Submit for final review by Departmental Representative.

.3 Provide before acceptance 1 Hard and 1 soft copy incorporating changes made during final review.

.4 Provide three copies of corrected manuals in printed format and three copies on CD within three weeks following completion of Acceptance Test. Provide manuals in hard cover three-ring binders with index page and indexing tab per section.

1.6 O&M MANUALS

.1 Custom design O&M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.

.2 Provide 2 complete sets of hard and soft copies prior to system or equipment tests

.3 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.

.4 Functional description to include:

.1 Functional description of theory of operation.

.2 Design philosophy.

.3 Specific functions of design philosophy and system.

.4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.

.5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.

.6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented or plannedfor implementation in automatic mode.

.5 System operation to include:

.1 Complete step-by-step procedures for operation of system including required actions at each OWS.

.2 Operation of computer peripherals, input and output formats.

.3 Emergency, alarm and failure recovery.

.4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.

.6 Software to include:

.1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.

.2 Detailed descriptions of program requirements and capabilities.

.3 Data necessary to permit modification, relocation, reprogramming and to permit new and existingsoftware modules to respond to changing system functional requirements without disrupting normal operation.

.4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device

.5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.

.6 Software for each Controller and single section referencing Controller common parameters and functions.

.7 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware's, plus diagnostics and repair/replacement of system hardware.

.8 System configuration document:

.1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.

.2 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.

.9 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

Not Used.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

.2 Section 25 05 01.

1.2 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates materials, colours and lettering sizes.

1.3 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA International).

.1 CSA C22.1-15, The Canadian Electrical Code, Part I (23rd Edition), Safety Standard for Electrical Installations.

1.4 DEFINITIONS

.1 For acronyms and definitions refer to Section 25 05 01.

1.5 SYSTEM DESCRIPTION

.1 Language Operating Requirements: provide identification for control items in English.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00supplemented and modified by requirements of this Section.

.2 Submit to Departmental Representative for approval samples of nameplates, identification tags and list of proposed wording.

PART 2 - PRODUCTS

2.1 NAMEPLATES FOR PANELS

.1 Identify by Plastic laminate, 3mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.

.2 Sizes: 25 x 67mm minimum.

.3 Lettering: minimum 7mm high, black.

.4 Inscriptions: machine engraved to identify function.

2.2 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic encased cards attached by plastic tie.

.2 Sizes: 50 x 100mm minimum.

.3 Lettering: minimum 5mm high produced from laser printer in black.

.4 Data to include: point name and point address.

.5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

2.3 NAMEPLATES FOR ROOM SENSORS

.1 Identify by stick-on labels using point identifier.

.2 Location: as directed by Departmental Representative.

.3 Letter size: to suit, clearly legible.

2.4 WARNING SIGNS

.1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.

.2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS" as reviewed by Departmental Representative.

2.5 WIRING

.1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.

.2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.

.3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

2.6 PNEUMATIC TUBING

.1 Numbered tape markings on tubing to provide uninterrupted tracing capability.

2.7 CONDUIT

.1 Colour code EMCS conduit.

.2 Pre-paint box covers and conduit fittings.

.3 Coding: confirm colour with Departmental Representative during "Preliminary Design Review".

PART 3 - EXECUTION

3.1 NAMEPLATES AND LABELS

.1 Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

3.2 EXISTING PANELS

Correct existing nameplates and legends to reflect changes made during Work.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

.2 Section 25 05 01.

.3 Section 23 36 00

.4 Section 26 05 00

.5 Section 25 08 20.

.6 Section 25 05 54.

1.2 REFERENCE STANDARDS

.1 American National Standards Institute (ANSI)

.1 ANSI/ASME B16.22-2013, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.

.2 ANSI/NFPA 70-2018, National Electrical Code.

.2 CSA Group

.1 CSA C22.1-15, Canadian Electrical Code

.2 CSA C22.2 No. 45.1-07(R2017), Electrical Rigid Metal Conduit.

.3 CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.

.4 CSA C22.2 No. 83-M1985(R2017), Electrical Metallic Tubing.

.5 CAN/CSA-C22.3 No. 1-15, Overhead Systems.

1.3 SYSTEM DESCRIPTION

.1 Electrical:

.1 Provide power wiring from emergency power panels to EMCS field panels. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.

.2 Hard wiring between field control devices and EMCS field panels.

.3 Communication wiring between EMCS field panels and OWS's including main control centre BECC.

.4 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.

.2 Pneumatic:

.1 Pneumatic tubing, valves and fittings for field control devices.

.3 Mechanical:

.1 Pipe Taps Required for EMCS equipment will be supplied and installed by Division 23.

.2 Wells and Control Valves Shall Be Supplied by EMCS Contractor and Installed by Division 23.

.3 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by Division 23. Costs to be carried by designated trade.

.4 VAV Terminal Units.

.1 Air flow probe for vav boxes to be supplied and installed under Section 23 36 00, clause

.5 Structural:

.1 Special steelwork as required for installation of work.

1.4 PERSONNEL QUALIFICATIONS

.1 Qualified supervisory personnel to:

.1 Continuously direct and monitor all work.

.2 Attend site meetings.

PART 2 - PRODUCTS

2.1 SPECIAL SUPPORTS

.1 Structural grade steel, primed and painted after construction and before installation.

2.2 WIRING

.1 As per requirements of Division 26.

.2 For 70V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.

.3 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.

.4 Sizes:

.1 120V Power supply: to match or exceed breaker, size #12 minimum.

.2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.

.3 Field wiring to digital device: #18 AWG.

.4 Analog input and output: Stranded 18 gauge copper twisted shielded.

.5 More than 4 conductors: #22 minimum solid copper.

.5 Terminations:

.1 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

2.3 CONDUIT

.1 As per requirements of Division 26.

.2 Electrical metallic tubing to CSA C22.2 No. 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 No. 56. Rigid steel threaded conduit to CSA C22.2 No. 45.1.

.3 Junction and pull boxes: welded steel.

.1 Surface mounting cast FS: screw-on flat covers.

.2 Flush mounting: covers with 25 mm minimum extension all round.

.4 Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys, complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.

.5 Outlet boxes: 100 mm minimum, square.

.6 Conduit boxes, fittings:

.1 Bushings and connectors: with nylon insulated throats.

.2 With push pennies to prevent entry of foreign materials.

.7 Fittings for rigid conduit:

.1 Couplings and fittings: threaded type steel.

.2 Double locknuts and insulated bushings: use on sheet metal boxes.

.3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.

.8 Fittings for thin wall conduit:

.1 Connectors and couplings: steel, set screw type.

2.4 WIRING DEVICES, COVER PLATES

.1 Conform to CSA.

.2 Receptacles:

.1 Duplex: CSA type 5-15R.

.2 Single: CSA type 5-15R.

.3 Cover plates and blank plates: finish to match other plates in area.

2.5 STARTERS, CONTROL DEVICES

.1 Across-the-line magnetic starters:

.1 Enclosures: CSA Type 1, except where otherwise specified.

.2 Size, type and rating: to suit motors.

.2 Starter diagrams:

.1 Provide copy of wiring and schematic diagrams - mount one copy in each starter with additional copies for operation and maintenance manual.

.3 Auxiliary Control Devices:

.1 Control transformers: 60 Hz, primary voltage to suit supply, 120 V single phase secondary, VA rating to suit load plus 20% margin.

.2 Auxiliary contacts: one "Normally Open" and one "Normally Closed" spare auxiliary contact in addition to maintained auxiliary contacts as indicated.

.3 Hand-Off-Automatic switch: heavy duty type, knob lever operator.

.4 Double voltage relays: with barrier to separate relay contacts from operating magnet. Operating coil voltage and contact rating as indicated.

.4 Finish for starters:

.1 Exterior: in accordance with Section 26 05 00.

.2 Interior: white.

2.6 SUPPORTS FOR CONDUIT, FASTENINGS, EQUIPMENT

.1 Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.

.1 Hollow masonry walls, suspended drywall ceilings: toggle bolts.

.2 Exposed conduits or cables:

.1 50 mm diameter and smaller: one-hole steel straps.

.2 Larger than 50 mm diameter: two-hole steel straps.

.3 Suspended support systems:

.1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.

.2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

3.2 SUPPORTS

.1 Install special supports as required and as indicated.

3.3 ELECTRICAL GENERAL

.1 Do complete installation in accordance with requirements of:

.1 Division 26, this specification.

.2 CSA 22.1 Canadian Electrical Code.

.3 ANSI/NFPA 70.

.4 ANSI C2.

.2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage above 70 Vcontacts and mark to prevent accidental injury.

.3 Do underground installation to CAN/CSA-C22.3 No.7, except where otherwise specified.

.4 Conform to manufacturer's recommendations for storage, handling and installation.

.5 Check factory connections and joints. Tighten where necessary to ensure continuity.

.6 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.

.7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.

.8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.

.9 Install conduits, and sleeves prior to pouring of concrete.

.10 Holes through exterior wall and roofs: flash and make weatherproof.

.11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.

.12 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

3.4 CONDUIT SYSTEM

.1 Communication wiring shall be installed in conduit. Provide complete conduit system to link Building Controllers to BECC. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fill not to exceed 40%. Design drawings do not show conduit layout.

.2 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.

.3 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Departmental Representative before starting such work. Provide complete conduit system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.

.4 Locate conduits at least 150 mm from parallel hot water pipes and at least 50 mm at crossovers.

.5 Bend conduit so that diameter is reduced by less than 1/10th original diameter.

.6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.

.7 Limit conduit length between pull boxes to less than 30 m.

.8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.

.9 Fastenings and supports for conduits, cables, and equipment:

.1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.

.2 Provide adequate support for raceways and cables, sloped vertically to equipment.

.3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Departmental Representative.

.10 Install polypropylene fish cord in empty conduits for future use.

.11 Where conduits become blocked, remove and replace blocked sections.

.12 Pass conduits through structural members only after receipt of Departmental Representative'swritten approval.

.13 Conduits may be run in flanged portion of structural steel.

.14 Group conduits wherever possible on suspended or surface channels.

.15 Pull boxes:

.1 Install in inconspicuous but accessible locations.

.2 Support boxes independently of connecting conduits.

.3 Fill boxes with paper or foam to prevent entry of construction material.

.4 Provide correct size of openings. Reducing washers not permitted.

.5 Mark location of pull boxes on record drawings.

.6 Identify AC power junction boxes, by panel and circuit breaker.

.16 Install terminal blocks or strips indicated in cabinets.

.17 Install bonding conductor for 120 volt and above in conduit.

3.5 WIRING

.1 Install multiple wiring in ducts simultaneously.

.2 Do not pull spliced wiring inside conduits or ducts.

.3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.

.4 Tests: use only qualified personnel. Demonstrate that:

.1 Circuits are continuous, free from shorts, unspecified grounds.

.2 Resistance to ground of all circuits is greater than 50 Megohms.

.5 Provide Departmental Representative with test results showing locations, circuits, results of tests.

.6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.

.7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.

.8 Do not allow wiring to come into direct physical contact with compression screw.

.9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

3.6 WIRING DEVICES, COVER PLATES

.1 Receptacles:

.1 Install vertically in gang type outlet box when more than one receptacle is required in one location.

.2 Cover plates:

.1 Install suitable common cover plate where wiring devices are grouped.

.2 Use flush type cover plates only on flush type outlet boxes.

3.7 STARTERS, CONTROL DEVICES

.1 Install and make power and control connections as indicated.

.2 Install correct over-current devices.

.3 Identify each wire, terminal for external connections with permanent number marking identical to diagram.

.4 Performance Verification:

.1 Operate switches and controls to verify functioning.

.2 Perform start and stop sequences of contactors and relays.

.3 Check that interlock sequences, with other separate related starters, equipment and auxiliary control devices, operate as specified.

3.8 GROUNDING

.1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.

.2 Install separate grounding conductors in conduit within building.

.3 Install ground wire in all PVC ducts and in tunnel conduit systems.

.4 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

3.9 TESTS

.1 General:

.1 Perform following tests in addition to tests specified Section 25 08 20.

.2 Give 14 days written notice of intention to test.

.3 Conduct in presence of Departmental Representativeand authority having jurisdiction.

.4 Conceal work only after tests satisfactorily completed.

.5 Report results of tests to Departmental Representativein writing.

.6 Preliminary tests:

.1 Conduct as directed to verify compliance with specified requirements.

.2 Make needed changes, adjustments, replacements.

.3 Insulation resistance tests:

.1 Megger all circuits, feeders, equipment for 120 - 600V with 1000V instrument. Resistance to ground to be more than required by Code before energizing.

.2 Test insulation between conductors and ground, efficiency of grounding system to satisfaction of Departmental Representativeand authority having jurisdiction.

3.10 IDENTIFICATION

.1 Refer to Section 25 05 54.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

.2 Section 25 05 01.

1.2 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Monitoring and Control System (EMCS).

1.3 DEFINITIONS

.1 BC(s) - Building Controller(s).

.2 OWS - Operator Work Station.

.3 For additional acronyms and definitions refer to Section 25 05 01

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00.

.2 Submit detailed preventative maintenance schedule for system components to Departmental Representative.

.3 Submit detailed inspection reports to Departmental Representative.

.4 Submit dated, maintenance task lists to Departmental Representative and include the following sensor and output point detail, as proof of system verification:

.1 Point name and location.

.2 Device type and range.

.3 Measured value.

.4 System displayed value.

.5 Calibration detail

.6 Indication if adjustment required,

.7 Other action taken or recommended.

.5 Submit network analysis report showing results with detailed recommendations to correct problems found.

.6 Records and logs: in accordance with Section 01 78 00

.1 Maintain records and logs of each maintenance task on site.

.2 Organize cumulative records for each major component and for entire EMCS chronologically.

.3 Submit records to Departmental Representative, after inspection indicating that planned and systematic maintenance have been accomplished.

.7 Revise and submit to Departmental Representative in accordance with Section 01 78 00 "As-built drawings" documentation and

commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

1.5 MAINTENANCE SERVICE DURING WARRANTY PERIOD

.1 Provide services, materials, and equipment to maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.

.2 Emergency Service Calls:

.1 Initiate service calls when EMCS is not functioning correctly.

.2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.

.3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.

.4 Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.

.5 Perform Work continuously until EMCS restored to reliable operating condition.

.3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.

.4 Work requests: record each service call request, when received separately on approved form and include:

.1 Serial number identifying component involved.

.2 Location, date and time call received.

.3 Nature of trouble.

.4 Names of personnel assigned.

.5 Instructions of work to be done.

.6 Amount and nature of materials used.

.7 Time and date work started.

.8 Time and date of completion.

.5 Provide system modifications in writing.

.1 No system modification, including operating parameters and control settings, to be made without prior written approval of Departmental Representative.

1.6 SERVICE CONTRACTS

.1 Provide in-depth technical expertise and assistance to Departmental Representative and Commissioning Manager in preparation and implementation of service contracts and in-house preventive maintenance procedures.

.2 Service Contracts to include:

.1 Annual verification of field points for operation and calibration.

.2 Complete inventory of installed system.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

.1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Departmental Representativeas described in Submittal article.

.2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.

.3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:

.1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.

.2 Check/Calibrate each field input/output device in accordance with Canada Labour Code - Part I.

.3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.

.4 Minor inspections to include, but not limited to:

.1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.

.2 Check equipment cooling fans as required.

.3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.

.4 Review system performance with Departmental Representative to discuss suggested or required changes.

.5 Major inspections to include, but not limited to:

.1 Minor inspection.

.2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.

.3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.

.4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.

.5 Provide mechanical adjustments, and necessary maintenance on printers.

.6 Run system software diagnostics as required.

.7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.

.1 Perform network analysis and provide report as described in Submittal article.

.6 Rectify deficiencies revealed by maintenance inspections and environmental checks.

.7 Continue system debugging and optimization.

.8 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.

.1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

.2 Section 25 05 01.

1.2 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA International).

.1 CSA T530-99, Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A)

1.3 DEFINITIONS

.1 Acronyms and definitions: refer to Section 25 05 01.

1.4 SYSTEM DESCRIPTION

.1 Data communication network to link Operator Workstations and Master Control Units (MCU).

.1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.

.2 Allow for future expansion of network, with selection of networking technology and communication protocols.

.2 Data communication network to include, but not limited to:

.1 EMCS-LAN.

.2 Modems.

.3 Network interface cards.

.4 Network management hardware and software.

.5 Network components necessary for complete network.

1.5 DESIGN REQUIREMENTS

.1 EMCS Local Area Network (EMCS-LAN).

.1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with IEEE 802.3/Ethernet Standard.

.2 EMCS-LAN to: BACnet.

.3 Each EMCS-LAN to be capable of supporting at least 50 devices.

.4 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.

.5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10Megabits per second minimum.

.6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.

.7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.

.2 Dynamic Data Access.

.1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.

.2 Access to data to be based upon logical identification of building equipment.

.3 Network Medium.

.1 Network medium: fibre optic cablecompatible with network protocol to be used within buildings.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

.2 Section 25 05 01.

.3 Section 25 05 02.

.4 Section 25 05 03

.5 Section 25 90 01

1.2 REFERENCE STANDARDS

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).

.1 ASHRAE 2003, Applications Handbook, SI Edition.

.2 Canadian Standards Association (CSA International).

.1 CSA C22.2 No.205-17, Signal Equipment.

.3 Institute of Electrical and Electronics Engineers (IEEE).

.1 IEEE C37.90.1-12, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

1.3 DEFINITIONS

.1 Acronyms and definitions: refer to Section 25 05 01.

1.4 DESCRIPTION

.1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.

.1 Provide sufficient controllers to meet intents and requirements of this section.

.2 Controller quantity, and point contents to be approved by Departmental Representativeat time of preliminary design review.

.2 Controllers: stand-alone intelligent Control Units.

.1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.

.2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.

.3 Capable of interfacing with operator interface device.

.4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

.1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

1.5 DESIGN REQUIREMENTS

.1 To include:

.1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.

.2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.

.3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.

.4 Control of systems as described in sequence of operations.

.5 Execution of optimization routines as listed in this section.

.2 Total spare capacity for MCUs and LCUs: at least 25% of each point type distributed throughout the MCUs and LCUs.

.3 Field Termination and Interface Devices:

.1 To: CSA C22.2 No.205.

.2 Electronically interface sensors and control devices to processor unit.

.3 Include, but not be limited to, following:

.1 Programmed firmware or logic circuits to meet functional and technical requirements.

.2 Power supplies for operation of logics devices and associated field equipment.

.3 Lockable wall cabinet.

.4 Required communications equipment and wiring (if remote units).

.5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.

.6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.

.7 Wiring terminations: use conveniently located screw type or spade lug terminals.

.4 AI interface equipment to:

.1 Convert analog signals to digital format with minimum 12 bit analog-to-digital resolution.

.2 Provide for following input signal types and ranges:

.1 4 - 20mA;

.2 0 - 10V DC;

.3 100/1000 ohm RTD input;

.3 Meet IEEE C37.90.1 surge withstand capability.

.4 Have common mode signal rejection greater than 60dB to 60Hz.

.5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.

.5 AO interface equipment:

.1 Convert digital data from controller processor to acceptable analog output signals using minimum 12bit digital-to-analog resolution.

.2 Provide for following output signal types and ranges:

.1 4 - 20mA.

.2 0 - 10V DC.

.3 Meet IEEE C37.90.1 surge withstand capability.

.6 DI interface equipment:

.1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.

.2 Meet IEEE C37.90.1 surge withstand capability.

.3 Accept pulsed inputs up to 2kHz.

.7 DO interface equipment:

.1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5amps at 24V AC.

.2 Switch up to 5amps at 220V AC using optional interface relay.

.4 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 20 % to 90 % non-condensing RH.

.5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.

.1 Provide for conduit entrance from top, bottom or sides of panel.

.2 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.

.3 Mounting details as approved by Departmental Representative for ceiling mounting.

.6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.

.7 Provide surge and low voltage protection for interconnecting wiring connections.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 25 05 02Process.

.1 Submit product data sheets for each product item proposed for this project.

1.7 MAINTENANCE

.1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03.

PART 2 - PRODUCTS

2.1 MASTER CONTROL UNIT (MCU)

.1 General: primary function of MCU is to provide co-ordination and supervision of subordinate devices in execution of optimization routines such as demand limiting or enthalpy control.

.2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices.

.1 MCU must support BACnet.

.3 MCU local I/O capacity as follows:

.1 MCU I/O points as allocated in I/O Summary Table referenced in MD13800.

.2 LCUs may be added to support system functions.

.4 Central Processing Unit (CPU).

.1 Processor to consist of minimum 16bit microprocessor capable of supporting software to meet specified requirements.

.2 CPU idle time to be more than 30% when system configured to maximum input and output with worst case program use.

.3 Minimum addressable memory to be at manufacturer's discretion but to support at least performance and technical specifications to include but not limited to:

.1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.

.2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS.

.4 Include uninterruptible clock accurate to plus or minus 5secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum 72hour operation in event of power failure.

.5 Local Operator Terminal (OT): Provide OT for each MCU unless otherwise specified in Section 25 90 01.

.1 Mount access/display panel in MCU or in suitable enclosure beside MCU as approved by Departmental Representative.

.2 Support operator's terminal for local command entry, instantaneous and historical data display, programs, additions and modifications.

.3 Display simultaneously minimum of 16point identifiers to allow operator to view single screen dynamic displays

depicting entire mechanical systems. Point identifiers to be in English.

.4 Functions to include, but not be limited to, following:

.1 Start and stop points.

.2 Modify setpoints.

.3 Modify PID loop parameters.

.4 Override PID control.

.5 Change time/date.

.6 Add/modify/start/stop weekly scheduling.

.7 Add/modify setpoint weekly scheduling.

.8 Enter temporary override schedules.

.9 Define holiday schedules.

.10 View analog limits.

.11 Enter/modify analog warning limits.

.12 Enter/modify analog alarm limits.

.13 Enter/modify analog differentials.

.5 Provide access to real and calculated points in controller to which it is connected or to other controller in network. This capability not to be restricted to subset of predefined "global points" but to provide totally open exchange of data between OT and other controller in network.

.6 Operator access to OTs: same as OWS user password and password changes to automatically be downloaded to controllers on network.

.7 Provide prompting to eliminate need for user to remember command format or point names. Prompting to be consistent with user's password clearance and types of points displayed to eliminate possibility of operator error.

.8 Identity of real or calculated points to be consistent with network devices. Use same point identifier as at OWS's for access of points at OT to eliminate cross-reference or look-up tables.

2.2 LOCAL CONTROL UNIT (LCU)

.1 Provide multiple control functions for typical built-up and package HVAC systems, hydronic systems and electrical systems.

.2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.

.3 Points integral to one Building System to be resident on only one controller.

.4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:

.1 Include minimum 2interface ports for connection of local computer terminal.

.2 Design so that shorts, opens or grounds on input or output will not interfere with other input or output signals.

.3 Physically separate line voltage (70V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.

.4 Include power supplies for operation of LCU and associated field equipment.

.5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.

.6 Provide conveniently located screw type or spade lug terminals for field wiring.

2.3 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)

.1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.

.1 TCU/ECU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook section 45.

.2 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.

.3 VAV Terminal Controller.

.1 Microprocessor based controller with integral flow transducer, including software routines to execute PID algorithms, calculate airflow for integral flow transducer and measure temperatures as per I/O Summary required inputs. Sequence of operation to ASHRAE HVAC Applications Handbook.

.2 Controller to support point definition; in accordance with Section 25 05 01.

.3 Controller to operate independent of network in case of communication failure.

.4 Controller to include damper actuator and terminations for input and output sensors and devices.

2.4 SOFTWARE

.1 General.

.1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.

.2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.

.3 Include initial programming of Controllers, for entire system.

.2 Program and data storage.

.1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.

.2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.

.3 Programming languages.

.1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.

.2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed unless approved by Departmental Representative.

.4 Operator Terminal interface.

.1 Operating and control functions include:

.1 Multi-level password access protection to allow user/manager to limit workstation control.

.2 Alarm management: processing and messages.

.3 Operator commands.

.4 Reports.

.5 Displays.

.6 Point identification.

.5 Pseudo or calculated points.

.1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.

.2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (e.g. cascading).

.6 Control Description Logic (CDL):

.1 Capable of generating on-line project-specific CDLs which are software based, programmed into RAM or EEPROM and backed up to OWS. Owner must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.

.2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.

.3 Perform changes to CDL on-line.

.4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.

.5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.

.6 MCU to be able to perform following pre-tested control algorithms:

.1 Two position control.

.2 Proportional Integral and Derivative (PID) control.

.7 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.

.8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

.9 Power Fail Restart: upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and analyse controlled equipment to determine its appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyse status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.

.7 Event and Alarm management: use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.

.8 Energy management programs: include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated feature.

.1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:

.1 Time of day scheduling.

.2 Calendar based scheduling.

.3 Holiday scheduling.

.4 Temporary schedule overrides.

.5 Optimal start stop.

.6 Night setback control.

.7 Enthalpy (economizer) switchover.

.8 Peak demand limiting.

.9 Temperature compensated load rolling.

.10 Fan speed/flow rate control.

.11 Cold deck reset.

.12 Hot deck reset.

.13 Hot water reset.

.14 Chilled water reset.

.15 Condenser water reset.

.16 Chiller sequencing.

.17 Night purge.

.2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.

.3 Apply programs to equipment and systems as specified or requested by the Departmental Representative.

.9 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.

.1 MCUs to accumulate and store automatically run-time for binary input and output points.

.2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.

.3 MCU to automatically count events (number of times pump is cycled off and on) daily, weekly or monthly basis.

.4 Totalization routine to have sampling resolution of 1min or less for analog inputs.

.5 Totalization to provide calculations and storage of accumulations up to 99,999.9units (eg. kWH, litres, tonnes, etc.).

.6 Store event totalization records with minimum of 9,999,999events before reset.

.7 User to be able to define warning limit and generate user-specified messages when limit reached.

2.5 LEVELS OF ADDRESS

.1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.

.1 Display analog values digitally to 1place of decimals with negative sign as required.

.2 Update displayed analog values and status when new values received.

.3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.

.4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

2.6 POINT NAME SUPPORT

.1 Controllers (MCU, LCU) to support PSPC point naming convention as defined in Section 25 05 01.

PART 3 - EXECUTION

3.1 LOCATION

.1 Location of Controllers to be approved by Departmental Representative.

3.2 INSTALLATION

.1 Install Controllers in secure locking enclosures as directed by Departmental Representative.

.2 Provide necessary power from local 120V branch circuit panel for equipment.

.3 Install tamper locks on breakers of circuit breaker panel.

.4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

PART 1 - GENERAL

1.1 SUMMARY

.1 Related Sections:

.1 Section 01 73 00.
.2 Section 07 84 00.
.3 Section 23 09 33.
.4 Section 23 33 15.
.5 Section 25 01 11.
.6 Section 25 05 01.
.7 Section 25 05 02.
.8 Section 25 05 54.
.9 Section 25 90 01.
.10 Section 26 05 00.
.11 Section 26 27 26.

1.2 REFERENCE STANDARDS

.1 National Electrical Manufacturer's Association (NEMA).

.1 NEMA 250-14, Enclosures for Electrical Equipment (1000 Volts Maximum).

.2 ASHRAE

.1 ASHRAE 15-2016, Standard 15-2016 Safety Standard for Refrigeration Systems and Designation and Classification of Refrigerants (ANSI Approved)

.2

.3 ANSI

.1 ANSI C12-7-2014, American National Standard for Requirements for Watthour Meter Sockets

.2 ANSI/IEEE C57.13-2016, IEEE Standard Requirements for Instrument Transformers

.3 ANSI/UL 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements (Includes Revisions 1 and 2, from 2005 and 2008)

.4 ASTM

.1 ASTM B148-14, Standard Specification for Aluminum-Bronze Sand Castings

.5 Air Movement and Control Association, Inc. (AMCA).

.1 AMCA 500-D-2012, Laboratory Method of Testing Dampers For Rating.

.6 Underwriters Laboratories

.1 UL 1971-2002, Signaling Devices for the Hearing Impaired.

.2 UL 464-2016, Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories

.7 Canadian Standards Association (CSA International).

.1 CSA-C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.

.2 CSA-C22.2 No. 61010-1-12(R2017) Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use

.3 CSA B52-13, Mechanical Refrigeration Code

1.3 DEFINITIONS

.1 Acronyms and Definitions: refer to Section 25 05 01.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02

.2 Manufacturer's Instructions:

.1 Submit manufacturer's installation instructions for specified equipment and devices.

PART 2 - PRODUCTS

2.1 GENERAL

.1 Control devices of each category to be of same type and manufacturer.

.2 External trim materials to be corrosion resistant.

.3 Operating conditions: 0- 32degrees C with 10- 90% RH (non-condensing) unless otherwise specified.

.4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.

.5 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.

.6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.

.7 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.

.8 Devices installed in user occupied space not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

.9 Range: including temperature, humidity, pressure, as indicated in I/O summary in Section 25 90 01.

2.2 TEMPERATURE SENSORS

.1 General: except for room sensors, to be resistance or thermocouple type to following requirements:

.1 Thermocouples: limit to temperature range of 200degrees C and over.

.2 RTD's: 100 or 1000 ohm at 0degrees C (plus or minus 0.2ohms) platinum element with strain minimizing

construction, 3integral anchored leadwires. Coefficient of resistivity: 0.00385ohms/ohm degrees C.

.3 Sensing element: hermetically sealed.

.4 Stem and tip construction: copper or type 304 stainless steel.

.5 Time constant response: less than 3 seconds to temperature change of 10degrees C.

.6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor.

.2 Room temperature sensors and display wall modules.

.1 Room temperature sensors.

.1 Provide the above in all areas except meeting rooms.

.2 Wall mounting, with cover, white finish.

.3 Element 10-50mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000ohm, accuracy of plus or minus 0.2degrees C.

.3 Duct temperature sensors:

.1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length as required for sufficient contact with process fluid to measure average conditions.

.2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 6000mm. Bend probe at field installation time to 100mm radius at point along probe without degradation of performance.

.4 Outdoor air temperature sensors:

.1 Outside air type: complete with probe length 100 - 150mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13mm conduit, weatherproof construction in NEMA 4 enclosure.

2.3 TEMPERATURE TRANSMITTERS

.1 Requirements:

.1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0degrees C, platinum resistance detector type sensors.

.2 Power supply: 24V DC into load of 575ohms. Power supply effect less than 0.01degrees C per volt change.

.3 Output signal: 4 - 20mA into500ohm maximum load.

.4 Input and output short circuit and open circuit protection.

.5 Output variation: less than 0.2% of full scale for supply voltage variation of plus or minus 10%.

.6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5% of full scale output.

.7 Maximum current to 100 or 1000 ohm RTD sensor: not to exceed 25mA.

.8 Integral zero and span adjustments.

.9 Temperature effects: not to exceed plus or minus 1.0% of full scale/ 50degrees C.

.10 Long term output drift: not to exceed 0.25% of full scale/ 6months.

.11 Transmitter ranges: select narrowest range to suit application from following:

.1 Minus 50degrees C to plus 50degrees C, plus or minus 0.5degrees C.

.2 0 to 100degrees C, plus or minus 0.5degrees C.

.3 0 to 50degrees C, plus or minus 0.25degrees C.

.4 0 to 25degrees C, plus or minus 0.1degrees C.

.5 10 to 35degrees C, plus or minus 0.25degrees C.

2.4 HUMIDITY SENSORS

.1 Room and Duct Requirements:

.1 Range: 5-90% RH minimum.

.2 Operating temperature range: 0-60degrees C.

.3 Absolute accuracy:

.1 Duct sensors: plus or minus 1%.

.2 Room sensors: plus or minus 1%.

.4 Sheath: stainless steel with integral shroud for specified operation in air streams of up to 10m/s.

.5 Maximum sensor non-linearity: plus or minus 2%RH with defined curves.

.6 Room sensors: wall mounted as indicated.

.7 Duct mounted sensors: locate so that sensing element is in air flow in duct.

.2 Outdoor Humidity Requirements:

.1 Range: 0- 100% RH minimum.

.2 Operating temperature range: -40-50degrees C.

.3 Absolute accuracy: plus or minus 1%.

.4 Temperature coefficient: plus or minus 0.03%RH/ degrees C over 0 to 50 degrees C.

.5 Must be unaffected by condensation or 100% saturation.

.6 No routine maintenance or calibration is required.

2.5 HUMIDITY TRANSMITTERS

.1 Requirements:

.1 Input signal: from RH sensor.

.2 Output signal: 4-20mA onto 500ohm maximum load.

.3 Input and output short circuit and open circuit protection.

.4 Output variations: not to exceed 0.2% of full scale output for supply voltage variations of plus or minus 10%.

.5 Output linearity error: plus or minus 1.0% maximum of full scale output.

.6 Integral zero and span adjustment.

.7 Temperature effect: plus or minus 1.0% full scale/ 6months.

.8 Long term output drift: not to exceed 0.25% of full scale output/ 6months.

2.6 PRESSURE TRANSDUCERS

.1 Requirements:

.1 Combined sensor and transmitter measuring pressure.

.1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, as applicable.

.2 Output signal: 4-20mA into 500ohm maximum load.

.3 Output variations: less than 0.2% full scale for supply voltage variations of plus or minus 10%.

.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5% of full scale output over entire range.

.5 Temperature effects: not to exceed plus or minus 1.5% full scale/ 50degrees C.

.6 Over-pressure input protection to at least twice rated input pressure.

.7 Output short circuit and open circuit protection.

.8 Accuracy: plus or minus 1% of Full Scale.

2.7 DIFFERENTIAL PRESSURE TRANSMITTERS

.1 Requirements:

.1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, as applicable.

.2 Output signal: 4-20mA into 500ohm maximum load.

.3 Output variations: less than 0.2% full scale for supply voltage variations of plus or minus 10%.

.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5% of full scale output over entire range.

.5 Integral zero and span adjustment.

.6 Temperature effects: not to exceed plus or minus 1.5% full scale/ 50degrees C.

.7 Over-pressure input protection to at least twice rated input pressure.

.8 Output short circuit and open circuit protection.

.9 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.8 STATIC PRESSURE SENSORS

.1 Requirements:

.1 Multipoint element with self-averaging manifold.

.1 Maximum pressure loss: 160Pa at 10m/s. (Air stream manifold).

.2 Accuracy: plus or minus 1% of actual duct static pressure.

2.9 STATIC PRESSURE TRANSMITTERS

.1 Requirements:

.1 Output signal: 4-20mA linear into 500ohm maximum load.

.2 Calibrated span: not to exceed 150% of duct static pressure at maximum flow.

.3 Accuracy: 0.4% of span.

.4 Repeatability: within 0.5% of output.

.5 Linearity: within 1.5% of span.

.6 Deadband or hysteresis: 0.1% of span.

.7 External exposed zero and span adjustment.

.8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit

2.10 VELOCITY PRESSURE SENSORS

.1 Requirements:

.1 Multipoint static and total pressure sensing element with self-averaging manifold with integral air equalizer and straightener section.

.2 Maximum pressure loss: 37Pa at 1000m/s.

.3 Accuracy: plus or minus 1% of actual duct velocity.

2.11 VELOCITY PRESSURE TRANSMITTERS

.1 Requirements:

.1 Output signal: 4-20mA linear into 500ohm maximum load.

.2 Calibrated span: not to exceed 125% of duct velocity pressure at maximum flow.

.3 Accuracy: 0.4% of span.

.4 Repeatability: within 0.1% of output.

.5 Linearity: within 0.5% of span.

.6 Deadband or hysteresis: 0.1% of span.

.7 External exposed zero and span adjustment.

.8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.12 LIQUID FLOW METERS

.1 Requirements:

.1 Pressure rating: as specified in I/O summaries.

.2 Temperature rating: as specified in I/O summaries.

.3 Repeatability: plus or minus 0.2%.

.4 Accuracy and linearity: plus or minus 1.0%.

.5 Flow rangability: at least 10:1.

.6 The flow tube shall be epoxy coated steel; the sensing electrodes shall be 316SS; the liner shall be polypropylene or ebonite for low temperature service, PFTE for hot water service (302 F maximum).

.7 Ends:

.1 NPS 2and under: screwed.

.2 NPS 2.1/2and over: flanged.

2.13 GAS METERS:

.1 Provide a Diaphragm Gas Meter complete with integral or remote transmitter.

.2 Transmitter output signal shall be a programmable pulse.

.3 Meter shall be temperature compensated for better accuracy.

.4 Meter shall meet ANSI B109.2 specification.

.5 Meter shall be Measurement Canada accredited.

2.14 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

.1 Requirements:

.1 Internal materials: suitable for continuous contact with compressed air, water, etc., as applicable.

.2 Adjustable setpoint and differential.

.3 Switch: snap action type, rated at 24 V DC 120V, 15 amps AC.

.4 Switch assembly: to operate automatically and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.

.5 Accuracy: within 2% repetitive switching.

.6 Provide switches with isolation valve and snubber, where code allows, between sensor and pressure source.

.7 Switches on high temperature hot water service: provide pigtail syphon.

2.16 TANK LEVEL SWITCHES

.1 Requirements:

.1 Indicate high/low water level and to alarm.

.2 For mounting on top of tank.

.3 Maximum operating temperature: 120degrees C.

.4 Snap action contacts rated 15 amp at 120 V.

.5 Adjustable setpoint and differential.

2.17 SUMP LEVEL SWITCHES

.1 Requirements:

.1 Liquid level activated switch sealed in waterproof and shockproof enclosure.

.2 Complete with float, flexible cord, weight. Instrument casing to be suitable for immersion in measured liquid.

.3 N.O./N.C. Contacts rated at 15 amps at 120V AC. CSA approval for up to 250 volt 10 amps AC.

2.18 WIND VELOCITY TRANSMITTERS

.1 Requirements:

.1 3-cup anemometer and airfoil vane mounted on common vertical axis, designed for mast mounting.

.2 Anemometer:

.1 Range: 0-160km/h.

.2 Threshold: 3.0 km/h.

.3 Accuracy: +/- 2%.

.3 Airfoil vane

.1 Range: 0-360 degrees with infinite resolution potentiometer with no loss of reading at transition point.

.2 Starting threshold: 1.1 M/s.

.3 Accuracy: +/- 0.5%.

.4 Output signals: 4 to 20Ma into 500ohm load.

.5 Provide two output signals: velocity, direction.

.6 Mast: aluminum, size and height as indicated.

.1 Provide at least 3 stainless steel guys, turnbuckles, anchor bolts. Follow manufacturer’s installation guidelines.

.2 Lightning protection as indicated on electrical drawings.

2.19 CURRENT / PNEUMATIC (I/P) TRANSDUCERS

.1 Requirements:

.1 Input range: 4to 20mA.

.2 Output range: proportional 20-104kPa 20-186kPa as applicable.

.3 Housing: dustproof or panel mounted.

.4 Internal materials: suitable for continuous contact with industrial standard instrument air.

.5 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 2% of full scale over entire range.

.6 Integral zero and span adjustment.

.7 Temperature effect: plus or minus 2.0% of full scale/ 50degrees C or less.

.8 Regulated supply pressure: 206kPa maximum.

.9 Air consumption: 16.5ml/s maximum.

.10 Integral gauge manifold c/w gauge (0-206 kPa).

2.20 SOLENOID CONTROL AIR VALVES

.1 Coil: 120V AC, as indicated.

.2 Capacity: to pass a minimum of 0.15 l/s air at 140 kPa differential.

2.21 AIR PRESSURE GAUGES

.1 Diameter: 38mm minimum.

.2 Range: zero to two times operating pressure of measured pressure media or nearest standard range.

2.22 ELECTROMECHANICAL RELAYS

.1 Requirements:

.1 Double voltage, DPDT, plug-in type with termination base.

.2 Coils: rated for 120V AC. Other voltage: provide transformer.

.3 Contacts: rated at 5amps at 120V AC.

.4 Relay to have visual status indication

2.23 SOLID STATE RELAYS

.1 General:

.1 Relays to be socket or rail mounted.

.2 Relays to have LED Indicator

.3 Input and output Barrier Strips to accept 14 to 28 AWG wire.

.4 Operating temperature range to be -20 degrees C to 70 degrees C.

.5 Relays to be CSA Certified.

.6 Input/output Isolation Voltage to be 4000 VAC at 25 degrees C for 1 second maximum duration.

.7 Operational frequency range, 45 to 65 HZ.

.2 Input:

.1 Control voltage, 3 to 32 VDC.

.2 Drop out voltage, 1.2 VDC.

.3 Maximum input current to match AO (Analog Output) board.

.3 Output.

.1 AC or DC Output Model to suit application.

2.24 CURRENT TRANSDUCERS

.1 Requirements:

.2 Purpose: combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:

.1 4-20 mA DC.

.2 0-1 volt DC.

.3 0-10 volts DC.

.4 0-20 volts DC.

.3 Frequency insensitive from 10 - 80 hz.

.4 Accuracy to 0.5% full scale.

.5 Zero and span adjustments. Field adjustable range to suit motor applications.

.6 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

2.25 CURRENT SENSING RELAYS

.1 Requirements:

.1 Suitable to detect belt loss or motor failure.

.2 Trip point adjustment, output status LED.

.3 Split core for easy mounting.

.4 Induced sensor power.

.5 Relay contacts: capable of handling 0.5amps at 30 VAC / DC. Output to be NO solid state.

.6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.

.7 Adjustable latch level.

2.26 CONTROL DAMPERS

.1 Construction: blades, 152mm wide, 1219mm long, maximum. Modular maximum size, 1219mm wide x 1219mm high. Three or more sections to be operated by jack shafts.

.2 Materials:

.1 Frame: 2.03mm minimum thickness extruded aluminum. For outdoor air and exhaust air applications, frames to be insulated.

.2 Blades: extruded aluminum. For outdoor air/exhaust air applications, blades to be internally insulated.

.3 Bearings: maintenance free, synthetic type of material.

.4 Linkage and shafts: aluminum, zinc and nickel plated steel.

.5 Seals: synthetic type, mechanically locked into blade edges.

.1 Frame seals: synthetic type, mechanically locked into frame sides.

.3 Performance: minimum damper leakage meet or exceed AMCA 500-Dratings.

.1 Size/Capacity: refer to damper schedule

.2 25L/s/m2maximum allowable leakage against 1000Pa static pressure for outdoor air and exhaust air applications.

.3 Temperature range: minus 40degrees C to plus 100degrees C.

.4 Arrangements: dampers mixing warm and cold air to be parallel blade, mounted at right angles to each other, with blades opening to mix air stream.

.5 Jack shafts:

.1 25 mm diameter solid shaft, constructed of corrosion resistant metal complete with required number of pillow block bearings to support jack shaft and operate dampers throughout their range.

.2 Include corrosion resistant connecting hardware to accommodate connection to damper actuating device.

.3 Install using manufacturer’s installation guidelines.

.4 Use same manufacturer as damper sections.

2.27 ELECTRONIC CONTROL DAMPER ACTUATORS

.1 Requirements:

.1 Direct mount proportional type as indicated.

.2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.

.3 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.

.4 Power requirements: 5VA maximum at 24 V AC.

.5 Operating range: 0 - 10 V DC or 4 - 20 mA DC.

.6 For VAV box applications floating control type actuators may be used.

.7 Damper actuator to drive damper from full open to full closed in less than 120seconds.

2.28 CONTROL VALVES

.1 Characteristics, materials and pressure ratings suitable for the application; refer to schedules.

.2 Flow characteristic as indicated on control valve schedule: equal percentage.

.1 Two-way: Equal percentage.

.2 Three-way: A Port: Equal percentage. B Port: Linear or modified linear.

.3 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.

.4 Normally open or Normally closed, as indicated.

.5 Two or Threeport, as indicated.

.6 Leakage rate ANSI class IV, 0.01% of full open valve capacity.

.7 Packing easily replaceable.

.8 Stem, stainless steel.

.9 Plug and seat, stainless steel, brass, bronze.

.10 Disc, replaceable, material to suit application.

.11 NPS 2 and under:

.1 Screwed National Pipe Thread (NPT) tapered female connections.

.2 Valves to ANSI Class 250, valves to bear ANSI mark.

.3 Rangeability 50:1minimum.

.12 NPS 2½ and larger:

.1 Flanged connections.

.2 Valves to ANSI Class 150or 250as indicated, valves to bear ANSI mark.

.3 Rangeability 100:1minimum.

.2 Butterfly Valves NPS 2 and larger:

.1 Type: High-performance (HPBV).

.2 Body: for chilled water ANSI Class 150 cast iron lugged or wafer bodyinstalled in locations as indicated. For heating water ANSI Class 150 carbon steel lugged or wafer body.

.3 End connections to suit flanges that are ANSI Class 150.

.4 Extended stem neck to provide adequate clearance for flanges and insulation.

.5 Pressure limit: bubble tight sealing to 170kilopascals.

.6 Disc/vane: 316 stainless steel, aluminum bronze to ASTM B148.

.7 Seat: for service on chilled water PTFE (polytetrafluoroethylene), EPDM (ethylene propylene diene monomer). For service on heating water PTFE, RTFE (reinforced PTFE).

.8 Stem: 316stainless steel.

.9 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.

.10 Flow characteristic linear.

.11 Maximum flow requirement as indicated on control valve schedule.

.12 Maximum pressure drop as indicated on control valve schedule: pressure drop not to exceed one half of inlet pressure.

.13 Normally open or Normally closed, as indicated.

.14 Valves are to be provided complete with mounting plate for installation of actuators.

2.29 ELECTRONIC / ELECTRIC VALVE ACTUATORS

.1 Requirements:

.1 Construction: steel, cast iron, aluminum.

.2 Control signal: Compatible with BC, AAC and ASC. Floating control signal is not acceptable.

.3 Positioning time: to suit application. 90sec maximum.

.4 Fail to normal position as indicated.

.5 Scale or dial indication of actual control valve position.

.6 Size actuator to meet requirements and performance of control valve specifications.

.7 For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.

.8 Minimum shut-off pressure: refer to control valve schedule.

2.30 WATTHOUR METERS AND CURRENT TRANSFORMERS

.1 Requirements:

.1 Include three phases, test and terminal blocks for watthour metre connections and connections for monitoring of current. Provide two transformers for 600 V 3 wire systems for watthour metre use. Accuracy: plus or minus 0.25% of full scale. For chiller applications: to have instantaneous indicator with analog or digital display.

.2 Watthour metre sockets: to ANSI C12.7.

.3 Potential and current transformers: to ANSI/IEEE C57.13.

.4 Potential transformers: provide two primary fuses.

.5 Demand meters: configure to measure demand at 15 minute intervals.

2.31 SURFACE WATER DETECTORS

.1 Requirements:

.1 Provide alarm on presence of water on floor.
.2 Expendable cartridge sensor.
.3 Internal waterproof switch.
.4 One set of dry contacts 2 amps at 24 V.
.5 Unaffected by moisture in air.
.6 Self-powered.

2.32 CO2 SENSORS:

.1 Requirements:

.1 Sensor shall employ non-dispersive infrared technology (NDIR).
.2 Accuracy shall be +/- 75 ppm over 0-1500 ppm range.
.3 Response time shall be less than 1 minute.
.4 Sensor shall have field selectable 0-10 VDC and 4-20 mA outputs.
.5 Power voltage shall be 20-30 VDC/AC.
.6 Operating temperature range shall be 0°C to 50°C.
.7 The sensor shall be wall/duct mount.
.8 Sensor must be able to maintain calibration within 2% for 1 year period of operation.

2.33 GAS DETECTION SYSTEM:

.1 Gas Detection Controller:

.1 Use: Centralized gas detection monitoring with real-time gas reading, selective alarm activation
.2 Enclosure: NEMA 4X Polycarbonate – ABS
.3 Power Requirement: 17-27 Vac, 24-38 Vdc, 500 mA
.4 Network: Three Modbus channels for up to 96 transmitters and an optional BACnet/LON/IP output; Communication Line Up to 609 m (2000 ft.) per channel
.5 Alarm Levels: fully programmable alarm levels; Time Delays 0, 30 sec., 45 sec., 1-99 minutes before and after alarm
.6 Outputs: 4 DPDT relays (alarms and/or fault) at 5 A, 30 Vdc or 250 Vac (resistive load); 65dBA buzzer
.7 Display: 122 x 32 dot matrix LCD display
.8 Operating Humidity Range: 0-95% RH, non-condensing
.9 Operating Temperature Range: -20 to 50°C (-4 to 122°F)
.10 Certifications: CAN/CSA C22.2 No 61010-1
.11 Conforms to: ANSI/UL 61010-1; IEC 61010-1 Including Amendments A1:1992 + A2:1995 and National Deviations (Canada, US)

.2 Wired or Stand-Alone Gas Transmitter:

.1 Use: Wall mounted, wired gas detector transmitter used in conjunction with controller

.2 Power Requirement: 24 Vac nominal (17-27), 50/60 Hz, 0.35A; 24 Vdc nominal (20-38Vdc)

.3 Network: Modbus RS-485; BACnet MS/TP master

.4 Display: 8 character, 2 line backlit LCD

.5 Visual Indicators: Green LED; Power, Amber LED 1: Alarm/ Fault, Amber LED 2: Alarm/ Fault

.6 Audible Alarm: >85 dbA at 3m (10ft)

.7 Relay Output: Network 1 DPDT relay, 5A @ 250Vac; 5A @ 30 Vdc; Stand Alone 2x DPDT relay, 5A @ 250Vac; 5A @ 30 Vdc

.8 Sensing Technology: Toxic = Electrochemical; Combustibles = Catalytic; Oxygen = Diffusion fuel cell

.9 Accuracy: Toxic, Combustibles, Oxygen = +/- 3%

.10 Detection Range: Carbon Monoxide = 0 - 250 ppm; Nitrogen Dioxide (NO2) = 0-10 ppm; Oxygen = 0-1 ppm; Combustibles = 0-100% LEL;

.11 Certified to: CAN/CSA C22.2 No. 61010-1

.12 Conforms to: ANSI/UL 61010-1

.3 Gas sensors for high hazard (Class 1 Zone 2) areas:

.1 Gas sensors for the High bay area and the Flammable storage rooms shall be suitable for use in class 1 zone 2 areas.

.2 3 wire, 4-20mA and RS485 MODBUS output fixed point detector with in-built alarm and fault relays for the protection of personnel and plant from flammable, toxic and Oxygen hazards. Incorporates a transmitter with local display and fully configurable via non-intrusive magnetic switch interface.

.3 Epoxy painted aluminum alloy ADC12 or 316 stainless steel housing. 316 stainless steel sensor.

.4 Integral mounting plate with 4x mounting holes suitable for M8 bolts.

.5 cUL Cable entries

.4 Horn/Strobe for high hazard (class 1 zone 2) areas:

.1 Horn strobe shall alarm when it receives a signal for gas levels outside of normal range.

.2 The horn strobe shall be a 2-Wire Horn Strobe, Standard cd, White colour; plain housing - listed to UL 1971 and UL 464 . Nominal Voltage Regulated 12 DC/FWR or regulated 24 DC/FWR1, Operating Voltage Range 8 to 17.5 V (12 V nominal) or 16 to 33 V (24 V nominal)

.3 The Horn strobe shall provide flashing at 1 Hz over the strobe’s entire operating voltage range. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. The horn shall have three audibility options and an option to switch between a temporal three-pattern and a non-temporal (continuous) pattern. The horn on horn strobe models shall operate on a coded or non-coded power supply.

2.34 CHILLER MECHANICAL ROOM REFRIGERANT GAS DETECTION SYSTEM:

.1 Gas Detection Controller /Expansion Module - Inside Chiller Mechanical Room

.1 Use: Centralized Stand Alone refrigerant gas detection monitoring main controller with real-time gas reading, selective alarm activation

.2 Power Requirement: 22-27 Vac, 29-38 Vdc, 2A max @ 29Vdc

.3 Up to 20 gas transmitters, Digital Communication Modbus RS-485 Line, Up to 61 m (200 ft.) from the controller.

.4 Alarm Levels: 3 fully programmable alarm levels

.5 Outputs: 4 DPDT form C relays (alarms and/or fault) at 5 A, 30 Vdc or 250 Vac (resistive load); 65dBA buzzer, 3 Outputs at 24 Vdc @ 250 mA each

.6 Iintegral Strobe/Horn: STAS flashing LED/105dBA, 4-28V, 2800Hz (RFSA)

.7 Display: 122 x 32 dot matrix backlit LCD display

.8 Visual Indicators: - Green LED – Normal Operation

.9 Red LED Gas Alarm A, B, and C

.10 Yellow LED: Fault/Service

.11 The Controller/expansion module must provide all the functionalities necessary to comply with current ASHRAE 15 guidelines and CSA B-52 Mechanical Codes.

.12 Manual Fan Start/Stop operation

.13 Audible Alarm with a silence key to acknowledge

.14 Visible Alarm

.15 Operating Humidity Range: 0-95% RH, non-condensing

.16 Operating Temperature Range: 0°C to 40°C (32°F to 100°F)

.17 Enclosure rating: NEMA 4X, ABS - Polycarbonate - indoor

.18 Certifications: CAN/CSA C22.2 No 61010-1

.19 Conforms to: ANSI/UL 61010-1; IEC 61010-1 Including Amendments A1:1992 + A2:1995 and National Deviations (Canada, US)

.2 Gas Detection Remote Annunciator Panel: Outside Chiller Mechanical Room

.1 Use: Remote Annunciator / Slave display panel located outside each entrance to Chiller Mechanical room

.2 Power Requirement: 22-27 Vac, 50 or 60 Hz, 29-38Vdc, 2.0 A max @ 24 Vdc

.3 Up to 10 remote Annunciator panels can be connected to the main refrigerant gas detection Controller; Digital Communication Modbus RS-485 up to 304m (1000ft)

.4 The remote annunciator panel must provide all the functionalities necessary to comply with Current ASHRAE 15 and CSA B-52 Mechanical Codes. This includes a key for manual ‘’fan start’’ only

operation, strobe/horn audible visual alarm on top of the unit

.5 Display 122 x 32 dot matrix backlit LCD display

.6 Visual Indicators: - Green LED – Normal Operation

.7 Red LED Gas Alarm A, B, and C

.8 Yellow LED: Fault/Service

.9 The Remote annunciator panel will indicate the exact concentration of refrigerant gas as displayed on the 301EMRFSA Main Controller and the refrigerant gas detected. The LCD display screen will indicate multiple alarm levels for each sensing point

.10 Operating Temperature Range: 0°C to 40°C (32°F to 100°F)

.11 Enclosure rating: NEMA 4X, ABS - Polycarbonate - indoor

.12 Certifications: CAN/CSA C22.2 No 61010-1

.13 Conforms to: ANSI/UL 61010-1; IEC 61010-1 Including Amendments A1:1992 + A2:1995 and National Deviations (Canada, US)

2.35 WIRED REFRIGERANT GAS TRANSMITTER:

.1 Use: Wall mounted, wired refrigerant gas detector transmitter used in conjunction with 301EMRFSA controller, Diffusion Type with no internal sample pump or filter maintenance required

.2 Power Requirement: 8.5 - 12.5 Vdc, 1A@10 Vdc Maximum

.3 Network: Modbus RS-485

.4 Sensing Technology: NDIR (Non Dispersive Infrared)

.5 Accuracy: ±10ppm @ 50 ppm / ±40ppm @ 500 ppm

.6 Detection Range: Refrigerants 0-1000 ppm

.7 R11, R12, R13B1, R22, R114, R123, R125, R134a, R227, R245A, R404A, R407C, R410A, R507, R508b

.8 Resolution: 1 ppm

.9 Response Time (T90) 60 seconds

.10 Operating Temperature Range: 0°C to 40°C (32°F to 100°F)

.11 0 to 95% RH (non-condensing)

.12 Enclosure NEMA 4X ABS/Polycarbonate - Indoor

.13 Certified to: CAN/CSA C22.2 No. 61010-1

.14 Conforms to: ANSI/UL 61010-1

2.36 PANELS

.1 Wall mountedenamelled steel cabinets with hinged and key-locked front door.

.2 Multiple panels as requiredto handle requirements with additional space to accommodate 25% additional capacity as required by Departmental Representative without adding additional cabinets.

.3 Panels to be lockable with same key.

2.37 WIRING

.1 In accordance with Section 26 27 26.

.2 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.

.3 Wiring must be continuous without joints.

.4 Sizes:

.1 Field wiring to digital device: #18AWG.

.2 Analog input and output: shielded #18 minimum solid copper.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

.2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.

.3 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.

.4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.

.5 Fire stopping: provide space for fire stopping in accordance with Section 07 84 00. Maintain fire rating integrity.

.6 Electrical:

.1 Complete installation in accordance with Section 26 05 00.

.2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.

.3 Refer to electrical control schematics included as part of control design schematics on drawings in Section 25 90 01. Trace existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by Departmental Representative before beginning Work.

.4 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

.5 Install communication wiring in conduit.

.1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).

.2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.

.3 Maximum conduit fill not to exceed 40%.

.4 Design drawings do not show conduit layout.

.6 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Departmental Representative to review before

starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

.7 VAV Terminal Units: supply, install and adjust as required.

.1 Air probe, actuator and associated vav controls.

.2 Tubing from air probe to dp sensor as well as installation and adjustment of air flow sensors and actuators.

.3 Co-ordinate air flow adjustments with balancing trade.

3.2 TEMPERATURE AND HUMIDITY SENSORS

.1 Stabilize to ensure minimum field adjustments or calibrations.

.2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.

.3 Outdoor installation:

.1 Protect from solar radiation and wind effects by non-corroding shields.

.2 Install in NEMA 4 enclosures.

.4 Duct installations:

.1 Do not mount in dead air space.

.2 Locate within sensor vibration and velocity limits.

.3 Securely mount extended surface sensor used to sense average temperature.

.4 Thermally isolate elements from brackets and supports to respond to air temperature only.

.5 Support sensor element separately from coils, filter racks.

.5 Averaging duct type temperature sensors.

.1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.

.2 Wire multiple sensors in series for low temperature protection applications.

.3 Wire multiple sensors separately for temperature measurement.

.4 Use software averaging algorithm to derive overall average for control purposes.

.6 Thermowells: install for piping installations.

.1 Locate well in elbow where pipe diameter is less than well insertion length.

.2 Thermowell to restrict flow by less than 30%.

.3 Use thermal conducting paste inside wells.

3.3 PANELS

.1 Arrange for conduit and tubing entry from top, bottom or either side.

.2 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.

.3 Identify wiring and conduit clearly.

3.4 MAGNEHELIC PRESSURE INDICATORS

.1 Install adjacent to fan system static pressure sensor and duct system velocity pressure sensor as reviewed by Departmental Representative.

.2 Locations: as indicated.

3.5 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS

.1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows.

.1 Protect sensing elements on high temperature hot water service with pigtail syphon between valve and sensor.

3.6 I/P TRANSDUCERS

.1 Install air pressure gauge on outlet.

3.7 AIR PRESSURE GAUGES

.1 Install pressure gauges on pneumatic devices, I/P, pilot positioners, motor operators, switches, relays, valves, damper operators, valve actuators.

.2 Install pressure gauge on output of auxiliary cabinet pneumatic devices.

3.8 IDENTIFICATION

.1 Identify field devices in accordance with Section 25 05 54.

3.9 AIR FLOW MEASURING STATIONS

.1 Protect air flow measuring assembly until cleaning of ducts is completed.

3.10 TESTING AND COMMISSIONING

Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01

.2 Section 25 05 01.

1.2 SEQUENCING

.1 Sequencing of operations for systems as follows:

1.3 NEW LAB AIR VALVE CONTROL WITH REHEAT

.1 Maintain the existing sequence that is installed for the system being replaced. Update graphics for new setpoints.

1.4 FUME HOOD EXHAUST AIR VALVES AND PERMINENT ENCLOSURE AIR VALVES(VALVES PROVIDED BY OTHERS, WIRING IS NOT PROVIDED BY OTHERS)

.1 Fully integrate valves into existing control system. Valves shall modulate in concert with other valves serving room to maintain airflow offsets.

1.5 EXHAUST ARM LAB AIR VALVES

.1 Provide one control switch located on wall adjacent to exhaust arm. One control switch shall be provided be exhaust air lab valve

.2 Exhaust Air Valves to be opened to maximum when switch is on. Valve to close to minimum when switch is off.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

EQUIPMENT NO.			SMB	
			Supply Valve	
Make				
Model				
Inlet Size (Diameter)	In	mm	10	254
Maximum Airflow	cfm	L/s	1,000	472
Minimum Airflow	cfm	L/s	50	24
Fan Airflow	cfm	L/s	n/a	0
Fan Motor	hp	kW	n/a	0.00
Air Pressure Drop	In H2O	Pa	1	249
SOUND DATA				
Inlet Static Pressure	In H2O	Pa	1.00	249
2nd Band	Discharge	Radiated	68	50
3rd Band	Discharge	Radiated	64	54
4th Band	Discharge	Radiated	58	52
Outlet Width	In	mm	10.0	254
Outlet Height	In	mm		--
Return Width	In	mm		--
Return Height	In	mm		--
			med pressure valve	
Remarks			c/w Silencer and	
			reheat coil	

EQUIPMENT NO.				
Make				
Model				
Inlet Size (Diameter)	In	mm		
Maximum Airflow	cfm	L/s		
Minimum Airflow	cfm	L/s		
Fan Airflow	cfm	L/s		
Fan Motor	hp	kW		
Air Pressure Drop	In H2O	Pa		
SOUND DATA				
Inlet Static Pressure	In H2O	Pa		
2nd Band	Discharge	Radiated		
3rd Band	Discharge	Radiated		
4th Band	Discharge	Radiated		
Outlet Width	In	mm		
Outlet Height	In	mm		
Return Width	In	mm		
Return Height	In	mm		
Remarks				

EQUIPMENT NO.					SL-SVB-1		SL-SVB-2	
					Control Valve SB		Control Valve SB	
Fan Served					Refer to dawings		Refer to dawings	
Airflow Rate	cfm	L/s			1,000	472	1,000	472
					Vibron		Vibron	
Type					28VRS-F/2		28EVRS-F/5	
Diameter	In	mm				--		--
Width	In	mm			14	356	14	356
Height	In	mm			14	356	14	356
Length	In	mm			36	914	36	914
INSERT LOSS								
2nd Band					7		8	
3rd Band					14		13	
4th Band					18		21	
Class								
Air Pressure Drop	In H2O	Pa			0.08	20	0.06	15
					Straight Silencer		Elbow Silencer	
Remarks					Supply with all SB		Coordinate leg lengths	
					Control Valves		with interference	
					shown with straight		drawings	
					silencers		Supply with all SB	
							Control Valves	
							shown with elbow	
							silencers	

EQUIPMENT NO.								
Fan Served								
Airflow Rate	cfm	L/s						
Type								
Diameter	In	mm						
Width	In	mm						
Height	In	mm						
Length	In	mm						
INSERT LOSS								
2nd Band								
3rd Band								
4th Band								
Class								
Air Pressure Drop	In H2O	Pa						
Remarks								

1. General

1.1. REFERENCE STANDARDS

1.1.1. CSA Group

.1 CSA C22.1-18, Canadian Electrical Code, Part 1 (23nd Edition), Safety Standard for Electrical Installations.

1.1.2. CSA C22.2 No. 0-10 (R2015) General requirements - Canadian electrical code, part II

1.1.3. CSA C22.2 No. 0.4-17 Bonding of Electrical Equipment

1.1.4. CAN3-C235-83(R2015), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.

.2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)

.1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.1.5. All work shall be performed in accordance with the latest codes, rules, regulations, by-laws and requirements of all authorities having jurisdiction except where the requirements of the drawings and specifications exceed the codes, rules, regulations, by-laws and requirements of the authorities having jurisdiction.

1.1.6. Drawings and specifications should not conflict with the above regulations but where there are apparent discrepancies the contractor shall notify the Engineer’s Representative.

1.2. DEFINITIONS

1.2.1. Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.3. ACTION AND INFORMATIONAL SUBMITTALS

1.3.1. Submit in accordance with Section 01 33 00.

1.3.2. Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for all equipment.

1.3.3. Submit for review single line electrical diagrams under plexiglass and locate in electrical distribution system in main electrical room.

1.3.4. Submit for review fire alarm riser diagram, plan and zoning of building under plexiglass at fire alarm control panel and annunciator.

1.3.5. Shop drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.

.2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.

.3 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.

.4 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.

.5 Submit 600 x 600mm minimum size drawings to authority having jurisdiction.

.6 If changes are required, notify the Departmental Representative of these changes before they are made.

.7 Shop Drawings shall be organized by Specification Section. Do not combine more than one section into one submission. Incorrect submissions will be returned without review.

.8 Submittals/Shop Drawings shall indicate clearly the materials and/or equipment actually being supplied, all details of construction, accurate dimensions, capacity, operating characteristics and performance. Each Shop Drawing shall give the identifying number of the specific assembly for which it was prepared (e.g. SWBD-1A).

.9 Submit shop drawings electronically, by email, in PDF format. Submissions that are not electronic without prior approval from the Engineer's Representative shall be returned as not reviewed. Provide the following information in the email submission:

.1 S+A project number and Contractor Shop Drawing Identifier in Subject Line

.2 Attachments shall be limited to 10MB

.3 Provide FTP hyperlink for all attachments in excess of 10MB with appropriate information for downloading the file (as required)

.4 Shop Drawing Submission to the following email address:

ContractAdmin.Toronto@smithandandersen.com

.10 Shop drawings submitted directly to Smith + Andersen personnel (and not copied to the email address provided above) without advanced permission will not be processed nor considered as received.

.11 Each Shop Drawing for non-catalogue items shall be prepared specifically for this project. Shop Drawings and brochures for catalogue items shall be marked clearly to show the items being supplied.

.12 When requested, Shop Drawings shall be supplemented by data explaining the theory of operation – for example: lighting control sequence of operation – the Engineer's Representative may also request that this information be added to the maintenance and operating manual.

.13 Provide a cover sheet with the project name, issue date, issue number, specification section number, and title of section with space for Shop Drawing review stamps for the Contractor and Engineer's Representative.

1.3.6. Certificates:

.1 Provide CSA certified material and equipment.

.2 Where CSA certified equipment or material is not available, submit such equipment or material to inspection authorities for special approval before delivery to site.

.3 Submit test results of installed electrical systems and instrumentation.

.4 Permits and fees: in accordance with General Conditions of contract.

.5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.

.6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Consultant and Departmental Representative.

1.3.7. Manufacturer's Field Reports: submit to Departmental Representative and Consultant manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.

1.4. CLOSEOUT SUBMITTALS

1.4.1. Submit in accordance with Section 01 78 00.

1.4.2. Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.

.1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.

.2 Operating instructions to include following:

.1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

.2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.

.3 Safety precautions.

.4 Procedures to be followed in event of equipment failure.

.5 Other items of instruction as recommended by manufacturer of each system or item of equipment.

.3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.

.4 Post instructions where directed.

.5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.

.6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

1.5. DELIVERY, STORAGE AND HANDLING

1.5.1. Deliver, store and handle materials in accordance with Section 01 61 00.

1.5.2. Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.1 Storage and Handling Requirements:

.2 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.3 Store and protect from nicks, scratches, and blemishes.

.4 Replace defective or damaged materials with new.

1.6. EXAMINATION AND PROTECTION OF SITE

1.6.1. Before submitting Bid, each trade shall examine the site to determine the conditions which may affect the proposed work. No claims for extra payment will be considered because of failure to fulfil this condition.

1.6.2. Contractor to document any existing conditions on site and submit a pre-condition survey including pictures. Contractor will be responsible to return the site back to its original form, which includes but is not limited to ground repair including grading and new sod and repair of damaged walls, doors and/or floors.

1.6.3. Contractor is to protect trees and plants on site and on adjacent properties. Plants to be protect with burlap. Trees and roots within construction area to be protected by the erection of temporary 2m high plywood hoarding at the drip line of the tree. Contractor to avoid unnecessary traffic, dumping and storage of materials at or near trees or plants.

1.6.4. When requested by the Owner and/or Engineer’s Representative, the Contractor is to provide digital pictures of the site, including but not limited to progress of work and installed equipment, via e-mail to the Owner and/or Engineer’s Representative.

1.7. DRAWINGS AND INSTALLATION

1.7.1. The drawings are intended to show the general character and scope of the work and not the exact details of the installation. The installation shall be complete with all accessories required for a complete and operative installation.

1.7.2. The location, arrangement and connection of equipment and materials shown on the drawings represent a close approximation to the intent and requirements of the contract. The right is reserved by the Engineer's Representative to make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to the Owner.

1.7.3. Certain details indicated on the drawings are general in nature and specific labelled detail references to each and every occurrence of use are not indicated, however, such details shall be applicable to every occurrence on the drawings.

1.7.4. The actual location of switches, outlets and luminaries, etc. shall be reviewed by the Engineer's Representative before installation.

1.7.5. The location and size of existing services shown on the drawings are based on the best available information. The actual location of existing services shall be verified in the field before work is commenced. Particular attention shall be paid to buried services.

1.7.6. Changes and modifications necessary to ensure co-ordination and avoid interference and conflicts with other trades or to accommodate existing conditions, shall be made at no extra cost to the Owner.

1.7.7. Leave areas clear where space is indicated as reserved for future equipment, and equipment for other trades.

1.7.8. Adequate space and provisions shall be left for removal of components and servicing of equipment, with minimum inconvenience to the operation of systems.

1.7.9. Where equipment is shown to be 'roughed-in only' obtain accurate information from the Engineer's Representative before proceeding with the work.

1.7.10. Contractor is to review Architect's specifications, drawings and details to confirm locations of devices and equipment.

1.7.11. The Contractor will reimburse the Engineer's Representative for their time spent on answering any written questions or requests for information where the answer is clearly identified on the drawings or in the specifications.

1.8. PERMITS AND FEES

1.8.1. Submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.

1.8.2. Pay all fees required for the performance of the work.

1.9. INSPECTION AND FEES

1.9.1. Furnish a Certificate of Acceptance from the Authorized Electrical Inspection Department on completion of work.

1.9.2. Request and obtain Special Inspection approval from the Authorized Electrical Inspection Department for any non-CSA approved control panels or other equipment fabricated by the contractor as part of this contract.

1.9.3. Pay all fees required for inspections.

1.10. INTERRUPTION OF SERVICES

1.10.1. Any interruption of the electrical services to any part of the building shall come at a time agreeable to the Engineer's Representative. Make all necessary arrangements with those concerned and include for any overtime required to ensure that the interruption is held to a minimum.

1.10.2. All such overtime work shall be carried out without additional cost to the Owners.

1.10.3. Modifications to existing electrical equipment, which will require shutdown, must be coordinated with the Owner and will only be permitted on weekdays from 10:00 pm to 6:00 am and on weekends from Friday at 7:00 pm to Sunday 6:00 pm. Exact weekends to be co-ordinated with the Owner. Consecutive weekends of shutdowns will not be allowed. Contractor to pay for all utility costs associated with shutdowns. Any work not associated with live equipment can be done during normal working hours. Work considered disruptive to the normal operation of the building will be done after normal business hours. Exact times to be co-ordinated with Owner.

1.10.4. Contractor to provide a minimum of 5 days written notice of a requirement for a shutdown. Contractor to include for separate meetings with the Owner and Engineer's Representative to discuss the shutdown in detail and to coordinate all the work being performed.

1.10.5. The Contractor is responsible for co-ordination and isolating of all existing services at all voltage levels required for the disconnections and connections to existing buildings. This includes shutting down and isolating existing low and medium voltage services. The owner will not perform any isolations for the contractor but will be present during the work. The contractor is to use qualified personnel for these shutdowns ensuring compliance with all applicable safety requirements.

1.10.6. The Contractor is responsible for any damages caused to existing systems when making connections.

1.10.7. The Contractor is to keep shutdowns of existing buildings to a minimum by scheduling the work and providing the required number of personnel to keep the shutdown to a minimum. This Contractor is to include for as many multiple teams of electricians as is feasible to keep the shutdown work to a minimum.

1.11. PRE-PURCHASED EQUIPMENT

1.11.1. The Electrical Trade shall assume complete responsibility for the Owner's pre-purchased equipment and its associated equipment as if it had been purchased by the Contractor, with the single exception of payment.

1.11.2. The Electrical Trade shall provide a warranty for all pre-purchased equipment during the warranty period and shall include for all labour, material and shipping charges not covered in the manufacturer's warranty to completely repair or replace any defective pre-purchased equipment at no cost to the Owner during the warranty period.

1.11.3. The Electrical Trade shall take complete responsibility for the co-ordination of delivery of the separate items of equipment and their proper placement as required by jobsite conditions.

1.11.4. The Electrical Trade shall provide all materials and labour required to incorporate pre-purchased equipment into a working system whether or not shown on the drawings or specified herein.

1.11.5. The following list of equipment is pre-purchased:

.1 26 50 00 Lighting

.2 26 09 24 Lighting Control Devices - Low Voltage

.3 26 52 00 Emergency Lighting

1.12. DEMOLITION

1.12.1. The demolition drawings show the general scope of the demolition and not exact details or total extent. For exact details and total extent each service must be carefully checked on site. Before removing services follow the service through to ensure other areas of the building are not affected.

1.12.2. Whenever existing services or equipment are to be removed, all electrical connections for such services shall be removed and securely terminated in an approved manner. If necessary

to facilitate installation of new work, any existing services and equipment shall be removed and then replaced by this division.

1.12.3. Whenever it becomes necessary to relocate any electrical services equipment to make possible installation of the work under this contract, such relocation shall be done by this division without additional cost to the Owner.

1.12.4. Make safe and disconnect all power and systems, as and when, and to the extent required to facilitate the demolition.

1.12.5. Ensure that all electrical, life safety services, and services for existing equipment, in areas outside the areas of this work, that are required to remain in service, shall do so.

1.12.6. Relocate any electrical feeders or equipment that are required to remain in service, that are secured to existing walls, floors or ceilings to be demolished or that are buried and required to be excavated for new work.

1.12.7. Remove and replace any electrical equipment on walls or ceilings that will be demolished and rebuilt.

1.12.8. Disconnect and remove existing light fixtures, devices, outlets, CCTV, security devices, etc. which are not to be reused. Such items shall be packaged and turned over to the Owner at a place designated by the Owner. Cut back and cap unused raceway and outlets and remove unused wiring back to panelboard in an approved manner.

1.12.9. Ensure that all existing equipment which is to be reused and/or relocated is thoroughly reviewed and refurbished to ensure correct operation when put back into service and to meet the requirements of the local authorities having jurisdiction. All existing electrical equipment which is no longer required shall be removed and disposed of off-site.

1.12.10. Carry out the work with a minimum of noise, dust and disturbance.

1.12.11. Provide tools and clean up equipment. Obtain the Owner's permission for the use of electrical, plumbing or drainage outlets.

1.12.12. Where a device is shown to be relocated on the drawings, contractor to remove and re-install device and back box and re-feed the device with new conduit and wire from the nearest existing accessible junction box.

1.12.13. Electrical Contractor is responsible for the patching and re-painting the entire wall where a device and/or box has been added, removed or relocated.

1.13. GROUNDING

1.13.1. Thoroughly ground all electrical equipment, cabinets, metal supporting frames, ventilating ducts and other apparatus where grounding is required in accordance with the requirements of the latest edition of the Canadian Electrical Code Part 1, C.S.A. C22.1 and corresponding Provincial and Municipal regulations. Do not depend upon conduits to provide the ground circuits.

1.13.2. Run separate green insulated stranded copper grounding conductors in all electrical conduits including those feeding toggle switches and receptacles.

2. Products

2.1. DESIGN REQUIREMENTS

2.1.1. Operating voltages: to CAN3-C235.

2.1.2. Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.

.1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

2.1.3. Language operating requirements: provide identification nameplates and labels for control items in English.

2.2. MATERIALS AND EQUIPMENT

2.2.1. Provide material and equipment in accordance with Section 01 61 00.

2.2.2. Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from inspection authorities before delivery to site and submit such approval as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

2.2.3. Factory assemble control panels and component assemblies.

2.3. WARNING SIGNS

2.3.1. Warning Signs: in accordance with requirements of inspection authorities and Departmental Representative.

2.3.2. Shield and mark all live parts with the appropriate voltage. Caution notices shall be worded in both English and French.

2.3.3. Decal signs, minimum size 175 x 250 mm.

2.4. WIRING TERMINATIONS

2.4.1. Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

2.5. EQUIPMENT IDENTIFICATION

2.5.1. Identify electrical equipment with nameplatesas follows:

.1 Nameplates: Lamicoid 3 mm melamine, black face, black core, lettering accurately aligned and engraved into core and red to match existing for emergency power

.2 Sizes as follows:

NAMEPLATE SIZES			
Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

2.5.2. Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.

2.5.3. Wording on nameplates and labels to be approved by Consultant and Departmental Representative prior to manufacture.

2.5.4. Allow for minimum of twenty-five (25) letters per nameplate and label.

2.5.5. Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

2.5.6. Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO. [_____].

2.5.7. Disconnects, starters and contactors: indicate equipment being controlled and voltage.

2.5.8. Terminal cabinets and pull boxes: indicate system and voltage.

2.5.9. Transformers: indicate capacity, primary and secondary voltages.

2.5.10. Coordinate names of equipment and systems with other Divisions to ensure that names and numbers match.

2.5.11. Provide two sets of lamicoid nameplates for each piece of equipment; one in English and one in French.

2.5.12. Lamicoid nameplates shall identify the equipment, the voltage characteristics and the power source for the equipment. Example: A new 120/240 volt single phase circuit breaker panelboard, L16, is fed from panelboard LD1 circuit 10.

"PANEL L16
120/240 V
FED FROM LD1-10"

PANNEAU L16
120/240 V
ALIMENTE PAR LD1-10

2.5.13. Provide warning labels for equipment fed from two or more sources - "DANGER MULTIPLE POWER FEED" black letters on a yellow background.

2.5.14. For all interior lamicoid nameplates, mount nameplates using two-sided tape.

2.5.15. For all exterior lamicoid nameplates, mount nameplates using self-tapping 2.3 mm (3/32") dia. slot head screws - two per nameplate for nameplates under 75 mm (3") in height and a minimum of 4 for larger nameplates. Holes in lamicoid nameplates to be 3.7 mm (3/16") diameter to allow for expansion of lamicoid due to exterior conditions.

.1 No drilling is to be done on live equipment.

.2 Metal filings from drilling are to be vacuumed from the enclosure interior

2.5.16. All lamicoid nameplates shall have a minimum border of 3 mm (1/8"). Characters shall be 9 mm (3/8") in size unless otherwise specified.

2.5.17. Identify lighting fixtures which are connected to emergency power with a label "EMERGENCY LIGHTING/ÉCLAIRAGE D'URGENCE", black letters on a yellow background.

2.5.18. Provide neatly typed updated circuit directories in a plastic holder on the inside door of new panelboards.

2.5.19. Carefully update panelboard circuit directories whenever adding, deleting, or modifying existing circuitry.

2.5.20. Identify molded case breaker with lamicoid nameplate.

2.6. WIRING IDENTIFICATION

2.6.1. Identify wiring with permanent indelible identifying markings, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

2.6.2. Maintain phase sequence and colour coding throughout.

2.6.3. Colour coding: to CSA C22.1.

2.6.4. Use colour coded wires in communication cables, matched throughout system.

2.7. CONDUIT AND CABLE IDENTIFICATION

2.7.1. Colour code conduits, boxes and metallic sheathed cables.

.1 Fire alarm – red conduit

.2 Emergency power circuits – yellow conduit

.3 Voice/data – blue conduit

.4 Gas detection system – purple conduit

.5 Building Automation system – orange conduit

.6 Security system – green conduit

.7 Control system – black conduit

2.7.2. Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15m intervals.

2.7.3. Colours: 25mm wide prime colour and 20mm wide auxiliary colour.

2.7.4. For system running with cable, half-lap wrap with dedicated coloured PVC tape to 100 mm width, tape every 5 m and both sides where cable penetrates a wall.

2.7.5. All other systems need not be coloured.

2.8. FINISHES

2.8.1. Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.1 Paint outdoor electrical equipment "equipment green" finish.

.2 Paint indoor switchgear and distribution enclosures light gray.

2.8.2. Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

2.9. ACOUSTICAL PERFORMANCE

2.9.1. In general provide equipment producing minimal sound levels in accordance with the best and latest practices established by the electrical industry.

2.9.2. Do not install any device or equipment containing a magnetic flux path metallic core, such as gas discharge lamp ballasts, dimmers, solenoids, etc., which are found to produce a noise level exceeding that of comparable available equipment.

2.10. SPRINKLERS

2.10.1. All electrical equipment shall be suitable for installation in a sprinklered environment and enclosures are to be CSA Type-2 sprinkler proof.

3. Execution

3.1. EXAMINATION

3.1.1. Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are in accordance with manufacturer’s written instructions.

.1 Visually inspect substrate in presence of Departmental Representative.

.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2. INSTALLATION

3.2.1. Do complete installation in accordance with CSA C22.1 except where specified otherwise.

3.2.2. Do overhead and underground systems in accordance with CAN/CSA-C22.3 No.1 except where specified otherwise.

3.3. NAMEPLATES AND LABELS

3.3.1. Ensure that manufacturer's registration plates are properly affixed to all apparatus showing the size, name of equipment, serial number, and all information usually provided, including voltage, cycle, phase and the name and address of the manufacturer.

3.3.2. Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.3.3. Do not paint over registration plates or approval labels. Leave openings through insulation for viewing the plates. Contractor's or sub-contractor's nameplate not acceptable.

3.4. CONDUIT AND CABLE INSTALLATION

3.4.1. Install conduit and sleeves prior to pouring of concrete.

.1 Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50 mm.

3.4.2. If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

3.4.3. Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

3.5. LOCATION OF OUTLETS

3.5.1. Locate outlets in accordance with Section 26 05 32.

3.5.2. Do not install outlets back-to-back in wall; allow minimum 150mm horizontal clearance between boxes.

3.5.3. Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm, and information is given before installation.

3.5.4. Locate light switches on latch side of doors.

.1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.6. MOUNTING HEIGHTS

3.6.1. Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

3.6.2. If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

3.6.3. Install electrical equipment at following heights unless indicated otherwise.

.1 Local switches: 1200mm.

.2 Wall receptacles:

.1 General: 400mm.

.2 Above top of continuous baseboard heater: 200mm.

.3 Above top of counters or counter splash backs: 175mm.

.4 In mechanical rooms: 1400mm.

.3 Panelboards: 2000 mm to top of panel

.4 Telephone and interphone outlets: 400mm.

.5 Wall mounted telephone and interphone outlets: 1200mm.

.6 Fire alarm stations: 1200mm.

.7 Fire alarm bells: 2300 mm.

.8 Television outlets: 400mm.

.9 Wall mounted speakers: 2100 mm.

.10 Clocks: 2100mm.

.11 Door bell pushbuttons: 1200 mm.

.12 Handicap pushbuttons: 1050 mm.

.13 Wall mounted Exit Signs

.1 For 2400 mm to 2500 mm ceiling heights: 2100 mm.

.2 For all ceilings heights greater than 2500 mm: 2400 mm.

.14 Wall mounted Battery Packs and Emergency Heads

.1 For 2400 mm to 2500 mm ceiling heights: 2100 mm.

.2 For all ceilings heights greater than 2500 mm: 2400 mm.

.15 Wall mounted occupancy sensors: 1200 mm.

.16 Wall mounted visible signal devices: entire lens shall be no less than 2000 mm and no more than 2400 mm.

.17 Top of remote annunciator and passive graphic panels shall be no more than 1800mm above finished floor.

.18 Wall mounted emergency telephone (Fireman's Handset): 1350 to 1500mm.

3.7. CO-ORDINATION OF PROTECTIVE DEVICES

3.7.1. Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

3.8. FIELD QUALITY CONTROL

3.8.1. Load Balance:

.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.3 Provide upon completion of work, load balance report as directed in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS, phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.

3.8.2. Conduct following tests in accordance with Section 01 45 00.

.1 Power generation and distribution system including phasing, voltage, grounding and load balancing.

.2 Circuits originating from branch distribution panels.

.3 Lighting and its control.

.4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

.5 Systems: fire alarm and communications where applicable.

.6 Insulation resistance testing:

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

.3 Check resistance to ground before energizing.

3.8.3. Carry out tests in presence of Departmental Representative.

3.8.4. Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

3.8.5. Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.2 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.

3.9. SYSTEM STARTUP

3.9.1. Instruct operating personnel and Departmental Representative in operation, care and maintenance of systems, system equipment and components.

3.9.2. Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

3.9.3. Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

3.10. CLEANING

3.10.1. Progress Cleaning: clean in accordance with Section 01 74 11.

3.10.2. Leave Work area clean at end of each day.

3.10.3. Clean all electrical equipment that has been exposed to construction dust and dirt.

3.10.4. Contractor to clean all electrical equipment, inside and out, prior to turn over to Owner. Equipment is subject to review by Engineer’s Representative and/or Owner.

3.10.5. Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

3.10.6. Contractor is responsible to remove their own waste from the site. All re-usable materials shall be recycled.

PART 1 - GENERAL

1.1 RE WORK INCLUDED

.1 Section 26 05 01.00 .

1.2 REFERENCE STANDARDS

.1 CSA International

.1 CAN/CSA-C22.2 No.18-latest edition, Outlet Boxes, Conduit Boxes and Fittings.

.2 CAN/CSA-C22.2 No.65-latest edition, Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).

.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)

.1 EEMAC 1Y-2-1961, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

.3 National Electrical Manufacturers Association (NEMA)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for wire and box connectors and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00.

.2 Operation and Maintenance Data: submit operation and maintenance data for wire and box connectors for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Pressure type wire connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors as required.

.2 Fixture type splicing connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.

.3 Bushing stud connectors: to EEMAC 1Y-2 and NEMA to consist of:

.1 Connector body and stud clamp for bar or copper.

.2 Clamp for stranded or round copper bar or conductors.

.3 Clamp for conductors.

.4 Stud clamp bolts.

.5 Bolts for copper bar.

.6 Sized for bars as indicated.

.4 Clamps or connectors for TECK cable, mineral insulated cable, flexible conduit, non-metallic sheathed cable and armoured cable, as required to: CAN/CSA-C22.2 No.18.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wire and box connectors installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Departmental Representative.

.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

.1 Remove insulation carefully from ends of conductors cables and:

.1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.

.2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CAN/CSA-C22.2 No.65.

.3 Install fixture type connectors and tighten to CAN/CSA-C22.2 No.65. Replace insulating cap.

.4 Install bushing stud connectors in accordance with NEMA or EEMAC 1Y-2.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

PART 1 - GENERAL

1.1 WORK INCLUDED

.1 Section 26 05 01.00 .

1.2 REFERENCE STANDARDS

.1 CSA C22.2 No.0.3, Test Methods for Electrical Wires and Cables, latest edition.

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

.3 CSA-C22.2 No. 51, Armoured Cables, latest edition.

.4 CSA C22.2 No. 75, Thermoplastic-Insulated Wires and Cables, latest edition.

.5 CSA-C22.2 No. 96, Portable Power Cables, latest edition.

.6 CSA-C22.2 No. 123, Metal Sheathed Cables, latest edition.

.7 CSA-C22.2 No. 124, Mineral-Insulated Cable, latest edition.

.8 CSA-C22.2 No. 131, Type TECK 90 Cable, latest edition.

.9 CSA-C22.2 No. 174, Cables and Cable Glands for Use in Hazardous Locations, latest edition.

.10 CAN/ULC S139, Standard Method of Fire Test for Evaluation of Integrity of Electrical Power, Data, and Optical Fibre Cables, latest edition.

.11 UL 2196, Standard for Tests for Fire Resistive Cables, latest edition.

.12 ASTM B800 - Standard Specification for 8000 Series Aluminium Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers, latest edition.

1.3 PRODUCT DATA

.1 Provide product data in accordance with Section 01 33 00-Submittal Procedures.

PART 2 - PRODUCTS

2.1 BUILDING WIRES

.1 Conductors: stranded for 10AWG and larger. Minimum size: 12AWG for lighting and power and no smaller than No. 16 AWG for control wiring.

.2 Copper conductors: size as indicated, with 600V for 120V systems and 1000V for 600V systems insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE and RWU90 XLPE where required, Jacketed.

.3 Copper conductors: size as indicated, with thermoplastic insulation type TWH or TWU rated at 600 V.

.4 Neutral supported cable: 3, 1, and 2phase insulated conductors of Copper and one neutral conductor of Copper steel reinforced, size

as indicated. Type: S90 Insulation: Type NSF-2 flame retardant rated 600 V.

2.2 TECK 90 CABLE

.1 Cable: in accordance with Section 26 05 00.

.2 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as indicated.

.3 Insulation:

.1 Ethylene propylene rubber EP.

.2 Cross-linked polyethylene XLPE.

.3 Rating: 600V for 120V systems and 1000V for 600V systems.

.4 Inner jacket: polyvinyl chloride material.

.5 Armour: interlocking aluminum.

.6 Overall covering: thermoplastic polyvinyl chloride, compliant to applicable Building Code classification for this project.

.7 Fastenings:

.1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two or more cables.

.3 Threaded rods: 6 mm diameter to support suspended channels.

.8 Connectors:

.1 Watertight, approved for TECK cable. Explosion proof where installed in explosion proof areas noted on the drawings.

2.3 MINERAL-INSULATED CABLES

.1 Conductors: solid bare soft-annealed copper, size as indicated.

.2 Insulation: compressed powdered magnesium oxide or silicon dioxide to form compact homogeneous mass throughout entire length of cable.

.3 Outer covering: annealed seamless copper sheath, Type M1 rated 600 V, 250 degrees C.

.4 Overall jacket: PVC applied over the sheath and compliant to applicable Building Code classification for this project.

.5 Two hour fire rating.

.6 Connectors: explosion-proof where required; watertight approved for MI cable.

.7 Termination kits: field installed approved for MI cable

2.4 ARMOURED CABLES

.1 Conductors: insulated, copper, size as indicated.

.2 Type: AC90.

.3 Armour: interlocking type fabricated from aluminum strip.

.4 Type: ACWU90 jacket over armour and compliant to applicable Building Code classification for wet locations.

.5 Connectors: anti short connectors.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00.

.2 Perform with local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

3.2 GENERAL CABLE INSTALLATION

.1 Install cable in trenches in accordance with Section 33 71 73.02.

.2 Lay cable in cable trays in accordance with Section 26 05 36.

.3 Terminate cables in accordance with Section 26 05 20.

.4 Cable Colour Coding: to Section 26 05 00.

.5 Conductor length for parallel feeders to be identical.

.6 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.

.7 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.

.8 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.

.9 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

.10 Provide a minimum of one bonding conductor for each three ungrounded conductors on all conduit and cable runs. Size bonding conductor to applicable tables of the Canadian Electrical Code. Provide separate bonding conductors for each ground fault circuit interrupter circuits. All bonding conductors to be copper and insulated with a green coloured insulation.

.11 All equipment, junction boxes, pull boxes, liquid tight flex, etc. to be bonded to ground through bonding conductors.

.12 Provide separate neutral conductor for each 120 volt circuit for all circuits feeding receptacles and power outlets.

.13 Provide a variable frequency drive (VFD) cable from each VFD unit to each motor. Wiring to be installed in accordance with the VFD and motor manufacturer instructions.

.14 All cable terminations to be compression type fittings for wire sizes greater than #8 AWG. All compression type fittings to be two-hole long barrel type with inspection / viewing window. Where mechanical screw type lugs are allowed by the Engineer’s Representative, they will be suitable for quantity of parallel runs of wire that are to be terminated under.

.15 Armoured Cable Type AC90 (BX) may only be used for individual drops from slab mounted junction box to recessed mounted light fixtures or where noted on the drawings where wiring is required to be installed within an existing wall. The maximum allowable distance of armoured cable is 3m. Contractor to receive written approval from the Engineer's Representative to run armoured cable further than 3m from junction box. Daisy changing of fixtures is only acceptable in dry wall ceilings. Wiring in conduit is to be brought to a junction box to allow for the transition to armoured cable. Armoured cable is not to be installed directly into electrical panels or run in walls for receptacles.

.16 Branch circuit wiring to be upsized as follows to address voltage drop when:

.17 The entire length of the circuit wiring exceeds 25 m – branch wiring to be a minimum of No. 10 AWG.

.18 The entire length of the circuit wiring exceeds 40 m – branch wiring to be a minimum of No. 8 AWG.

.19 The entire length of the circuit wiring exceeds 60 m – branch wiring to be a minimum of No. 6 AWG.

.20 Wire Splicing

.21 Splice up to and including No. 6 AWG with nylon insulated expandable spring type connectors.

.22 Splice larger conductors using compression type connectors wrapped in PVC insulation rated at the respective voltage.

3.3 INSTALLATION OF BUILDING WIRES

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 26 05 34.

.2 In underground ducts in accordance with Section 33 71 19.

.3 In surface and lighting fixture raceways in accordance with Section 26 05 33.

.4 All conductors are to be colour coded. Provide colour tape at all terminations to identify all conductors in each run.

3.4 INSTALLATION OF TECK90 CABLE (0 -1000 V)

.1 Group cables wherever possible on channels.

.2 Install cable exposed, securely supported by staples and straps.

.3 Terminate cables in accordance with manufacturer's instructions.

.4 Fastenings:

.5 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.

.6 Channel type supports for two or more cables.

.7 Galvanized threaded rods: 6 mm dia. minimum to support suspended channels.

.8 Connectors:

.9 Watertight, approved for respective cables.

.10 For single conductor cables, ground the sheath at the upstream (source) panel and provide insulated fibre plate at the load end, so as to prevent circulating sheath currents.

3.5 INSTALLATION OF MINERAL-INSULATED CABLES

.1 Install cable exposed, securely supported by straps.

.2 Support 2 hour fire rated cables at 1 m intervals.

.3 Make cable terminations by using factory-made kits.

.4 Cable terminations: use thermoplastic sleeving over bare conductors.

.5 Where cables are buried in cast concrete or masonry, sleeve for exit and entry of cables.

.6 Do not splice cables unless indicated.

.7 Handling:

.1 Cable shall be uncoiled by rolling or rotating supply reel. Do not pull from coil periphery or centre.

.8 Bending:

.1 Not less than six (6) times the cable diameter for cable not more than 250 kcmil.

.2 Not less than twelve (12) times the cable diameter for cable diameter for cable more than 350 and 500 kcmil.

.9 Splicing:

.1 All fire rated splices shall be made in the factory. In the event of a field splice is necessary, it must be made in the field by manufacturer’s field technician.

.10 Terminations:

.1 Field made terminations shall be made with cable manufacturer’s termination kits only. Stripping tools, crimping and compression tools available from the manufacturer shall be used for proper cable termination.

.2 Connections to ferrous cabinets for single conductor cables shall incorporate brass plates. Installed per manufacturer’s drawing.

.3 At cable terminations use thermoplastic sleeving over bare conductors.

.11 Sheath induction reduction:

.1 When multi-phase circuits have paralleled single conductors, cables shall be run in groups having one of each phase in each group.

.2 Each set of paralleled conductors shall be separated by at least two single cable diameters.

.3 Exposed or Surface Installations:

.4 Cable shall be secured directly to fire rated building structure using:

.1 Straps: 13 mm wide x 38 mm long by 0.75 mm thick stainless steel or copper straps. Each strap shall contain two 5 mm holes for securing with 5 mm by minimum 44 mm long steel anchors.

.5 Support 2 hr fire rated cables at 1 m intervals.

.12 Wall or floor penetrations:

.1 Provide approved fire stopping of all penetrations.

.2 Neatly train and lace cable inside boxes, equipment, and panelboards.

.3 Where cables are buried in cast concrete or masonry, sleeve for entry of cables.

.4 When penetrating a fire rated wall or fire rated floor, the cable must extend a minimum of 305mm beyond the fire rated wall or fire rated floor. The 305mm dimension can be in any direction as 305mm of cable length is required to allow for proper heat dissipation such that cable terminations do not overheat.

3.6 INSTALLATION OF ARMOURED CABLES

.1 Group cables wherever possible on channels.

3.7 FIELD QUALITY CONTROL

.1 Prior to energizing wires/cables, measure insulation resistance of each wire/cable. Ensure readings are acceptable per installation recommendations. Tabulate and submit for approval as a submittal.

.2 All Wires and Cables to be tested on site as defined in Section 26 08 01.00 . Contractor to oversee all testing and correct any deficiencies noted.

3.8 INSTALLATION OF CONTROL CABLES

.1 Install control cables in conduit.

.2 Ground control cable shield.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 26 05 01

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:

.3 Conduit and equipment provided under the Electrical division shall be complete with all necessary supports and hangers required for a safe and workmanlike installation.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00- Common Product Requirements.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

PART 2 - PRODUCTS

2.1 SUPPORT CHANNELS

.1 U shape, size 41 x 41mm, 2.5mm thick, set in poured concrete walls and ceilings, suspended or surface mounted.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Secure equipment to masonry, tile and plaster surfaces with lead anchors.

.2 Secure equipment to poured concrete with expandable inserts.

.3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.

.4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.

.5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.6 Fasten exposed conduit or cables to building construction or support system using straps.

.1 One-hole steel straps to secure surface conduits and cables 53 mm and smaller.

.2 Two-hole steel straps for conduits and cables larger than 53 mm.

.3 Beam clamps to secure conduit to exposed steel work.

.7 Suspended support systems.

.1 Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips.

.2 Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.

.8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.10 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.11 Do not use supports or equipment installed for other trades for conduit or cable support.

.12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

3.2 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.

1.1 GENERAL

1.2 WORK INCLUDED

.1 Section 26 05 01.00 .

.2 Section 26 05 63.00 .

1.3 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA International)

.1 CSA C22.1-latest edition, Canadian Electrical Code, Part 1, latest edition.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00-.

.2 Product Data:

.1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Provide shop drawings: in accordance with Section 01 33 00.

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.

PART 2 - PRODUCTS

2.1 SPLITTERS

.1 Construction: sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.

.2 Terminations: main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

.3 Spare Terminals: minimum three spare terminals or lugs on each connection or lug block sized less than 400 A.

2.2 JUNCTION AND PULL BOXES

.1 Construction: welded steel enclosure.

.2 Covers Flush Mounted: 25 mm minimum extension all around.

.3 Covers Surface Mounted: screw-on flat covers.

2.3 CABINETS

.1 Construction: welded sheet steel hinged door, handle, lock 2 keys, latch and catch

.2 Type E Empty: surface return flange mounting.

.3 Type T Terminal: surface return flange mounting containing sheet steel, 19 mm, fire resistant plywood backboard.

PART 3 - EXECUTION

3.1 SPLITTER INSTALLATION

.1 Mount plumb, true and square to building lines.

.2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

.1 Install pull boxes in inconspicuous but accessible locations.

.2 Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise.

.3 Install terminal block as indicated in Type T cabinets.

.4 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

3.3 IDENTIFICATION

.1 Equipment Identification: to Section 26 05 00.

.2 Identification Labels: size 2 indicating system name, voltage and phase.

PART 1 - GENERAL

1.1 WORK INCLUDED

.1 Section 26 05 01.00 .

1.2 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA International)

.1 CSA C22.1-latest edition, Canadian Electrical Code, Part 1,

.2 National Building Code of Canada, latest edition.

.3 CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Submit samples for floor box in accordance with Section 01 33 00.

PART 2 - PRODUCTS

2.1 OUTLET AND CONDUIT BOXES GENERAL

.1 Size boxes in accordance with CSA C22.1.

.2 102mm square or larger outlet boxes as required.

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 347 V outlet boxes for 347 V switching devices.

.6 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 GALVANIZED STEEL OUTLET BOXES

.1 One-piece electro-galvanized construction.

.2 Single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

.3 Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48mm.

.4 102mm square or octagonal outlet boxes for lighting fixture outlets.

.5 Extension and plaster rings for flush mounting devices in finished tile or plaster walls.

2.3 MASONRY BOXES

.1 Electro-galvanized steel masonry and multi single gang boxes for devices flush mounted in exposed block walls.

2.4 CONCRETE BOXES

.1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 FLOOR BOXES

.1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brushed aluminum or brass faceplate. Device mounting plate to accommodate short or long ear single or duplex receptacles. Minimum depth: 73 mm for receptacles and communication outlets.

.2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 21 and 27 mm conduit. Minimum size: 73 mm deep.

2.6 CONDUIT BOXES

.1 Cast FS or FD boxes with factory-threaded hubs and mounting feet for surface wiring of devices.

2.7 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE

.1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm with two double clamps to take non-metallic sheathed cables.

2.8 FITTINGS - GENERAL

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of debris.

.3 Conduit outlet bodies for conduit up to 35mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

2.9 SERVICE FITTINGS

.1 'High tension' receptacle fitting made of 2 piece die-cast aluminum with brushed aluminum housing finish for 1 duplex receptacles. Bottom plate with two knockouts for centered or offset installation. 12 x 102 mm extension piece as indicated.

.2 Pedestal type 'low tension' fitting made of 2 piece die cast aluminum with brushed aluminum housing finish to accommodate two amphenol jack connectors.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Support boxes independently of connecting conduits.

.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

.3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.

.4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.

.5 Vacuum clean interior of outlet boxes before installation of wiring devices.

.6 Identify systems for outlet boxes as required.

.7 Non-combustible electrical outlet boxes that penetrate a fire separation or a membrane forming part of an assembly required to have a fire-resistance rating, do not require fire stops provided,

.1 they do not exceed:

.1 100 cm2 each in area, AND

.2 an aggregate area of 650 cm2 in any 9.3 m2 of surface area, AND

.3 the annular space between the membrane and the box does not exceed 3 mm.

.8 Where the conditions of clause 3.1.5 are not met, provide fire stops for the outlet boxes.

.9 Opposing outlets on non-fire rated partition walls shall have a minimum 150 mm horizontal separation. Outlets shall not be mounted back to back.

.10 Conform to the fire stopping requirements of the building code: unless provided with a fire stop in accordance with CAN/ULC-S115, “Fire Tests of Fire Stop Systems”, electrical outlet boxes on opposite sides of a vertical fire separation required to have a fire-resistance rating shall be separated by a horizontal distance of not less than 600 mm, or be installed in adjacent stud cavities.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 26 05 01.00

.2 Section 26 05 31.00

.3 Section 26 05 32.00

1.2 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA International) CAN/CSA C22.2 No. 18-latest edition, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.

.1 CSA C22.2 No. 45-latest edition, Rigid Metal Conduit.

.2 CSA C22.2 No. 56-latest edition, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.

.3 CSA C22.2 No. 83-latest edition, Electrical Metallic Tubing.

.4 CSA C22.2 No. 211.2-latest edition, Rigid PVC (Unplasticized) Conduit.

.5 CAN/CSA C22.2 No. 227.3-latest edition, Nonmetallic Mechanical Protection Tubing (NMPT), A National Standard of Canada.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00.

.2 Product data: submit manufacturer's printed product literature, specifications and datasheets.

.1 Submit cable manufacturing data.

.3 Quality assurance submittals:

.1 Test reports: submit certified test reports.

.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.

PART 2 - PRODUCTS

2.1 CABLES AND REELS

.1 Provide cables on reels or coils.

.1 Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.

.2 Each coil or reel of cable to contain only one continuous cable without splices.

.3 Identify cables for exclusively dc applications.

.4 Reel and mark shielded cables rated 2,001 volts and above.

2.2 CONDUITS

.1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel threaded.

.2 Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside.

.3 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.

.4 Rigid pvc conduit: to CSA C22.2 No. 211.2.

.5 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal or steel.

2.3 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits NPS 2 and smaller. Two hole steel straps for conduits larger than NPS 2.

.2 Beam clamps to secure conduits to exposed steel work.

.3 Channel type supports for two or more conduits at 1 m oc.

.4 Hot dipped galvanized threaded rods, 6 mm dia. minimum, to support suspended channels.

2.4 CONDUIT FITTINGS

.1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.

.2 Factory "ells" where 90 bends are required for 1” and larger conduits when a hydraulic bender is not used.

.3 Connectors, and couplings for EMT conduit are to be set-screw steel type. Below the level of suspended ceilings, in a sprinklered environment, provide watertight fittings and “O” rings on all conduit runs and when conduit is terminated at any piece of electrical equipment.

.4 Provide plastic bushings for all connectors, rigid nipples and rigid conduit 32mm or larger.

2.5 EXPANSION FITTINGS FOR RIGID CONDUIT

.1 Weatherproof expansion fittings with internal bonding assembly suitable for 200 mm linear expansion.

.2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.

.3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.6 FISH CORD

.1 Fish cord to be made of polypropylene.

PART 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 datasheets.

3.2 INSTALLATION

.1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.2 Conceal conduits except in mechanical and electrical service rooms or in unfinished areas. Conduits to have their own support system and are to be supported independently of the ceiling grid or ceiling support system.

.3 Where vertically run conduit passes through a slab, Contractor to provide a 100mm high concrete pad with the pad extending 100mm on all sides of the conduit.

.4 Use electrical metallic tubing (EMT) conduit except where specified otherwise.

.5 Use epoxy coated conduit in corrosive areas.

.6 Use rigid galvanized steel threaded conduit where conduit is subject to mechanical injury.

.7 Use rigid PVC conduit underground or in corrosive areas and where indicated.

.8 Use flexible metal conduit for connection to motors or vibrating equipment in dry areas, connection to recessed incandescent fixtures without a prewired outlet box, connection to surface or recessed fluorescent fixtures and work in movable metal partitions.

.9 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations. Use only liquid tight fittings when using liquid tight flexible metal conduit. Liquid tight flexible metal conduit to have a jacket with an FT6 rating when used in plenums otherwise provide a minimum FT4 rating.

.10 Use explosion proof flexible connection for connection to explosion proof motors.

.11 Install conduit sealing fittings in hazardous areas. Fill with compound.

.12 Minimum conduit size for lighting and power circuits: NPS 21mm, unless otherwise noted on the drawings.

.13 Install EMT conduit from a raised floor branch circuit panel to outlet boxes located in sub floor.

.14 Install EMT conduit from a raised floor branch circuit panel to junction box in sub-floor. Run flexible metal conduit from junction box to outlet boxes for equipment connections in sub-floor.

.15 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.16 Mechanically bend steel conduit over 19 mm dia.

.17 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.18 Install fish cord in empty conduits.

.19 Run two 27mm spare conduits up to ceiling space and two 27mm spare conduits down to sub-floor space from each flush panel. Terminate these conduits in 152 x 152 x 102 mm junction boxes or in case of an exposed concrete slab, terminate each conduit in flush concrete or surface type box.

.20 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.

.21 Dry conduits out before installing wire.

.22 All cutting and patching of masonry/concrete floors, walls, and roof for electrical services shall be by this Division. Obtain approval from the Landlord and/or structural Engineer's Representative before cutting any structural walls or floors. Cutting and drilling shall only be at times allowed by the Landlord. Check and verify the location of existing mechanical and electrical services in walls and below the floor slab in all areas requiring core drilling and cutting. Protect all tenant areas where core drilling occurs. Carefully chip top and bottom of slab to expose rebar to minimize cutting of rebar when core drilling. Provide x-ray study before drilling or cutting where required by the Landlord and/or structural Engineer's Representative.

.23 Provide sleeves for all new conduit passing through floor and roof slabs, beams, concrete walls and slab to slab partitions, etc.

.24 Where cables and conduits pass through partitions and through floors that are not fire rated, provide an air-tight seal around the cables and conduits.

.25 Where cables and conduits pass through floors and fire rated walls, pack space between conduit (or cable) and sleeve with an approved fire stop as specified in Section 26 05 01.00 .

.26 Prior to installation of any wire or cable in the ducts, pull through each duct a flexible mandrel not less than 300 mm long and size for the internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging ducts where concrete has not set completely. Notify the engineer's representative no less than 48 hours prior to the event, so that the engineer's representative may witness.

3.3 SURFACE CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.

.3 Run conduits in flanged portion of structural steel.

.4 Group conduits wherever possible on suspended or surface mounted channels.

.5 Do not pass conduits through structural members, except as indicated.

.6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

.7 Conduits must not be used to support other conduits.

3.4 CONCEALED CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Do not install horizontal runs in masonry walls.

.3 Do not install conduits in terrazzo or concrete toppings.

3.5 CONDUITS IN CAST-IN-PLACE CONCRETE

.1 Locate to suit reinforcing steel.

.1 Install in centre one third of slab.

.2 Protect conduits from damage where they stub out of concrete.

.3 Install sleeves where conduits pass through slab or wall.

.4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed.

.1 Use cold mastic between sleeve and conduit.

.5 Conduits in slabs: minimum slab thickness 4 times conduit diameter.

.6 Encase conduits completely in concrete with minimum 25 mm concrete cover.

.7 Organize conduits in slab to minimize cross-overs.

3.6 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

.1 Run conduits 25 mm and larger below slab and encased in 75 mm concrete envelope. Provide 50 mm of sand over concrete envelope below floor slab.

3.7 CONDUITS UNDERGROUND

.1 Slope conduits to provide drainage.

.2 For all non-PVC conduits run underground, provide waterproof joints with heavy coat of bituminous paint.

PART 1 - GENERAL

1.1 SUMMARY

.1 The work covered in this section is subject to the requirements in the General Conditions of the Specifications. Contractor shall coordinate the work in this section with the trades covered in other sections of the specification to provide a complete and operable system.

.2 Extent of lighting control system work is indicated by drawings and by the requirements of this section. It is the intent of this section to provide an integrated, energy saving lighting control system including Lighting Control Panels, Occupancy Sensors, and Daylighting Controls (if applicable) from a single supplier. Contractor is responsible for confirming that the panels and sensors interoperate as a single system.

.3 Low voltage control system is to be designed to provide remote switching of lighting loads by use of:

.1 Low voltage momentary contact switches.

.2 Low voltage relays.

.3 Control transformers.

.4 Low voltage rectifiers.

.5 Manual and automatic program control.

1.2 REFERENCE STANDARDS

.1 N/A

1.3 ACTION AND INFORMATIONAL 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 in accordance with Section 01 33 00-.

.3 Closeout Submittals:

.1 Submit maintenance data in accordance with Section 01 78 00.

.4 Quality assurance submittals: submit following in accordance with Section 01 33 00.

.1 Test reports:

.1 Submit certified test reports indicating compliance with specifications for specified performance characteristics and physical properties.

.2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Control system: by one manufacturer and assembled from compatible components.

2.2 LIGHTING CONTROL PANELS

.1 Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:

.1 Enclosure/Tub shall be NEMA 2 sprinkler proof, sized to accept an interior with 1 - 8 relays, 1 - 24 relays and 6 four-pole contactors, or 1 - 48 relays and 6 four-pole contactors.

.2 Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.

.3 Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:

.1 Removable, plug-in terminal blocks with screwless connections for all low voltage terminations.

.2 Individual terminal block, override pushbutton, and LED status light for each relay.

.3 Direct wired switch inputs associated with each relay and group channel shall support two- or three-wire, momentary or maintained contact switches or 24VDC input from occupancy sensors.

.4 Automatic support for occupancy sensor sequence of operation. Direct wired low voltage inputs automatically reconfigure when connected to an occupancy sensor head. Occupancy sensor shall switch lighting on and off during unoccupied periods but shall not turn lighting off during scheduled occupancy periods.

.5 Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches and digital occupancy sensors.

.6 Isolated contacts within each relay shall provide true relay state to the electronics. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems.

.7 Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.

.8 Group, channel, and pattern control of relays shall be provided through a simple keypad interface within the panel. Any group of relays can be associated with a channel for direct on/off control or pattern (scene) control via a simple programming sequence using the relay and channel override pushbuttons and LED displays.

.9 Relay group status for each channel shall be provided through bi-color operation of the LED indicators. Solid red indicates that all relays in the group are on, solid green indicates that the group is in a mixed state, and blinking green indicates that the relays have blink warned and are currently timing out.

.10 Each relay and channel terminal block shall provide a 24V pilot light signal. It shall be possible to configure the system for support for any Class 2 pilot light voltage with the use of an auxiliary power supply.

.11 Single-pole latching relays with modular plug-in design.

2.3 LOW VOLTAGE RELAYS

.1 Electrically operated by momentary impulse, mechanically latched until de-activated.

.2 Operating voltage: 24 V, ac.

.3 Auxiliary contacts for pilot light.

.4 Coloured pre-stripped leads.

.5 Relays shall provide the following ratings and features:

.1 20 amp ballast at 347V

.2 20 amp tungsten at 120V

.3 20 amp resistive at 347V

.4 1.5 HP motor at 120V

.5 Minimum 14,000 amp short circuit current rating (SCCR) at 347V

.6 Individually replaceable, 13 mm KO mounting with removable Class 2 wire harness.

.7 Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.

.8 Dual line and load terminals each support two #12 - #10 solid or stranded conductors.

.9 Tested to 300,000 mechanical on/off cycles.

.10 Isolated low voltage contacts provide for true relay status feedback and pilot light indication.

2.4 MICROPROCESSOR CONTROLLER

.1 The lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field

devices. Digital communications shall be RS485 master/slave token passing-based using the BACnet protocol or equivalent.

.2 The panel shall have provision for an individual BACnet device ID. The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.

.3 The panel shall support MS/TP MAC addresses in the range of 0 - 127 and baud rates of 9600k, 38400k and 76800k bits per second.

.4 Lighting control relays shall be controllable as binary output objects in the instance range of 1 - 48. The state of each relay shall be readable and writable by the BAS via the object present value property.

.5 Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 - 48.

.6 The eight channel groups associated with the panel shall be represented by binary value objects in the instance range of 1 - 8. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the occupied mode. Commanding 0 or NULL shall put the relays into the unoccupied mode.

.7 Setup and commissioning of the panel shall not require manufacturer-specific software or configuration tools of any kind. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the on-board LCD display and user keypad. Provide BACnet objects for panel setup and control as follows:

.1 Binary output objects in the instance range of 1 - 48 (one per relay) for on/off control of relays.

.2 Binary value objects in the instance range of 1 - 8 (one per channel) for normal hours/after-hours schedule control.

.3 Binary input objects in the instance range of 1 - 48 (one per relay) for reading true on/off state of the relays.

.4 Analog value objects in the instance range of 1 - 48 (one per relay) shall assign relays to channel groups in the range of 1 - 8.

.5 Binary value objects in the instance range of 101 - 108 (one per channel group) shall assign the channel to follow auto-on or manual-on mode when transitioning to occupied.

.6 Analog value objects in the instance range of 101 - 108 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.

.7 Analog value objects in the instance range of 211 - 208 (one per channel) shall assign an after-hours time delay value to the channel in the range of 1 - 240 minutes.

.8 Multi-state value objects in the instance range of 1 - 8 (one per channel) shall provide the state of the relays assigned to the channel. Valid states shall be ALL ON, MIXED, BLINK, and ALL OFF.

.8 The description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.

.9 The BO and BV objects shall support BACnet priority array with a relinquish default of off and after hours respectively.

.10 The lighting control panel shall support schedule, group, and photocell control functions via the network as configured in the Manufacturer's Lighting Control Software or building automation system. The lighting control panel shall be fully compatible with building automation systems that are BACnet compliant.

2.5 USER INTERFACE

.1 Each lighting control panel shall be supplied with an integral user interface consisting of a keypad and associated OLED display screen. The user interface shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. The user interface shall have the following functions as a minimum:

.2 Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.

.3 Enter meaningful names for the panel, relays, and channels.

.4 View normal hours/after-hours status of each channel.

.5 Override the normal hours/after-hours mode for each channel.

.6 View the 16 priority array slots for each channel and relay.

.7 Program the schedule response for each channel as:

.1 Automatic-on or manual-on.

.2 Enable/disable blink warn.

.3 Enter override time delay as 0 (none) to 240 minutes.

2.6 CONTROL TRANSFORMER

.1 Power supply to lighting control panels shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.

2.7 OCCUPANCY SENSORS

.1 Provide digital occupancy sensors to control relays in locations as shown on the plans. Sensors shall be either passive infrared, ultrasonic, or dual technology as indicated. Sensors shall be either ceiling or wall mounded and connect to the panel using Cat 6 cable with RJ-45 terminations or manufacturer specific wiring. Digital occupancy sensors shall have the following features:

.1 Setup and calibration shall be digital and precisely repeatable from sensor to sensor.

.2 User interface with pushbuttons and illuminated LCD screen for setup and calibration.

.3 Ladder-free setup and calibration

.4 Sensitivity, 0 - 100% in 10% increments.

.5 Time delay, 1 - 30 minutes in 1 minute increments.

.6 Test mode with five-second time delay for simplified walk testing.

.7 BAS tie-in.

2.8 RECTIFIER

.1 Silicon type: 24 V, ac, 60 Hz input, 7.5 A continuous duty, 20 A intermittent duty output.

2.9 MANUAL CONTROL SWITCHES

.1 Provide digital wall switches with 1, 2, 3, 4, or 8 buttons, in the colors indicated on the plans. Switches shall connect to the panel via standard Cat 6 cable with RJ-45 terminations or manufacturer specific wiring. Digital wall switches shall have the following features:

.1 Available colors: white, ivory, light almond, grey or black.

.2 Single gang device shall fit standard decorator opening and use standard wall plates.

.3 LED indicator on each button for status and locator function.

.4 Concealed configuration button with LED indicator for binding buttons to relays, no software or computer shall be required.

.5 Selectable function mode per button shall be momentary toggle (on/off), on only, or off only.

.6 Removable button assembly for field color change or substitution of engraved buttons.

.7 Two RJ-45 ports or manufacturer specific ports for connection to panel or other switches and/or occupancy sensors.

.8 Open topology digital network via Cat 6 wire or manufacturer specific wiring.

2.10 LIGHTING PROGRAMMING AND CONTROL INTERFACE

.1 The lighting control system manager shall be a compact controller capable of hosting the schedule, photocell, and group relay control functions for a network of up to 96 lighting control panels. The lighting control system manager shall provide the following features:

.1 Provision for 1 to 3 separate network segments to facilitate efficient network wire routing.

.2 Web browser-based user interface.

.3 User interface accessible from most smart phone browsers when Internet connected.

.4 Login security access control restricting some users to view-only or other limited operations.

.5 Automatic discovery of the lighting control panels.

.6 Familiar navigation-tree-based browsing to individual lighting control panels.

.7 View/override current status of channels and relays.

.8 Assign relays to channels.

.9 Set channel operating parameters:

.1 Automatic-on or manual-on operation.

.2 Enable/disable blink warn.

.3 Override duration time, 0 (none) to 240 minutes.

.10 Create and run schedules:

.1 Normal hours/after-hours schedules for channels.

.2 On/off schedules for relays.

.3 Support for a minimum of 100 unique schedules, each with up to four time events per day.

.4 Support annual schedules, holiday schedules and unique date-bound schedules.

.11 Ethernet connectivity for user access via direct-wired connection, LAN/WAN, or Internet connection.

.12 BACnet IP connectivity for connection to building automation systems.

PART 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 Locate and install equipment in accordance with manufacturer's recommendations and as indicated.

3.3 SYSTEM START UP AND COMMISSIONING

.1 Manufacturer shall provide a factory authorized technician to confirm proper installation and operation of the lighting control panels, switches, and occupancy sensors.

.2 The technician shall provide training on the lighting control features of the system and shall verify that the lighting control system is capable of communicating with the building automation system.

.3 The system integrator or BAS vendor shall be responsible for all integration including the mapping of BACnet objects into the BAS logic, schedules and graphics.

3.4 TESTS

.1 Actuate control units in presence of Engineer’s Representative to demonstrate lighting circuits are controlled as designated.

.2 Demonstrate the operation of the system through the computer software and the BAS system.

3.5 TRAINING

.1 Provide four half days of training of the Owner and the Owner's maintenance staff on the operation and maintenance of the system.

.2 Training to be recorded for use by Owner in the future.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 26 05 01.00.

.2 Section 26 28 16.00.

1.2 REFERENCE STANDARDS

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for switchboards and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Submit maintenance materials in accordance with Section 01 78 00.

.2 Provide spare parts as recommended by manufacturer for maintenance period of 2 years minimum.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors in dry location off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect switchboards from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 SWITCHBOARD

.1 Ratings as identified on the drawings and/or schedules.

.2 Switchboard breakers to have a minimum short circuit current rating of 22kA at 600V. Fused sections to have a minimum short circuit current rating of 100kA at 600V. Switchboard busing to be rated at a minimum of 65kA.

.3 Enclosures to be dead-front, CSA Type 2 sprinkler proof enclosure, size as indicated.

.4 Hinged access panels with captive knurled thumb screws.

.5 Bus bars and main connections: copper.

.6 Bus from load terminals of main breaker via metering section to main lugs of distribution section.

.7 Identify phases with colour coding.

.8 Provide two hole long barrel compression lugs with inspection / viewing window for the main feeder terminations. Size as per the drawings.

.9 Breakers and/or fuse sections shall be bolt-on.

.10 Make provisions to extend the main bus to future cubicles on each end of the switchboard.

2.2 CIRCUIT BREAKERS

.1 Circuit breakers to be supplied as per Section 26 28 16.00.

.2 All breakers to be factory installed and tested.

2.3 FUSIBLE DISCONNECTS AND FUSES

.1 Fusible horsepower rated disconnect switch sized as indicated.

.2 Provision for padlocking in on-off position by three padlocks.

.3 Mechanically interlocked door to prevent opening when handle is in the ON position.

.4 Fuse: size as indicated, class J, current limiting in fuse holders without adapters.

.5 Quick-make, quick-break action.

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

2.4 GROUNDING

.1 Copper ground bus extending full width of cubicles and located at bottom.

.2 Provide two hole long barrel compression lugs with inspection / viewing window for the ground cable terminations. Size as per the drawings.

2.5 FINISHES

.1 Apply finishes in accordance with Section 26 05 01.00.

.2 Switchboard to be painted: baked grey enamel.

2.6 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification.

.2 Label all branch feeders with names as indicated on drawings.

2.7 FACTORY TESTING

.1 Testing shall be witnessed by the Technical Service Start-Up Services Contractor.

.2 Include in your bid for the complete cost of two people to attend the factory witness testing for the equipment. Cost to include but not limited to all travel, food and lodging costs.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Locate switchboard and secure in position. Install floor mounted switchboards on a 100 mm concrete housekeeping pad.

.2 Connect main incoming feeder to line terminals of main breaker, if applicable.

.3 Connect load terminals of distribution switches or breakers to feeders.

.4 Check factory made connections for mechanical security and electrical continuity.

.5 Check trip unit settings and fuse sizes against co-ordination study to ensure proper working and protection of components.

3.2 TESTING

.1 Contractor to review and test that all wiring has been connected as per the manufacturer drawings.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 26 05 01.00.

.2 Section 26 50 00.00.

.3 Section 26 05 21.00.

.4 Section 26 05 34.00.

1.2 REFERENCE STANDARDS

.1 CSA International

.1 CSA C22.2 No.141, Emergency Lighting Equipment.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for emergency lighting and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00.

.2 Operation and Maintenance Data: submit operation and maintenance data for emergency lighting for incorporation into manual.

1.5 WARRANTY

.1 For batteries, the warranty period shall be extended to 120 months, with a no-charge replacement during the first 5 years and a pro-rata charge on the second 5 years.

PART 2 - PRODUCTS

2.1 EQUIPMENT

.1 Supply voltage: 120 V, ac.

.2 Output voltage: 24 V dc.

.3 Operating time: 120 minutes, unless otherwise noted in schedules.

.4 Battery: 10 year sealed, valve regulated, lead calcium.

.5 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations. Recharges battery within 24 hours in accordance with CSA.

.6 Solid state transfer circuit.

.7 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.

.8 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.

.9 Lamp heads: integral on unit and remote as indicated, 345 horizontal and 180 vertical adjustment. Lamp type: MR16, wattage to be 50W unless noted otherwise on drawings or in the “Battery Unit Schedule” (i.e. 35W, 50W).

.10 Directional remote head lamps to have narrow beam spread distribution.

.11 Recessed remote head lamps to have flood beam spread distribution.

.12 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.

.13 Finish: Baked white enamel.

.14 Auxiliary equipment:

.1 Ammeter.
.2 Voltmeter.
.3 Test switch.
.4 Time delay relay.
.5 Battery disconnect device.
.6 ac input and dc output terminal blocks inside cabinet.
.7 Bracket.
.8 Cord and single twist-lock plug connection for ac.
.9 RFI suppressors.

2.2 WIRING OF REMOTE HEADS AND EXIT SIGNS

.1 Conduit: As per Section 26 05 34.00.

.2 Conductors: As per Section 26 05 21.00, sized as per manufacturer’s recommendation and compliant to the applicable electrical codes.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install unit equipment and remote mounted fixtures. Interconnect all heads with central battery pack.

.2 Direct heads to optimize illumination of egress pathways to minimum building code requirements.

.3 Connect exit lights to unit equipment.

.4 Contractor is to include the supply and installation of one additional head or an additional 5% of the total number of heads shown on the drawings, whichever is greater in the bid price. The installation is to include all wiring and conduit required to install the heads. If the heads are not installed during construction then the spare heads are to be turned over to the Owner at the end of the project.

3.2 TESTING AND COMMISSIONING

.1 Contractor shall commission and test the entire system and adjust as necessary.

.2 Trip breaker(s) feeding battery unit(s) to simulate power failure to building. Test the operation of each unit to document the duration of runtime. Testing shall be performed during non-daylight hours.

.3 Inform Engineer's Representative 10 days in advance prior to testing being performed in order for Engineer's Representative to make arrangements to witness testing of emergency lighting system.

.4 Provide Engineer's Representative with signed test report by Contractor that each unit successfully operated for the required duration of time.

.5 Re-test voltage of battery units 24 hours after initial testing to verify rated nominal voltage of unit. If battery unit has not recharged properly, replace unit and re-test as stated above at no additional cost to Owner.

3.3 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by emergency lighting installation.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 26 05 01.00.

1.2 REFERENCE STANDARDS

.1 CSA International

.1 CSA C22.2 No. 5-latest edition, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00- Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for circuit breakers and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Include time-current characteristic curves for breakers with ampacity of 400 A and over with interrupting capacity of 22,000 A symmetrical (RMS) and over at system voltage.

PART 2 - PRODUCTS

2.1 BREAKERS GENERAL

.1 Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 deg. C. ambient.

.2 Common-trip breakers: with single handle for multi-pole applications.

.3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

.4 Circuit breakers with interchangeable trips as indicated.

2.2 THERMAL MAGNETIC BREAKERS

.1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 MAGNETIC BREAKERS

.1 Moulded case circuit breakers to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

2.4 FUSED THERMAL MAGNETIC BREAKERS

.1 Fused thermal magnetic breakers with current limiting fuses internally mounted. Time current limiting characteristics of fuses coordinated with time current tripping characteristics of circuit breaker. Coordination to result in interruption by breaker of fault-level currents up to interrupting capacity of breaker. Fuses individually removable and interlocked with breaker. The removal of fuse cover, blowing of a fuse or removal of a fuse, shall trip the breaker.

2.5 SOLID STATE TRIP BREAKERS

.1 Moulded case circuit breaker to operate by means of a solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition and long time, short time, instantaneous tripping for phase and ground fault short circuit protection.

2.6 ACCESSORIES

.1 Include:

.1 shunt trip, when electrically operated or when indicated.

.2 auxiliary switches, when electrically operated or when indicated.

.3 motor-operated mechanism, when electrical operation indicated.

.4 on-off locking device.

.5 handle mechanism.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install circuit breakers as indicated.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 26 05 01.00.

.2 Section 26 05 21.00.

.3 Section 26 06 05.16.

1.2 REFERENCE STANDARDS

American National Standards Institute (ANSI)

.1 ANSI C82.1, Lamp Ballasts-Line Frequency Fluorescent Lamp Ballast.

.2 ANSI C82.4, Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps Multi Supply Type.

.2 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)

.1 ANSI/IEEE C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

.3 ASTM International Inc.

.1 ASTM F1137, Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.

.4 Canadian Standards Association (CSA International)

.5 ICES-005, Radio Frequency Lighting Devices.

.6 Underwriters' Laboratories of Canada (ULC)

1.3 SUBSTITUTION

.1 The lighting equipment for this project and specified herein has been carefully selected for its ability to meet the project’s luminous environment requirements. Manual and computer calculations have been performed to ensure that the lighting equipment that has been specified complies with established criteria. The Engineer’s Representative reserves the right not to accept any alternates or substitutions. If alternates or substitutions are entertained, then it is the responsibility of the Contractor/Supplier to provide all information required herein and detailed layouts and lighting calculations demonstrating that the performance of the alternate luminaire meets or exceeds the original lighting design while not consuming any additional energy. The Contractor/Supplier is responsible to ensure the light levels provided in the alternate submittal package will achieve the design light levels. Where the light levels are not achieved, the Contractor is responsible to replace the luminaire with a luminaire that will meet the required levels with no increase in energy use at no cost to the Owner. Rather than replacing the luminaires, the Engineer’s Representative may accept the installation of additional luminaires by the Contractor at no cost to the Owner in order to achieve the required light levels.

.2 Accompanying the request for a luminaire or lamp substitution, the contractor shall submit a complete lighting calculation

report with photometric modeling of the space showing light levels including average, maximum, minimum and max to min values.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00- Submittal Procedures.

.2 Submit a shop drawing for each luminaire specified, including lamp.

.3 Luminaire submittals are to consist of a physical description, manufacturer's specification sheets, dimensioned drawings, and complete photometric data from an independent test laboratory in the form of IES computer files of the equipment being submitted and hard copy of the photometric report. Coordinate ceiling types to ensure proper supports and luminaire framing.

.4 Lamp submittals are to consist of manufacturer's technical data with respective luminaire shop drawing. Submittal to include operating wattage, rated life, colour temperature, base type, lamp shape, CRI, voltage and mercury content.

.5 LED submittals are to consist of manufacturer's technical data for diodes and drivers with respective luminaire shop drawing. Submittal to include operating wattage, voltage, maximum distance from drivers, wiring diagrams and lumen output at time of delivery. LED Drivers must have a 50,000 hours warranty.

.6 Ballast submittals are to consist of manufacturer's technical data with respective luminaire shop drawing. Submittal to include operating wattage, input voltage, ballast efficiency, maximum distance for remote ballasts, power factor, and operating temperature.

.7 Where samples are indicated on the luminaire schedule, they are to be provided with shop drawings at time of shop drawing submittals unless noted otherwise.

1.5 FIXED PER UNIT COST LUMINAIRES

.1 Listed in the luminaire schedule are a fixed per unit cost for certain luminaire types. Electrical contractor is responsible for completing a take-off of the drawings to determine quantity of each luminaire type and use the listed fixed unit price to calculate the total cost per luminaire type. The total cost for all luminaires shall be carried in the bid for the electrical contract. Provide a breakdown of the total cost, per luminaire type, that is carried under the electrical contract. All luminaires are to be included in the electrical contract including all luminaires identified with fixed unit costs. The electrical contractor is to include fixed per unit cost luminaires in Light Fixtures – Materials in the standard progress draw breakdown defined in Section 26 05 01.00.

.2 The fixed per unit cost excludes applicable taxes and includes lamps and distributor markups. Electrical Contractor is responsible to include in the base bid for delivery, scheduling, receiving, storage, partial assembly, installation, wiring, aiming, cleaning and warranties for all fixed per unit cost luminaires. Show the applicable taxes as a separate line item.

1.6 CASH ALLOWANCE LUMINAIRES

.1 Listed in the luminaire schedule are 'cash allowance' fixtures for certain luminaire types. A complete take-off of the drawings has been done to determine the quantity of each 'cash allowance' luminaire type and the total cost has been carried in the Div-0/1 cash allowance value. The total cost for all 'cash allowance' luminaires are NOT to be carried in the bid for the electrical contract.

.2 After tender award to the successful Electrical Contractor, the Consultant shall provide the Electrical Contractor the exact manufacturer/model number(s) of all 'cash allowance' luminaires and the Electrical Contractor shall be responsible for purchasing the fixtures through the monies from the cash allowance.

.3 Provide a breakdown of the total cost, per luminaire type, that is carried under the base electrical contract. All luminaires are to be included in the base electrical contract excluding all luminaires identified as 'cash allowance' luminaires. However the Electrical Contractor is to include 'cash allowance' luminaires in Light Fixtures – Materials in the standard progress draw breakdown defined in Section 26 05 01.00 once the Consultant provides the Electrical Contractor with the exact manufacturer/model number(s).

.4 The cash allowance value carried excludes applicable taxes and includes lamps and distributor markups. Electrical Contractor is responsible to include in the base bid for delivery, scheduling, receiving, storage, partial assembly, installation, wiring, aiming, cleaning and warranties for all 'cash allowance' luminaires. Show the applicable taxes as a separate line item.

1.7 WARRANTY

.1 The manufacturer shall provide a one-year warranty against defects in material and workmanship for 12 months after initial start-up.

.2 LED's, Drivers, Lamps and ballasts showing signs of premature failure shall be replaced at no cost to the owner

1.8 QUALITY ASSURANCE

.1 Provide mock-ups in accordance with Section 01 45 00.

1.9 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00- Common Product Requirements.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

PART 2 - PRODUCTS

2.1 GENERAL

.1 All products must be CSA or CUL approved.

2.2 LAMPS AND LEDS

.1 All Lamps are to meet the standards of the Consortium of Energy Efficiency (CEE) guidelines.

.2 Refer to luminaire schedule for project specific details, and lamps required.

.3 Incandescent, tungsten halogen, high intensity discharge, compact fluorescent and linear fluorescent lamps are to be in accordance with the lamp specifications detailed in the Luminaire Schedule and as noted below. Luminaire schedule shall take precedence where differences occur.

.4 All lamps are to be new and are to be from the same manufacturing batch to avoid colour differences. Replace all lamps that exhibit colour shift, or exhibit premature lumen intensity decline, at no cost to the owner.

.5 Incandescent and Halogen

.1 Incandescent lamp rated life shall be minimum 4,000 hours at rated voltage.

.2 Halogen lamp rated life shall be minimum 5,000 hours at rated voltage. All MR16 lamps shall be “Constant Colour” or “IR (Infrared) reflective”.

.3 Dichroic reflector lamps are to be provided with glass lens and shall not spill light from the back of the lamp unless noted in the luminaire schedule. Beam pattern and spread are as indicated on luminaire schedule.

.6 Linear Fluorescent

.1 Linear T5 fluorescent lamps shall have a minimum average rated life of 20,000 hours. The peak lumen output will be at 35 deg. C. The CRI shall be 85 or better and the colour temperature will be 3500 deg. K. unless noted otherwise on the luminaire schedule. Lamp wattage as noted on Luminaire Schedule.

.2 Linear T8 fluorescent lamps shall have a minimum average rated life of 20,000 hours. The peak lumen output will be at 35 deg. C. The CRI shall be 85 or better and the colour temperature will be 3500 deg. K. unless noted otherwise on the luminaire schedule. Lamp wattage as noted on Luminaire Schedule.

.3 All linear fluorescents must be low content mercury lamps. The Standard of acceptance are Philips “Alto”, Sylvania “Ecologic XP” for T8 lamps, Sylvania “Pentron” for T5 lamps and GE “Ecolux” series.

.7 Compact Fluorescent

.1 Compact fluorescent lamps are to be single end 4-pin with amalgam technology (lower mercury content) and shall have a minimum average rated life of 16,000 hours. The CRI shall be 82 or better and the colour temperature will be 3500 deg. K. unless noted otherwise on the luminaire schedule. Lamp wattage as noted on Luminaire Schedule.

.2 32W compact fluorescents must not be switched repeatedly, and should be on for extended periods of time. Compact fluorescents should not be used with occupancy sensors due to performance issues.

.8 High Intensity Discharge (HID)

.1 Metal halide lamps shall have a minimum 10,000 hour life and a minimum CRI of 60.

.2 Ceramic Metal halide lamps shall have a minimum 9,000 hour life and a minimum CRI of 81.

.3 All metal halide lamps must be low content mercury lamps.

.9 Light Emitting Diodes (LED)

.1 LEDs shall meet the standards of IESNA LM-79 and LM-80.

.2 All LED drivers shall be tested and comply with the maximum in-rush current limits as stated in NEMA 410.

.3 Colour temperature shall be as indicated on the luminaire schedule. Lamps are to be binned with no visible colour variance (3100K to 3300K maximum range). Rated life for 1 watt white LED shall be 50,000 hours. Lumen output to be maximum based on latest technology at time of delivery.

.4 All LED luminaires that present signs of failure on site, within the warranty period, must be replaced at no cost to the owner. If temporary luminaires are required to replace any failed LED luminaires, during the waiting time for parts (i.e. drivers, boards, heat sinks, etc.), the labour cost including installation, temporary luminaire supply, temporary luminaire removal and reinstallation of the LED luminaire must be provided at no cost of the owner. Additional electrical costs, associated with higher Wattage temporary luminaires, must be reimbursed with interest to the owner by the manufacturer.

.5 In case of failure of an LED luminaire, complete or part thereof, an independent third party testing Laboratory (approved by Smith + Andersen) shall be commissioned by the manufacturer or vendor to perform tests on samples taken from the failed luminaires installed on corresponding site. All reporting including the test results must be submitted to Smith + Andersen for evaluation and final approval.

.6 Any additional time involved by Smith + Andersen will be billed at our hourly rates to the manufacturer or vendor.

.10 Induction lamps

.11 Induction lamps shall have a minimum 100,000 hour life. The Standard of acceptance are Osram/Sylvania and Philips. Minimum CRI of 80.

2.3 DRIVERS

.1 All drivers are to be tested and comply with maximum in-rush current limits within NEMA 410 standards. This is to be clearly indicated on shop drawing submittal.

.2 LED dimming shall be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experience in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.

.3 Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.

.4 Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.

.5 No visible change in light output with a variation of plus/minus 10 percent line voltage input.

.6 Total Harmonic Distortion less than 20% percent and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.

.7 Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:

.1 Adjustment of forward LED voltage, supporting 3V through 55V.

.2 Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA

.3 Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.

.8 Driver must be able to operate for a (+/- 10%)supply voltage of 120V through 277VAC at 60Hz.

.9 Driver should be UL Recognized under the component program and shall be modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.

.10 Driver shall include ability to provide no light output when the analog control signal drops below 0.5 V, or the DALI/DMX digital signal calls for light to be extinguished and shall consume 0.5 watts or less in this standby. Control deadband between 0.5V and 0.65V shall be included to allow for voltage variation of incoming signal without causing noticeable variation in fixture to fixture output.

.11 Over the entire range of available drive currents, driver shall provide step-free, continuous dimming to black from 100 percent to 0.1 percent and 0% relative light output, or 100 – 1% light output and step to 0% where indicated. Driver shall respond similarly when raising from 0% to 100%

.1 Driver must be capable of 20 bit dimming resolution for white light LED drivers or 15 bit resolution for RGBW LED drivers.

.12 Driver must be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels

.13 Drivers to track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.

.14 Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index

(ANSI/IES RP-16-10). At all points within the dimming range from 100-0.1 percent luminaire shall have:

.15 LED dimming driver shall provide continuous step-free, flicker free dimming similar to incandescent source.

.16 Base specification: Flicker index shall less than 5% at all frequencies below 1000 Hz.

.17 Preferred specification: Flicker index shall be equal to incandescent, less than 1% at all frequencies below 1000 Hz.

.18 Control Input

.1 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers

.1 Must meet IEC 60929 Annex E for General White Lighting LED drivers

.2 Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.

.2 Must meet ESTA E1.3 for RGBW LED drivers

2.4 BALLASTS

.1 All Ballasts shall comply with CSA C22.2 No. 74 and are to meet or exceed the standards of the Certified Ballast Manufacturers Association (CBM).

.2 All ballasts shall be tested and comply with maximum in-rush current limits as stated in NEMA 410.

.3 Not all ballasts could be used, refer to luminaire schedule for project specific details.

.4 Ballasts shall operate at voltage and control lamps as noted in the Luminaire Schedule.

.5 Ballasts for T5 and T8 lamps will be programmed rapid start, will start at minimum 0 deg. C. (indoors) and minus 29 deg. C. (outdoors). Ballasts shall meet ANSI C62.41 Category A transient voltage protection requirements. PF shall be greater than .95, and shall meet FCC Class A specifications for EMI/RFI. The maximum case temperature will not exceed 70 deg. C.

.6 Ballasts for compact fluorescent lamps to be universal input type electronic with end-of-lamp sensing. PF shall be greater than .98, BF shall be greater than .98, THD < 10%. Ballasts shall meet FCC Class A specifications for EMI/RFI.

.7 Ballasts for HID lamps will be suitable for operation in 40 deg. C. temperatures, with a minimum starting temperature of minus 30 deg. C. at 90 % of line voltage. They shall be encapsulated in a steel enclosure. Insulation is to be Class H (minimum 180 deg. C.) vacuum impregnated with silica filled polyester compound. Coils are to be precision or bobbin wound. Sound rating is to be minimum class B. Continuous operation for 60,000 hours at maximum rated load and temperature. Ballast factor of 1.0, .95 minimum power factor, 1.8 minimum crest factor.

.8 Electronic dimming ballasts for T5 and T8 lamped fluorescent luminaires are to be compatible with lamp type and quantity and shall meet the following requirements:

.1 Dimming range from 100% to 1% illuminance level with continuous, flicker free output with ambient noise level ≤ 27dB over the entire dimming range.

.2 Maximum lead length from ballast to lamp socket is seven feet for T-8 lamps, and 3 feet for T-5 lamps.

.3 PF > .95.

.4 BF ≥ .85.

.5 THD < 10% at full light output.

.6 Lamp crest factor ≤ 1.6.

.7 Inrush current to be internally limited to not exceed 3 amps at 347V or 7A at 120V.

.8 Preheating of lamp cathodes before applying arc voltage.

.9 Withstand 4000V surges as per ANSI C62.41.

.10 Improper line voltage and control wiring shall not damage ballast. Each ballast is to be tested at low, medium and high end of range by manufacturer.

.11 Meet FCC Class A specifications for EMI/RFI.

.9 Electronic dimming ballasts for compact fluorescent luminaires are to be compatible with lamp type and quantity and shall meet the following requirements:

.1 Dimming range from 100% to 1% illuminance level with continuous, flicker free output over the entire dimming range.

.2 Maximum lead length from ballast to lamp socket is 3 feet.

.3 PF > .95.

.4 BF ≥ .93.

.5 THD < 10% at full light output.

.6 Lamp crest factor ≤ 1.6.

.7 Inrush current to be internally limited to not exceed 3 amps at 120V.

.8 Preheating of lamp cathodes before applying arc voltage.

.9 Withstand surges as per ANSI C62.41.

.10 Improper line voltage and control wiring shall not damage ballast. Each ballast is to be tested at low, medium and high end of range by manufacturer.

.11 Meet FCC Class A specifications for EMI/RFI.

.12 Minimum starting temperature of 10 deg. C.

.10 Ballasts shall contain no PCB’s and audible rating will be class A or better.

.11 Racks are to be provided for remote ballasts.

.12 Ballasts with unacceptable noise levels are to be replaced at no cost to the owner.

2.5 LUMINAIRES

.1 All luminaires are to be complete with mounting brackets, transformers, supports, trims, louvers, lenses and other

accessories as required to make luminaire operational and allow it to be installed in the respective location.

.2 Luminaires shall be suitable for the environment where installed, include seals and gaskets, and corrosion resistant baked-on finish as required and as specified.

.3 Louvers, lenses and diffusers must be of suitable thickness to prevent sagging.

.4 Where drawings show luminaires mounted end-to-end, luminaires shall be suitable for continuous, seamless and tandem mounting.

.5 Fluorescent luminaires designed for continuous, seamless and tandem mounting shall only be constructed with four foot lamps. Two and three foot lamps are not acceptable unless indicated on drawings or luminaire schedule.

.6 All poles are to come complete with internal vibration dampeners to accommodate wind conditions to avoid damage due to wind-induced vibrations.

.7 All concrete bases for poles and bollards shall be designed to accommodate the height, weight, etc. of the pole/bollard and its accessories for the soil conditions for which it is installed. Engineered shop drawings shall be provided that is signed by a structural engineer registered in the local jurisdiction.

.8 Where cameras are shown to be installed on poles, the poles shall be stiffened to reduce vibration and sway, and shall be rated for video recording cameras.

.9 The supply and installation of fixed per unit cost and 'cash allowance' luminaires shall comply with all standards set forth in Electrical Specifications. Electrical Contractor is responsible to include in the base bid for delivery, scheduling, receiving, storage, partial assembly, installation, wiring, aiming, cleaning and warranties for all fixed per unit cost and 'cash allowance' luminaires.

.10 The following is a list of generic type designation for luminaires. The project specific luminaire schedule is to be referenced for the specific types and designations and the respective specifications.

.1 Designations beginning with the letter 'C' denote compact fluorescent type.

.2 Designations beginning with the letter 'D' denote incandescent or halogen type.

.3 Designations beginning with the letter 'F' denote fluorescent type.

.4 Designations beginning with the letter 'H' denote high intensity discharge type.

.5 Designations beginning with the letter 'L' denote LED type.

.6 Designations beginning with the letter 'J' denote Induction type.

.7 Designations beginning with the letter 'X' denote exit sign.

2.6 LUMINAIRES

.1 As indicated in luminaire schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 It is the responsibility of the contractor to obtain the information related to the luminaire and luminaire trim finishes/colours from the Interior Designer or Architects prior to the fabrication of luminaires. The Contractor shall provide adequate time for the design team to review and comment on luminaire and luminaire trim finishes

.2 The contractor will provide, receive, unload, uncrate, store, protect and install lamps, luminaires, and other related lighting equipment as specified herein. Lamps for all equipment will be provided and installed by the contractor according to equipment manufacturer's instructions.

.3 The Electrical Contractor shall be responsible for the supply and installation of all concrete bases for poles and bollards. Unless otherwise shown on the drawings, concrete bases to be ArtForm style or Approved Equal and shall extend a minimum 900mm above grade in parking lots and a minimum 150mm above grade in pedestrian walkways.

.4 Poles and bollards are to be installed on independent concrete bases unless indicated otherwise on the drawings or schedules. Coordinate brackets for cameras and supports for banners with pole manufacturer.

.5 Install remote ballasts in racks and wire luminaires to ballasts in conduit. Provide wiring as per manufacturer's recommendations.

.6 Locate luminaires in accordance with the Architect's Drawings. Coordinate exact locations on site. Refer to Architect's drawings for dimensions of coves and valences. Fluorescent staggered coves must have a minimum of two inches overlap.

.7 Install in accordance with Manufacturer's Instructions, Local Codes, Electrical Division Drawings and Specifications.

.8 All suspended luminaires shall have cables and support stems vertically aligned.

.9 Suspend luminaires in mechanical rooms after all the mechanical equipment and ductwork are installed. Luminaires are not to be suspended from mechanical pipes, ductwork or other building services.

.10 All luminaires shall be installed underneath other services located within ceiling space. Contractor is responsible for interference drawings to ensure all services in ceiling are coordinated.

.11 Any dimensions provided in the drawings or schedules are intended as general guidelines. For exact dimensioning refer to the Architectural drawings. The detailed information shall be cross referenced with the electrical specifications and the Luminaire Schedule applying the most stringent requirement.

.12 It is the responsibility of the Electrical Contractor to coordinate luminaire trims and mounting system with ceiling finishes. Luminaires delivered on site with the wrong ceiling mounting system shall be replaced without additional costs for the owner. Restocking fees will not be accepted.

.13 For suspended ceiling installations support luminaires from structural slab in accordance with local inspection requirements.

.14 Where luminaires are mounted in tandem, align luminaires mounted in continuous rows to form straight uninterrupted line.

.15 Align luminaires mounted individually parallel or perpendicular to building grid lines.

.16 Ensure light leakage does not occur from openings and trim rings. Contractor is responsible to repair the ceiling at no cost to the Owner if cut-out is too large.

.17 Connect luminaires to lighting circuits.

.18 Provide all wiring in conduit with junction boxes on a grid pattern to limit the run of flexible armoured cable drops from the ceiling mounted junction box to each luminaire to a maximum of 3 m in length unless approved otherwise in writing from the Engineer’s Representative.

.19 Modular wiring systems shall be employed only where indicated or with approval of the Engineer’s Representative.

.20 Luminaires are not to be used as temporary construction lighting. After being tested to ensure acceptable operation, luminaires will not be used until substantial completion unless permission is received from the owner, architect or Engineer’s Representative.

.21 Lamps are to be installed after luminaire is cleaned. All fluorescent lamps shall be run through a minimum of 12 hours initial start to increase the lamp life and all lamps shall be run through a minimum of 100 hours initial start prior to any dimming.

.22 Clean all luminaires, inside and out at time of substantial completion. Replace all scratched or damaged luminaires, lenses, louvers and diffusers at no cost to the owner.

.23 Installation of exit signs

.1 Rough-in and installation of exit signs shall be carefully coordinated on site such that after installation of all equipment/services, including equipment/services from other trades (i.e. sprinkler lines, plumbing pipes, way-finding signs, etc.), shall not interfere with the line-of-sight visibility of the exit sign(s) from approach of the intended egress pathway(s).

.2 If exit sign(s) have been installed and do not meet the satisfaction of the Engineer’s Representative/Architect, the Contractor shall lower, raise or relocate the exit sign(s) such that proper and adequate visibility of the exit sign(s) is achieved at no additional cost to the Owner.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 26 05 01.00.

.2 Section 26 05 21.00.

.3 Section 26 05 34.00.

1.2 REFERENCE STANDARDS

.1 CSA International

.1 CSA C22.2 No.141, Emergency Lighting Equipment.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for emergency lighting and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00.

.2 Operation and Maintenance Data: submit operation and maintenance data for emergency lighting for incorporation into manual.

1.5 WARRANTY

.1 For batteries, the warranty period shall be extended to 120 months, with a no-charge replacement during the first 5 years and a pro-rata charge on the second 5 years.

PART 2 - PRODUCTS

2.1 EQUIPMENT

.1 Supply voltage: 120 V, ac.

.2 Output voltage: 24 V dc.

.3 Operating time: 120 minutes, unless otherwise noted in schedules.

.4 Battery: 10 year sealed, valve regulated, lead calcium.

.5 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations. Recharges battery within 24 hours in accordance with CSA.

.6 Solid state transfer circuit.

.7 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.

.8 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.

.9 Lamp heads: integral on unit and remote as indicated, 345 horizontal and 180 vertical adjustment. Lamp type: MR16, wattage to be 50W unless noted otherwise on drawings or in the "Battery Unit Schedule" (i.e. 35W, 50W).

.10 Directional remote head lamps to have narrow beam spread distribution.

.11 Recessed remote head lamps to have flood beam spread distribution.

.12 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.

.13 Finish: Baked white enamel.

.14 Auxiliary equipment:

.1 Ammeter.
.2 Voltmeter.
.3 Test switch.
.4 Time delay relay.
.5 Battery disconnect device.
.6 ac input and dc output terminal blocks inside cabinet.
.7 Bracket.
.8 Cord and single twist-lock plug connection for ac.
.9 RFI suppressors.

2.2 WIRING OF REMOTE HEADS AND EXIT SIGNS

.1 Conduit: As per Section 26 05 34.

.2 Conductors: As per Section 26 05 21sized as per manufacturer's recommendation and compliant to the applicable electrical codes.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install unit equipment and remote mounted fixtures. Interconnect all heads with central battery pack.

.2 Direct heads to optimize illumination of egress pathways to minimum building code requirements.

.3 Connect exit lights to unit equipment.

.4 Contractor is to include the supply and installation of one additional head or an additional 5% of the total number of heads shown on the drawings, whichever is greater in the bid price. The installation is to include all wiring and conduit required to install the heads. If the heads are not installed during construction then the spare heads are to be turned over to the Owner at the end of the project.

3.2 TESTING AND COMMISSIONING

.1 Contractor shall commission and test the entire system and adjust as necessary.

.2 Trip breaker(s) feeding battery unit(s) to simulate power failure to building. Test the operation of each unit to document the duration of runtime. Testing shall be performed during non-daylight hours.

.3 Inform Engineer's Representative 10 days in advance prior to testing being performed in order for Engineer's Representative to make arrangements to witness testing of emergency lighting system.

.4 Provide Engineer's Representative with signed test report by Contractor that each unit successfully operated for the required duration of time.

.5 Re-test voltage of battery units 24 hours after initial testing to verify rated nominal voltage of unit. If battery unit has not recharged properly, replace unit and re-test as stated above at no additional cost to Owner.

3.3 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by emergency lighting installation.

LIGHTING LUMINAIRE SCHEDULE

Section 26 06 05.16 - LUMINAIRE SCHEDULE
Project Name: NRC - CCAMM Speakman Drive Mississauga Ontario
Project number: 16158.000.E.001

Smith + Andersen
4211 Yonge St., Suite 500
Toronto, Ontario M2P 2A9

TYPE	VOLT.	LAMP(S)	DIMENSIONS	DESCRIPTION	DRIVERS/ POWER SUPPLY	MANUFACTURER/ CATALOGUE NUMBER	MINIMUM PERFORMANCE REQUIRED	LOCATED
LED								
L1	120V	12.15 W/ft (4000K LED), 85 CRI	6"W x 3 1/2"H x 4'L	**Recessed T-Bar, Armstrong Techzone ceiling, LED fixture.** Rigid extruded aluminum body,die cast zinc alloy powder coated. White Powder Coated Sheet Steel Reflector. Closed extruded acrylic lens for easy cleaning. **White finish.** Certified to UL and CUL standards *** Pre-purchased fixtures, installation only***	0-10V dimming driver	Axis Beam6 LED	1000 lm/ft	Lab Area - General Lighting
L2	120V	21.2W (4000K LED) Medium Beam, 85 CRI	4" Dia. x 5-1/2" H	**Recessed downlight with medium reflector** with a semi-specular finish. Self flanged, aluminum lower reflector in combination with a lensed upper optical chamber.	0-10V dimming driver	HH4 LED 4" ***No alternate fixture will be accepted***	2000 lumens	Lab Area - General Lighting
EMERGENCY LIGHTING								
X1	120V	LED		Architectural Edge-lit **Pictogram** Exit Sign, slim-profile extruded aluminum housing, high-output LED. Universal surface mounting - wall, ceiling, or end mount. Extruded acrylic panel with pictogram legend. Refer to drawings for mounting, number of faces and direction of arrows. **AC only.** *** Pre-purchased fixtures, installation only***				

NOTES:

1. All luminaires need to be consistent on technology and must match reference standard description regardless of catalogue number. Where finishes are not indicated, allow for special finish. Manufacturer/Catalogue number not listed will not be considered.

2. The Electrical Contractor is responsible for the supply and installation of all fixed per unit cost luminaires as part of the base electrical contract. The Electrical Contractor is responsible for the installation of all cash allowance luminaires as part of the base electrical contract. Refer to specification 16505 or 26 51 13.00 for more details.

3. LED's are to be latest technology to proved maximum lumens, binned, best colour and longest life at time of purchase. Drivers are to be the latest technology at time of purchase.

4.LED luminaires dimensions listed are the maximum size allowed. Luminaires provided can be smaller than the dimension listed.

5. All luminaires diameter and depth listed are the maximum size allowed. Luminaires provided can be smaller than the dimension listed.

6. All LED luminaires that present signs of failure on site, within the warranty period, must be replaced at no cost to the owner. If temporary luminaires are required to replace any failed LED luminaires, during the waiting time for parts (i.e. drivers, boards, heat sinks, etc.), the labour cost including installation, temporary luminaire supply, temporary luminaire removal and reinstallation of the LED fixture must be provided at no cost of the owner. Additional electrical costs, associated with higher Wattage temporary luminaires, must be reimbursed with interest to the owner by the manufacturer.

7. In case of failure of a LED luminaire complete or part there of the luminaire failure, a independent third party testing Laboratory (approved by Smith + Andersen) shall be commissioned by the manufacturer or vendor to perform tests on samples taken from the failed luminaires installed on corresponding site. All reporting including the test results must be submitted to Smith + Andersen for evaluation and final approval.

8. Any additional time (related to luminaire manufacturing issues) involved by Smith + Andersen will be billed at our hourly rates to the manufacturer or vendor.

9. All LED parts and accessories must be replaceable on site without removal of the luminaire.

10. Equivalents will only be considered at Smith + Andersen discretion prior to tender close. Sample must be supplied with plug and cord for mock-up

11. Poles and bases are to be designed to accommodate wind conditions to avoid damage due to wind-induced vibrations. Shop drawings are to be signed by a structural engineer registered in the local jurisdiction.

LIGHTING CONTROLS SEQUENCE OF OPERATIONS

LIGHTING SEQUENCE OF Smith + Andersen

Project Name: Project Name: NRC - CCAMM Speakman Drive Mississauga Ontario

Project Number: 16158.000.E.001

Date: 10-Jan-20

Space Type	Sequence:
Interior	
Offices, Office areas, Lab Support/Entry, Quiet Room	Sequence: **ON:** Lights automatically turn on to full brightness upon trigger of occupancy sensor(s). **OFF:** Lights automatically turn off when the room has been vacated after 15 minutes. **ADJUST**: Lights adjacent to perimeter windows to automatically dim when sufficient amount of daylight is sensed by the photocell during ON operation. Applicable where daylight sensors are shown on drawings. **Emergency lights are also controlled. Provide UL-924 listed relay to control emergency lighting. **Lights come to full brightness when fire alarm system is in "alarm" mode.
Labs	Sequence: **ON:** User enters the space and the lights automatically turn on via occupancy sensor. **OFF:** 30 minutes after the room has been vacated, the lights will automatically turn off. **ADJUST**: Lights adjacent to perimeter windows to automatically dim when sufficient amount of daylight is sensed by the photocell during ON operation. Applicable where daylight sensors are shown on drawings. **Override switch** located in every lab pod to allow full dimming control of lab lighting fixtures, including emergency lighting. **Emergency lights are also controlled. Provide UL-924 listed relay to control emergency lighting. **Lights come to full brightness when fire alarm system is in "alarm" mode.

GENERAL NOTES:
1) Opening and closing hours and scheduling times to be confirmed by Owner during commissioning.
2) Lighting control system to come complete with required accessories and devices. Contractor to review luminaire schedule and ensure compatibility between drivers and lighting control system.
3) Electrical contractor to follow manufacturer recommendations for wiring and installation. All wiring by electrical contractor.

PANEL SCHEDULES

PANEL: RP-1A
PROJECT NAME: NRC MISSISAUGA
PROJECT #: 16158.E.000

LOCATION: LAB CORRIDOR 119

FED FROM: PP-1A

Smith + Andersen

TYPE/ INFO	DESCRIPTION	D.F [%]	CONN. LOAD [W]	DEMAND LOAD [W]	BKR [A]	CCT NO.	Φ	CCT NO.	BKR [A]	DEMAND LOAD [W]	CONN. LOAD [W]	D.F [%]	DESCRIPTION	TYPE/ INFO
REC	Lab Receptacle - 105	100	300	300	20	**1**	**A**	**2**	20	300	300	100	Lab Lighting	LTS
REC	Lab Receptacle - 105	100	300	300	20	**3**	**B**	**4**	**2P**	300	300	100	**Lab Receptacle - 105**	REC
REC	Receptacles - Lab Support 105.2	100	300	300	20	**5**	**C**	**6**	**20**	300	300	100		REC
REC	Receptacles - Lab Support 105.2	100	300	300	20	**7**	**A**	**8**	20	300	300	100	Lab Receptacle - 105	REC
REC	Receptacles - Lab Support 105.2	100	300	300	20	**9**	**B**	**10**	20	300	300	100	Receptacles - Lab Entry 105.1	GFCI
REC	Receptacles - Lab Support 105.2	100	300	300	20	**11**	**C**	**12**	20	300	300	100	Receptacles - Lab Entry 105.1	GFCI
REC	Lab Receptacle - 105	100	300	300	20	**13**	**A**	**14**	20	300	300	100	Receptacles - Housekeeping	GFCI
		100	300	300	3P	**15**	**B**	**16**	20	300	300	100	Auto Flush/Auto Faucet/Soap Dispenser	REC
D.C	Fume Hood 208V Equipment	100	300	300	↓	**17**	**C**	**18**	20	150	150	100	Gas Shut Off	D.C
	Lab 105	100	300	300	30	**19**	**A**	**20**	15	180	180	100	Motorized Blinds	D.C
		100	300	300	3P	**21**	**B**	**22**	**20**	300	300	100	**Lab Receptacle - 105**	REC
D.C	Fume Hood 208V Equipment	100	300	300	↓	**23**	**C**	**24**	3P	300	300	100		
	Lab 105	100	300	300	30	**25**	**A**	**26**	↓	300	300	100	Fume Hood 208V Equipment	D.C
REC	Lab Receptacle - 105	100	300	300	2P	**27**	**B**	**28**	30	300	300	100	Lab 105	
REC	Lab Receptacle - 105	100	300	300	20	**29**	**C**	**30**	3P	300	300	100		
REC	Lab Receptacle - 105	100	300	300	20	**31**	**A**	**32**	↓	300	300	100	Fume Hood 208V Equipment	D.C
D.C	Motorized Benches - Lab 105	100	300	300	15	**33**	**B**	**34**	30	300	300	100	Lab 105	
D.C	Motorized Benches - Lab 105	100	300	300	15	**35**	**C**	**36**	**2P**	300	300	100	**Lab Receptacle - 105**	REC
REC	**Lab Receptacle - 105**	100	300	300	**2P**	**37**	**A**	**38**	**20**	300	300	100		REC
REC		100	300	300	**20**	**39**	**B**	**40**	**2P**	300	300	100	**Lab Receptacle - 105**	REC
REC	Lab Receptacle - 105	100	300	300	20	**41**	**C**	**42**	**20**	300	300	100		

PANEL OPTIONS:

2	:CSA ENCLOSURE RATING	☐	FLUSH
☐	FEED THROUGH	☒	SURFACE
☐	SUB-FEED	☒	BOLT-ON BREAKER
☐	MAIN BREAKER	☐	SPD
☐	200% RATED NEUTRAL BUS	☐	
☐	ISOLATED GROUND BUS	☐	

LOAD A [KW]:	4.08
LOAD B [KW]:	4.2
LOAD C [KW]:	4.05
TOTAL [KW]:	12.3
CURRENT A [A]:	34
CURRENT B [A]:	35
CURRENT C [A]:	34

PHASE VOLTAGE [V]:	120
LINE VOLTAGE [V]:	208
PHASE:	3Φ
WIRE:	4
MAINS [A]:	225
MAIN BREAKER [A]:	
I.C. [kA]:	10

LEGEND:

BAS-Building Automation System	R.C-Relay Controlled	LTS-Lighting
GFCI-Ground Fault Circuit Interrupter	M-Motor	HID-High Intensity Discharge Lighting Breaker
AFCI-Arc Fault Circuit Interrupter	D.F-Demand Factor	
SPD - Surge Protection Device	REC-Receptacle	D.C-Direct Connection
BLO-Breaker Lock-On Device		

NOTES:

1. Panel Enclosure To Be Sprinklerproof.
2. Panels greater than 66 circuits to be double tub.
3. Surge Protection Device (SPD) to be in a separate barriered enclosure with separate cover.
4. Terminate circuits for BAS in 4"x4" junction box 10' from panel.

PANEL: RP-1B
PROJECT NAME: NRC MISSISAUGA
PROJECT #: 16158.E.000

LOCATION: LAB CORRIDOR 119

FED FROM: PP-1A

Smith + Andersen

TYPE/ INFO	DESCRIPTION	D.F [%]	CONN. LOAD [W]	DEMAND LOAD [W]	BKR [A]	CCT NO.	Φ	CCT NO.	BKR [A]	DEMAND LOAD [W]	CONN. LOAD [W]	D.F [%]	DESCRIPTION	TYPE/ INFO
REC	Auto Flush/Auto Faucet/Soap Dispenser	100	300	300	20	1	A	2	20	300	300	100	Lab Lighting	LTS
REC	Spare	100			20	3	B	4	20			100	Spare	
REC	Receptacles - Lab Support 106.2	100	300	300	20	5	C	6	20			100	Spare	
REC	Receptacles - Lab Support 106.2	100	300	300	20	7	A	8	20			100	Spare	
REC	Receptacles - Lab Support 106.2	100	300	300	20	9	B	10	20	300	300	100	Receptacles - Lab Entry 106.1	GFCI
REC	Receptacles - Lab Support 106.2	100	300	300	20	11	C	12	20	300	300	100	Receptacles - Lab Entry 106.1	GFCI
REC	Lab Receptacle - 106	100	300	300	20	13	A	14	20	300	300	100	Receptacles - Housekeeping	GFCI
REC	Lab Receptacle - 106	100	300	300	20	15	B	16	20			100	Spare	
REC	Lab Receptacle - 106	100	300	300	20	17	C	18	20	150	150	100	Gas Shut Off	
REC	Lab Receptacle - 106	100	300	300	20	19	A	20	15	180	180	100	Motorized Blinds	D.C
REC	**Lab Receptacle - 106**	**100**	**300**	300	**2P**	21	B	22				100	Space	
REC		**100**	**300**	300	**20**	23	C	24	20	300	300	100	Lab Receptacle - 106	REC
REC	**Lab Receptacle - 106**	**100**	**300**	300	**2P**	25	A	26	20	300	300	100	Lab Receptacle - 106	REC
REC		**100**	**300**	300	**20**	27	B	28	20	300	300	100	Lab Receptacle - 106	REC
REC	Lab Receptacle - 106	100	300	300	20	29	C	30	20	300	300	100	Lab Receptacle - 106	REC
REC	Lab Receptacle - 106	100	300	300	20	31	A	32	**2P**	**300**	**300**	**100**	**Lab Receptacle - 106**	**REC**
REC	**Lab Receptacle - 106**	**100**	**300**	**300**	**2P**	33	B	34	**20**	**300**	**300**	**100**		**REC**
REC		**100**	**300**	**300**	**20**	35	C	36	**2P**	300	**300**	**100**	**Lab Receptacle - 106**	**REC**
	Space	100				37	A	38	**20**	300	**300**	**100**		**REC**
	Space	100				39	B	40				100	Space	
	Space	100				41	C	42				100	Space	

PANEL OPTIONS:

2	:CSA ENCLOSURE RATING	☐	FLUSH
☐	FEED THROUGH	☒	SURFACE
☐	SUB-FEED	☒	BOLT-ON BREAKER
☐	MAIN BREAKER	☐	SPD
☐	200% RATED NEUTRAL BUS	☐	
☐	ISOLATED GROUND BUS	☐	

LOAD A [KW]:	3.48
LOAD B [KW]:	2.4
LOAD C [KW]:	3.15
TOTAL [KW]:	9.03
CURRENT A [A]:	29
CURRENT B [A]:	20
CURRENT C [A]:	26

PHASE VOLTAGE [V]:	120
LINE VOLTAGE [V]:	208
PHASE:	3Φ
WIRE:	4
MAINS [A]:	225
MAIN BREAKER [A]:	
I.C. [kA]:	10

LEGEND:

BAS-Building Automation System	R.C-Relay Controlled	LTS-Lighting
GFCI-Ground Fault Circuit Interrupter	M-Motor	HID-High Intensity Discharge Lighting Breaker
AFCI-Arc Fault Circuit Interrupter	D.F-Demand Factor	
SPD - Surge Protection Device	REC-Receptacle	D.C-Direct Connection
BLO-Breaker Lock-On Device		

NOTES:

1. Panel Enclosure To Be Sprinklerproof.
2. Panels greater than 66 circuits to be double tub.
3. Surge Protection Device (SPD) to be in a separate barriered enclosure with separate cover.
4. Terminate circuits for BAS in 4"x4" junction box 10' from panel.

PANEL: RP-1C
PROJECT NAME: NRC MISSISAUGA
PROJECT #: 16158.E.000

LOCATION: LAB CORRIDOR 119

FED FROM: PP-1A

Smith + Andersen

TYPE/ INFO	DESCRIPTION	D.F [%]	CONN. LOAD [W]	DEMAND LOAD [W]	BKR [A]	CCT NO.	Φ	CCT NO.	BKR [A]	DEMAND LOAD [W]	CONN. LOAD [W]	D.F [%]	DESCRIPTION	TYPE/ INFO
REC	**Lab Receptacle - 108**	**100**	**300**	**300**	**2P**	**1**	**A**	**2**	20	300	300	100	Lab Lighting	LTS
REC		**100**	**300**	**300**	**20**	**3**	**B**	**4**	20	300	300	100	Lab Lighting	LTS
REC	**Lab Receptacle - 108**	**100**	**300**	300	**2P**	**5**	**C**	**6**	20	300	300	100	Lab Receptacle - 107	REC
REC		**100**	**300**	300	**20**	**7**	**A**	**8**	20	300	300	100	Lab Receptacle - 107	REC
REC	**Lab Receptacle - 108**	**100**	**300**	300	**2P**	**9**	**B**	**10**	20	300	300	100	Lab Receptacle - 107	REC
REC		**100**	**300**	300	**20**	**11**	**C**	**12**	20	300	300	100	Receptacles - Lab Entry 107.1	GFCI
REC	**Lab Receptacle - 107**	**100**	**300**	300	**2P**	**13**	**A**	**14**	20	300	300	100	Receptacles - Lab Entry 107.1	GFCI
REC		**100**	**300**	300	**20**	**15**	**B**	**16**	20	300	300	100	Receptacles - Characterization Lab (GFCI)	GFCI
REC	**Lab Receptacle - 107**	**100**	**300**	300	**2P**	**17**	**C**	**18**	20	300	300	100	Receptacles - Characterization Lab (GFCI)	GFCI
REC		**100**	**300**	300	**20**	**19**	**A**	**20**	20	150	150	100	Gas Shut Off	
REC	**Lab Receptacle - 107**	**100**	**300**	300	**2P**	**21**	**B**	**22**	20	300	300	100	Auto Flush/Auto Faucet/Soap Dispenser	
REC		**100**	**300**	300	**20**	**23**	**C**	**24**	15	360	360	100	Motorized Blinds	D.C
REC	Lab Receptacle - 108	100	300	300	20	**25**	**A**	**26**	15	180	180	100	Motorized Blinds	D.C
REC	Lab Receptacle - 108	100	300	300	20	**27**	**B**	**28**	20	300	300	100	**Lab Receptacle - 108**	D.C
REC	Lab Receptacle - 108	100	300	300	20	**29**	**C**	**30**	20	300	300	100	Receptacles - Lab Support 107.2	REC
REC	**Lab Receptacle - 108**	100	300	300	**2P**	**31**	**A**	**32**	20	300	300	100	Receptacles - Lab Support 107.2	REC
REC		100	300	300	**20**	**33**	**B**	**34**	3P	300	300	100		
REC	Lab Receptacle - 108	100	300	300	20	**35**	**C**	**36**	↓	300	300	100	Fume Hood 208V Equipment	D.C
REC	Lab Receptacle - 108	100	300	300	20	**37**	**A**	**38**	30	300	300	100	Receptacles - Lab Support 107.2	
REC	Lab Receptacle - 108	100	300	300	20	**39**	**B**	**40**	20	300	300	100	Receptacle - Housekeeping	REC
REC	Lab Receptacle - 107	100	300	300	20	**41**	**C**	**42**	3P	300	300	100		
REC	Lab Receptacle - 108	100	300	300	20	**43**	**A**	**44**	↓	300	300	100	Fume Hood 208V Equipment	D.C
REC	Lab Receptacle - 107	100	300	300	20	**45**	**B**	**46**	30	150	150	100	Receptacles - Lab Support 107.2	
REC	**Lab Receptacle - 107**	100	300	300	**2P**	**47**	**C**	**48**	20	150	150	100	Receptacles - Lab Support 107.2	REC
REC		100	300	300	**20**	**49**	**A**	**50**	20	300	300	100	Receptacles - Lab Support 107.2	REC
REC	Lab Receptacle - 107	100	300	300	20	**51**	**B**	**52**	20	300	300	100	Receptacles - Lab Support 107.2	REC
REC	Lab Receptacle - 107	100	300	300	20	**53**	**C**	**54**	20	300	300	100	Receptacles - Lab Support 107.2	REC
REC	Lab Receptacle - 107	100	300	300	20	**55**	**A**	**56**	**2P**	**300**	**300**	**100**	**Lab Receptacle - 107**	**REC**
REC	**Lab Receptacle - 107**	**100**	**300**	**300**	**2P**	**57**	**B**	**58**	**20**	**300**	**300**	**100**		**REC**
REC		**100**	**300**	**300**	**20**	**59**	**C**	**60**	20	300	300	100	Space	

PANEL OPTIONS:

2	:CSA ENCLOSURE RATING	☐	FLUSH
☐	FEED THROUGH	☒	SURFACE
☐	SUB-FEED	☒	BOLT-ON BREAKER
☐	MAIN BREAKER	☐	SPD
☐	200% RATED NEUTRAL BUS	☐	

LOAD A [KW]:	6.03
LOAD B [KW]:	6.15
LOAD C [KW]:	6.21
TOTAL [KW]:	18.4
CURRENT A [A]:	50

PHASE VOLTAGE [V]:	120
LINE VOLTAGE [V]:	208
PHASE:	3Φ
WIRE:	4
MAINS [A]:	225
MAIN BREAKER [A]:	

PANEL: RP-1C PROJECT NAME: NRC MISSISAUGA PROJECT #: 16158.E.000	LOCATION: LAB CORRIDOR 119 FED FROM: PP-1A	Smith + Andersen

TYPE/ INFO	DESCRIPTION	D.F [%]	CONN. LOAD [W]	DEMAND LOAD [W]	BKR [A]	CCT NO.	Φ	CCT NO.	BKR [A]	DEMAND LOAD [W]	CONN. LOAD [W]	D.F [%]	DESCRIPTION	TYPE/ INFO
☐	ISOLATED GROUND BUS	☐			CURRENT B [A]:				51				I.C. [kA]:	10
					CURRENT C [A]:				52					

LEGEND:		
BAS-Building Automation System	R.C-Relay Controlled	LTS-Lighting
GFCI-Ground Fault Circuit Interrupter	M-Motor	HID-High Intensity Discharge Lighting Breaker
AFCI-Arc Fault Circuit Interrupter	D.F-Demand Factor	
SPD - Surge Protection Device	REC-Receptacle	D.C-Direct Connection
BLO-Breaker Lock-On Device		

NOTES:

1. Panel Enclosure To Be Sprinklerproof.
2. Panels greater than 66 circuits to be double tub.
3. Surge Protection Device (SPD) to be in a separate barriered enclosure with separate cover.
4. Terminate circuits for BAS in 4"x4" junction box 10' from panel.

PANEL: RP-1D
PROJECT NAME: NRC MISSISAUGA
PROJECT #: 16158.E.000

LOCATION: Lab Corridor 119

FED FROM: PP-1A

Smith + Andersen

TYPE/ INFO	DESCRIPTION	D.F [%]	CONN. LOAD [W]	DEMAND LOAD [W]	BKR [A]	CCT NO.	Φ	CCT NO.	BKR [A]	DEMAND LOAD [W]	CONN. LOAD [W]	D.F [%]	DESCRIPTION	TYPE/ INFO
REC	Auto Flush/Auto Faucet/Soap Dispenser	100	300	300	20	1	A	2	20	300	300	100	Lab Lighting	LTS
REC	**Lab Receptacle - 118**	100	300	300	2P	3	B	4	2P	300	300	100	**Lab Receptacle - 118**	REC
REC		100	300	300	20	5	C	6	20	300	300	100		REC
REC	**Lab Receptacle - 118**	100	300	300	2P	7	A	8	20	300	300	100	Lab Receptacle - 118	REC
REC		100	300	300	20	9	B	10	20	300	300	100	Receptacles - Lab Entry 118.1	GFCI
REC	**Lab Receptacle - 118**	100	300	300	2P	11	C	12	20	300	300	100	Receptacles - Lab Entry 118.1	GFCI
REC		100	300	300	20	13	A	14	20	300	300	100	Receptacles - Housekeeping	GFCI
REC	**Lab Receptacle - 118**	100	300	300	2P	15	B	16	20	300	300	100	Receptacles - Lab Support 118.2	REC
REC		100	300	300	20	17	C	18	20	150	150	100	Gas Shut Off	D.C
REC	Lab Receptacle - 118	100	300	300	20	19	A	20	15	360	360	100	Motorized Blinds	D.C
REC	Receptacles - Lab Support 118.2	100	300	300	20	21	B	22	15	360	360	100	Motorized Blinds	D.C
		100	300	300	3P	23	C	24	20	300	300	100	Receptacle - Housekeeping	REC
D.C	Fume Hood 208V Equipment	100	300	300	↓	25	A	26	20	300	300	100	Receptacles - Lab Support 118.2	REC
	Lab Support 118.2	100	300	300	30	27	B	28	20	300	300	100	Receptacles - Lab Support 118.2	REC
REC		100	300	300	3P	29	C	30	20	300	300	100	Lab Receptacle - 118	REC
REC	Fume Hood 208V Equipment	100	300	300	↓	31	A	32	20	300	300	100	Lab Receptacle - 118	REC
REC	Lab Support 118.2	100	300	300	30	33	B	34	20	300	300	100	Lab Receptacle - 118	REC
D.C	Fume Hood Receptacle - Lab Support 118.2	100	150	150	20	35	C	36	20	300	300	100	Receptacles - Lab Support 118.2	REC
REC	Fume Hood Receptacle - Lab Support 118.2	100	150	150	20	37	A	38	20	300	300	100	Lab Receptacle - 118	REC
REC	**Lab Receptacle - 118**	100	300	300	2P	39	B	40	20	300	300	100	Lab Receptacle - 118	REC
REC		100	300	300	20	41	C	42				100	Space	

PANEL OPTIONS:

2	:CSA ENCLOSURE RATING	☐	FLUSH
☐	FEED THROUGH	☒	SURFACE
☐	SUB-FEED	☒	BOLT-ON BREAKER
☐	MAIN BREAKER	☐	SPD
☐	200% RATED NEUTRAL BUS	☐	
☐	ISOLATED GROUND BUS	☐	

LOAD A [KW]:	4.11
LOAD B [KW]:	4.26
LOAD C [KW]:	3.6
TOTAL [KW]:	12
CURRENT A [A]:	34
CURRENT B [A]:	36
CURRENT C [A]:	30

PHASE VOLTAGE [V]:	120
LINE VOLTAGE [V]:	208
PHASE:	3Φ
WIRE:	4
MAINS [A]:	225
MAIN BREAKER [A]:	
I.C. [kA]:	10

LEGEND:

BAS-Building Automation System	R.C-Relay Controlled	LTS-Lighting
GFCI-Ground Fault Circuit Interrupter	M-Motor	HID-High Intensity Discharge Lighting Breaker
AFCI-Arc Fault Circuit Interrupter	D.F-Demand Factor	
SPD - Surge Protection Device	REC-Receptacle	D.C-Direct Connection
BLO-Breaker Lock-On Device		

NOTES:

1. Panel Enclosure To Be Sprinklerproof.
2. Panels greater than 66 circuits to be double tub.
3. Surge Protection Device (SPD) to be in a separate barriered enclosure with separate cover.
4. Terminate circuits for BAS in 4"x4" junction box 10' from panel.

PANEL: RP-1E
PROJECT NAME: NRC MISSISAUGA
PROJECT #: 16158.E.000

LOCATION: LAB CORRIDOR 119

FED FROM: PP-1A

Smith + Andersen

TYPE/ INFO	DESCRIPTION	D.F [%]	CONN. LOAD [W]	DEMAND LOAD [W]	BKR [A]	CCT NO.	Φ	CCT NO.	BKR [A]	DEMAND LOAD [W]	CONN. LOAD [W]	D.F [%]	DESCRIPTION	TYPE/ INFO
REC	Auto Flush/Auto Faucet/Soap Dispenser	100	300	300	20	**1**	**A**	**2**	20	300	300	100	Lab Lighting	LTS
REC	Lab Receptacle - 117	100	300	300	20	**3**	**B**	**4**	20	300	300	100	Lab Receptacle - 117	REC
REC	Lab Receptacle - 117	100	300	300	20	**5**	**C**	**6**	20	300	300	100	Lab Receptacle - 117	REC
		100	300	300	3P	**7**	**A**	**8**	20	300	300	100	**Lab Receptacle - 117**	REC
D.C	Fume Hood 208V Equipment	100	300	300	↓	**9**	**B**	**10**	20	300	300	100	Receptacles - Lab Entry 118.1	GFCI
	Lab 117	100	300	300	30	**11**	**C**	**12**	20	300	300	100	Receptacles - Lab Entry 118.1	GFCI
		100	300	300	3P	**13**	**A**	**14**	20	300	300	100	Receptacles - Housekeeping	GFCI
D.C	Fume Hood 208V Equipment	100	300	300	↓	**15**	**B**	**16**	20	300	300	100	**Lab Receptacle - 117**	REC
	Lab 117	100	300	300	30	**17**	**C**	**18**	20	150	150	100	Gas Shut Off	D.C
REC	Receptacles - Lab Support 117.2	100	300	300	20	**19**	**A**	**20**	**2P**	150	150	100	**Lab Receptacle - 117**	REC
REC	Receptacles - Lab Support 117.2	100	300	300	20	**21**	**B**	**22**	**20**	150	150	100		REC
REC	Receptacles - Lab Support 117.2	100	300	300	2P	**23**	**C**	**24**	20	300	300	100	Receptacle - Housekeeping	REC
REC	Receptacles - Lab Support 117.2	100	300	300	20	**25**	**A**	**26**	**2P**	300	300	100	**Lab Receptacle - 117**	REC
REC	Receptacles - Lab Support 117.2	100	300	300	2P	**27**	**B**	**28**	**20**	300	300	100		REC
REC	**Lab Receptacle - 117**	100	300	300	**2P**	**29**	**C**	**30**	20	300	300	100	Lab Receptacle - 117	REC
REC		100	300	300	**20**	**31**	**A**	**32**	30	300	300	100		
REC	Lab Receptacle - 117	100	300	300	20	**33**	**B**	**34**	↓	300	300	100	Fume Hood 208V Equipment	D.C
REC	Lab Receptacle - 117	100	300	300	20	**35**	**C**	**36**	3P	300	300	100	Lab 117	
REC	Lab Receptacle - 117	100	300	300	20	**37**	**A**	**38**	30	300	300	100		
REC	**Lab Receptacle - 117**	100	300	300	**2P**	**39**	**B**	**40**	↓	300	300	100	Fume Hood 208V Equipment	D.C
REC		100	300	300	**20**	**41**	**C**	**42**	3P	300	300	100	Lab 117	

PANEL OPTIONS:

2	:CSA ENCLOSURE RATING	☐	FLUSH
☐	FEED THROUGH	☒	SURFACE
☐	SUB-FEED	☒	BOLT-ON BREAKER
☐	MAIN BREAKER	☐	SPD
☐	200% RATED NEUTRAL BUS	☐	
☐	ISOLATED GROUND BUS	☐	

LOAD A [KW]:	4.05
LOAD B [KW]:	4.05
LOAD C [KW]:	4.05
TOTAL [KW]:	12.2
CURRENT A [A]:	34
CURRENT B [A]:	34
CURRENT C [A]:	34

PHASE VOLTAGE [V]:	120
LINE VOLTAGE [V]:	208
PHASE:	3Φ
WIRE:	4
MAINS [A]:	225
MAIN BREAKER [A]:	
I.C. [kA]:	10

LEGEND:

BAS-Building Automation System	R.C-Relay Controlled	LTS-Lighting
GFCI-Ground Fault Circuit Interrupter	M-Motor	HID-High Intensity Discharge Lighting Breaker
AFCI-Arc Fault Circuit Interrupter	D.F-Demand Factor	
SPD - Surge Protection Device	REC-Receptacle	D.C-Direct Connection
BLO-Breaker Lock-On Device		

NOTES:

1. Panel Enclosure To Be Sprinklerproof.
2. Panels greater than 66 circuits to be double tub.
3. Surge Protection Device (SPD) to be in a separate barriered enclosure with separate cover.
4. Terminate circuits for BAS in 4"x4" junction box 10' from panel.

PANEL: RP-1EA
PROJECT NAME: NRC MISSISAUGA
PROJECT #: 16158.E.000

LOCATION: ELECTRICAL ROOM 103
FED FROM:

Smith + Andersen

TYPE/ INFO	DESCRIPTION	D.F [%]	CONN. LOAD [W]	DEMAND LOAD [W]	BKR [A]	CCT NO.	Φ	CCT NO.	BKR [A]	DEMAND LOAD [W]	CONN. LOAD [W]	D.F [%]	DESCRIPTION	TYPE/ INFO
LTS	Receptacles - Comms Room.	100	600	600	20	**1**	**A**	**2**	20	300	300	100	Security Panel	LTS
REC	L5-20 Receptacle - Telecomm Room.	100	150	150	20	**3**	**B**	**4**	20	300	300	100	Lab Receptacle	REC
REC	Receptacle - First Aid	100	150	150	20	**5**	**C**	**6**	20	300	300	100	Lab Receptacle	REC
REC	L5-20 Receptacle - Telecomm Room.	100	150	150	20	**7**	**A**	**8**	20	120	120	100	Gas Monitoring	D.C
REC	L5-20 Receptacle - Telecomm Room.	100	150	150	20	**9**	**B**	**10**	20	696	696	100	EF-01-01	D.C
REC	L5-20 Receptacle - Telecomm Room.	100	150	150	20	**11**	**C**	**12**	20	150	150	100	Lab Receptacle	REC
REC	filtration	100	167	167	20	**13**	**A**	**14**	20	696	696	100	EF-01-03	D.C
D.C	EF-01-02	100	696	696	20	**15**	**B**	**16**	20	167	167	100	Pre-Action System (Flammable Gas Storage)	D.C
D.C	Pre-Action System (Flammable Liquid Storage)	100	167	167	20	**17**	**C**	**18**	20	1440	1440	100	FFH-01-02 (Stairwell)	D.C
REC	Lab Receptacle	100	150	150	20	**19**	**A**	**20**	20	333	333	100	ADO - Office Area	D.C
D.C	FFH-01-01 (stairwell)	100	1440	1440	20	**21**	**B**	**22**	20	300	300	100	Lab Receptacle	REC
REC	Lab Receptacle	100	300	300	20	**23**	**C**	**24**	20	150	150	100	Lab Receptacle	REC
REC	Lab Receptacle	100	300	300	20	**25**	**A**	**26**	20	150	150	100	Lab Receptacle	REC
REC	Lab Receptacle	100	300	300	20	**27**	**B**	**28**	20	150	150	100	Lab Receptacle	REC
REC	Lab Receptacle	100	300	300	20	**29**	**C**	**30**	2P	167	167	100	Spare	
REC	Lab Receptacle	100	300	300	20	**31**	**A**	**32**	30	167	167	100		
REC	Lab Receptacle	100	300	300	20	**33**	**B**	**34**	20	1000	1000	100	Fume Hood Receptacle - Lab 118	REC
REC	Spare	100			20	**35**	**C**	**36**	20			100	Spare	REC
REC	Spare	100			20	**37**	**A**	**38**	20			100	Spare	REC
REC	Spare	100			20	**39**	**B**	**40**	20	300	300	100	Lab Receptacle - 118	REC
REC	Lab Receptacle	100	300	300	20	**41**	**C**	**42**	20	300	300	100	Lab Receptacle - 118	REC
REC	Lab Receptacle	100	300	300	20	**43**	**A**	**44**	20	300	300	100	Lab Receptacle - 118	REC
REC	Fume Hood Receptacle	100	300	300	20	**45**	**B**	**46**	20	300	300	100	Lab Receptacle - 118	REC
REC	Lab Receptacle	100	300	300	20	**47**	**C**	**48**	20	300	300	100	Lab Receptacle - 118	REC
REC	Lab Receptacle	100	300	300	20	**49**	**A**	**50**	20	300	300	100	Lab Receptacle	REC
REC	Lab Receptacle	100	300	300	20	**51**	**B**	**52**	20	300	300	100	Lab Receptacle	REC
REC	Lab Receptacle	100	300	300	20	**53**	**C**	**54**	20	300	300	100	Lab Receptacle - 118	REC
REC	Lab Receptacle	100	300	300	20	**55**	**A**	**56**	20	300	300	100	Lab Receptacle - 118	REC
REC	Lab Receptacle	100	300	300	20	**57**	**B**	**58**	20	300	300	100	Lab Receptacle	REC
REC	Lab Receptacle	100	300	300	20	**59**	**C**	**60**	20	300	300	100	Lab Receptacle	REC
REC	Lab Receptacle	100	300	300	20	**61**	**A**	**62**	20	300	300	100	Lab Receptacle	REC
REC	Lab Receptacle	100	300	300	20	**63**	**B**	**64**	20	300	300	100	Lab Receptacle	REC
REC	Fume Hood Receptacle	100	300	300	20	**65**	**C**	**66**	20	300	300	100	Lab Receptacle	REC
D.C	Hazmat Drum	100	167	167	20	**67**	**A**	**68**	3P	167	167	100		
D.C	Hazmat Drum	100	167	167	20	**69**	**B**	**70**	↓	167	167	100	Generator	D.C
D.C	Elevator E1	100	400	400	20	**71**	**C**	**72**	60	167	167	100		
D.C	Elevator E2	100	400	400	20	**73**	**A**	**74**	20	300	300	100	Lab Receptacle	REC

PANEL: RP-1EA
PROJECT NAME: NRC MISSISAUGA
PROJECT #: 16158.E.000

LOCATION: ELECTRICAL ROOM 103
FED FROM:

Smith + Andersen

TYPE/ INFO	DESCRIPTION	D.F [%]	CONN. LOAD [W]	DEMAND LOAD [W]	BKR [A]	CCT NO.	Φ	CCT NO.	BKR [A]	DEMAND LOAD [W]	CONN. LOAD [W]	D.F [%]	DESCRIPTION	TYPE/ INFO
REC	Lab Receptacle	100	300	300	20	**75**	**B**	**76**	20	167	167	100	L1 BAS	D.C
REC	Lab Receptacle	100	300	300	20	**77**	**C**	**78**	20	167	167	100	L2 BAS	D.C
REC	Lab Receptacle	100	300	300	20	**79**	**A**	**80**	20	300	300	100	Fume Hood Receptacle	REC
REC	Lab Receptacle	100	300	300	20	**81**	**B**	**82**	20	300	300	100	Lab Receptacle	REC
REC	Lab Receptacle	100	300	300	20	**83**	**C**	**84**	20	300	300	100	Lab Receptacle	REC

PANEL OPTIONS:

2	:CSA ENCLOSURE RATING	☐	FLUSH
☐	FEED THROUGH	☒	SURFACE
☐	SUB-FEED	☒	BOLT-ON BREAKER
☐	MAIN BREAKER	☐	SPD
☐	200% RATED NEUTRAL BUS	☐	
☐	ISOLATED GROUND BUS	☐	

LOAD A [KW]:	7.47
LOAD B [KW]:	9.75
LOAD C [KW]:	7.91
TOTAL [KW]:	25.1
CURRENT A [A]:	62
CURRENT B [A]:	81
CURRENT C [A]:	66

PHASE VOLTAGE [V]:	120
LINE VOLTAGE [V]:	208
PHASE:	3Φ
WIRE:	4
MAINS [A]:	225
MAIN BREAKER [A]:	
I.C. [kA]:	10

LEGEND:

BAS-Building Automation System	R.C-Relay Controlled	LTS-Lighting
GFCI-Ground Fault Circuit Interrupter	M-Motor	HID-High Intensity Discharge Lighting Breaker
AFCI-Arc Fault Circuit Interrupter	D.F-Demand Factor	
SPD - Surge Protection Device	REC-Receptacle	D.C-Direct Connection
BLO-Breaker Lock-On Device		

NOTES:

1. Panel Enclosure To Be Sprinklerproof.
2. Panels greater than 66 circuits to be double tub.
3. Surge Protection Device (SPD) to be in a separate barriered enclosure with separate cover.
4. Terminate circuits for BAS in 4"x4" junction box 10' from panel.

PANEL: RP-1EB

PROJECT NAME: NRC MISSISAUGA

PROJECT #: 16158.E.000

LOCATION: ELECTRICAL ROOM 103

FED FROM: RP-1EA

Smith + Andersen

TYPE/ INFO	DESCRIPTION	D.F [%]	CONN. LOAD [W]	DEMAND LOAD [W]	BKR [A]	CCT NO.	Φ	CCT NO.	BKR [A]	DEMAND LOAD [W]	CONN. LOAD [W]	D.F [%]	DESCRIPTION	TYPE/ INFO
REC	LAB RECEPTACLE 106	100	300	300	20	**1**	**A**	**2**	20	300	300	100	LAB RECEPTACLE - High Bay Lab - 113	REC
REC	LAB RECEPTACLE 106	100	300	300	20	**3**	**B**	**4**	20	300	300	100	LAB RECEPTACLE - High Bay Lab - 113	REC
REC	LAB RECEPTACLE 105	100	300	300	20	**5**	**C**	**6**	20	300	300	100	LAB RECEPTACLE - High Bay Lab - 113	REC
REC	LAB RECEPTACLE 105	100	300	300	20	**7**	**A**	**8**	20	300	300	100	Receptacles - Lab Support 113.2	REC
REC	FUME HOOD RECEPTACLE - Lab 105	100	150	150	20	**9**	**B**	**10**	20	300	300	100	Receptacles - Lab Support 113.2	REC
REC	LAB RECEPTACLE 105	100	300	300	20	**11**	**C**	**12**	20	300	300	100	LAB RECEPTACLE - High Bay Lab - 113	REC
REC	LAB RECEPTACLE 105	100	300	300	20	**13**	**A**	**14**	20	300	300	100	LAB RECEPTACLE - High Bay Lab - 113	REC
REC	LAB RECEPTACLE 105	100	300	300	20	**15**	**B**	**16**	20	300	300	100	LAB RECEPTACLE - High Bay Lab - 113	REC
REC	LAB RECEPTACLE 105	100	300	300	20	**17**	**C**	**18**	20	300	300	100	LAB RECEPTACLE - High Bay Lab - 113	REC
REC	LAB RECEPTACLE 105	100	300	300	20	**19**	**A**	**20**	20	300	300	100	LAB RECEPTACLE - High Bay Lab - 113	REC
REC	Spare	100	300	300	20	**21**	**B**	**22**	20	300	300	100	LAB RECEPTACLE - High Bay Lab - 113	REC
REC	Spare	100	300	300	20	**23**	**C**	**24**	20	300	300	100	Spare	REC
REC	Spare	100	300	300	20	**25**	**A**	**26**	20	300	300	100	LAB RECEPTACLE - High Bay Lab - 113	REC
REC	Spare	100	300	300	20	**27**	**B**	**28**	20			100		
		100			20	**29**	**C**	**30**	20			100		
		100			20	**31**	**A**	**32**	20			100		
		100			20	**33**	**B**	**34**	20			100		
		100			20	**35**	**C**	**36**	20			100		
		100			15	**37**	**A**	**38**	20			100		
		100			15	**39**	**B**	**40**	20			100		
		100			15	**41**	**C**	**42**	20			100		
		100			15	**43**	**A**	**44**	15			100		
		100			15	**45**	**B**	**46**	15			100		
		100			15	**47**	**C**	**48**	15			100		
		100			15	**49**	**A**	**50**	15			100		
		100			15	**51**	**B**	**52**	15			100		
		100			15	**53**	**C**	**54**	15			100		
		100			15	**55**	**A**	**56**	15			100		
		100			15	**57**	**B**	**58**	15			100		
		100			15	**59**	**C**	**60**	15			100		
		100			15	**61**	**A**	**62**	15			100		
		100			15	**63**	**B**	**64**	15			100		
		100			15	**65**	**C**	**66**	15			100		
		100			15	**67**	**A**	**68**	15			100		
		100			15	**69**	**B**	**70**	15			100		
		100			15	**71**	**C**	**72**	15			100		
		100			15	**73**	**A**	**74**	15			100		
		100			15	**75**	**B**	**76**	15			100		
		100			15	**77**	**C**	**78**	15			100		
		100			15	**79**	**A**	**80**	15			100		

PANEL: RP-1EB
PROJECT NAME: NRC MISSISAUGA
PROJECT #: 16158.E.000

LOCATION: ELECTRICAL ROOM 103

FED FROM: RP-1EA

Smith + Andersen

TYPE/ INFO	DESCRIPTION	D.F [%]	CONN. LOAD [W]	DEMAND LOAD [W]	BKR [A]	CCT NO.	Φ	CCT NO.	BKR [A]	DEMAND LOAD [W]	CONN. LOAD [W]	D.F [%]	DESCRIPTION	TYPE/ INFO
		100			15	**81**	**B**	**82**	15			100		
		100			15	**83**	**C**	**84**	15			100		

PANEL OPTIONS:

2	:CSA ENCLOSURE RATING	☐	FLUSH
☐	FEED THROUGH	☒	SURFACE
☐	SUB-FEED	☒	BOLT-ON BREAKER
☐	MAIN BREAKER	☐	SPD
☐	200% RATED NEUTRAL BUS	☐	
☐	ISOLATED GROUND BUS	☐	

LOAD A [KW]:	3
LOAD B [KW]:	2.55
LOAD C [KW]:	2.4
TOTAL [KW]:	7.95
CURRENT A [A]:	25
CURRENT B [A]:	21
CURRENT C [A]:	20

PHASE VOLTAGE [V]:	120
LINE VOLTAGE [V]:	208
PHASE:	3Φ
WIRE:	4
MAINS [A]:	225
MAIN BREAKER [A]:	
I.C. [kA]:	10

LEGEND:

BAS-Building Automation System	R.C-Relay Controlled	LTS-Lighting
GFCI-Ground Fault Circuit Interrupter	M-Motor	HID-High Intensity Discharge Lighting Breaker
AFCI-Arc Fault Circuit Interrupter	D.F-Demand Factor	
SPD - Surge Protection Device	REC-Receptacle	D.C-Direct Connection
BLO-Breaker Lock-On Device		

NOTES:

1. Panel Enclosure To Be Sprinklerproof.
2. Panels greater than 66 circuits to be double tub.
3. Surge Protection Device (SPD) to be in a separate barriered enclosure with separate cover.
4. Terminate circuits for BAS in 4"x4" junction box 10' from panel.

FOR OFFICE USE ONLY:

UPSTREAM PROTECTION [A]:	N/A	INSERT UPSTREAM PROTECTION SIZE TO CONFIRM PROPER SIZE
TRANSFORMER UPSTREAM [kVA]:	N/A	INSERT IMMEDIATE UPSTREAM TRANSFORMER FEEDING PANEL TO CONFIRM PROPER PANEL AND TRANSFORMER SIZE

LOADS BALANCED ACROSS PHASES:	**BALANCED**
PANEL MAINS SIZED PROPERLY:	YES
MAIN BREAKER SIZED PROPERLY:	N/A
UPSTREAM PROTECTION SIZED PROPERLY:	N/A
TF PRIMARY PROTECTION LOADING APPROPRIATE:	N/A
LOAD ON TRANSFORMER APPROPRIATE:	N/A

GREEN CELLS ARE DROP DOWN LISTS
YELLOW CELLS ARE USER INPUT FIELDS

PANEL: RP-1F
PROJECT NAME: NRC MISSISAUGA
PROJECT #: 16158.E.000

LOCATION: LAB CORRIDOR 119

FED FROM: PP-1A

Smith + Andersen

TYPE/ INFO	DESCRIPTION	D.F [%]	CONN. LOAD [W]	DEMAND LOAD [W]	BKR [A]	CCT NO.	Φ	CCT NO.	BKR [A]	DEMAND LOAD [W]	CONN. LOAD [W]	D.F [%]	DESCRIPTION	TYPE/ INFO
REC	Auto Flush/Auto Faucet/Soap Dispenser	100	300	300	20	**1**	**A**	**2**	20	300	300	100	Lab Lighting	LTS
REC		100	300	300	3P	**3**	**B**	**4**	20	300	300	100	Lab Lighting	REC
REC	Fume Hood 208V Equipment	100	300	300	↓	**5**	**C**	**6**	20	300	300	100	Lab Receptacle - 116	REC
REC	Lab 116	100	300	300	30	**7**	**A**	**8**	20	300	300	100	Lab Receptacle - 116	REC
REC		100	300	300	3P	**9**	**B**	**10**	20	300	300	100	Receptacles - Lab Entry 116.1	GFCI
REC	Fume Hood 208V Equipment	100	300	300	↓	**11**	**C**	**12**	20	300	300	100	Receptacles - Lab Entry 116.1	GFCI
REC	Lab 116	100	300	300	30	**13**	**A**	**14**	20	300	300	100	Receptacles - Housekeeping	GFCI
REC	**Lab Receptacle - 116**	100	300	300	**2P**	**15**	**B**	**16**	20	300	300	100	Lab Receptacle - 116	
REC		100	300	300	**20**	**17**	**C**	**18**	20	150	150	100	Gas Shut Off	
REC	Lab Receptacle - 116	100	300	300	20	**19**	**A**	**20**	15	360	360	100	Motorized Blinds	D.C
REC	Receptacles - Lab Support 116.2	100	300	300	20	**21**	**B**	**22**	15	180	180	100	Motorized Blinds	D.C
	Receptacles - Lab Support 116.2	100	300	300	2P	**23**	**C**	**24**	20	300	300	100	Receptacle - Housekeeping	REC
D.C	Receptacles - Lab Support 116.2	100	300	300	20	**25**	**A**	**26**	3P	300	300	100		REC
	Receptacles - Lab Support 116.2	100	300	300	2P	**27**	**B**	**28**	↓	300	300	100	Fume Hood 208V Equipment	REC
REC	Lab Receptacle - 116	100	300	300	20	**29**	**C**	**30**	30	300	300	100	Lab 116	REC
REC	Lab Receptacle - 116	100	300	300	20	**31**	**A**	**32**	3P	300	300	100		REC
REC	**Lab Receptacle - 116**	100	300	300	**2P**	**33**	**B**	**34**	↓	300	300	100	Fume Hood 208V Equipment	REC
REC		100	300	300	**20**	**35**	**C**	**36**	30	300	300	100	Lab 116	REC
REC	**Lab Receptacle - 116**	100	300	300	**2P**	**37**	**A**	**38**	20	300	300	100	Lab Receptacle - 116	REC
REC		100	300	300	**20**	**39**	**B**	**40**	**2P**	300	300	100	**Lab Receptacle - 116**	REC
REC	Lab Receptacle - 116	100	300	300	20	**41**	**C**	**42**	**20**	300	300	100		REC

PANEL OPTIONS:

2	:CSA ENCLOSURE RATING	☐	FLUSH
☐	FEED THROUGH	☒	SURFACE
☐	SUB-FEED	☒	BOLT-ON BREAKER
☐	MAIN BREAKER	☐	SPD
☐	200% RATED NEUTRAL BUS	☐	
☐	ISOLATED GROUND BUS	☐	

LOAD A [KW]:	4.26
LOAD B [KW]:	4.08
LOAD C [KW]:	4.05
TOTAL [KW]:	12.4
CURRENT A [A]:	36
CURRENT B [A]:	34
CURRENT C [A]:	34

PHASE VOLTAGE [V]:	120
LINE VOLTAGE [V]:	208
PHASE:	3Φ
WIRE:	4
MAINS [A]:	225
MAIN BREAKER [A]:	
I.C. [kA]:	10

LEGEND:

BAS-Building Automation System	R.C-Relay Controlled	LTS-Lighting
GFCI-Ground Fault Circuit Interrupter	M-Motor	HID-High Intensity Discharge Lighting Breaker
AFCI-Arc Fault Circuit Interrupter	D.F-Demand Factor	
SPD - Surge Protection Device	REC-Receptacle	D.C-Direct Connection
BLO-Breaker Lock-On Device		

NOTES:

1. Panel Enclosure To Be Sprinklerproof.
2. Panels greater than 66 circuits to be double tub.
3. Surge Protection Device (SPD) to be in a separate barriered enclosure with separate cover.
4. Terminate circuits for BAS in 4"x4" junction box 10' from panel.

PANEL: RP-1G
PROJECT NAME: NRC MISSISAUGA
PROJECT #: 16158.E.000

LOCATION: LAB CORRIDOR 119

FED FROM: PP-1A

Smith + Andersen

TYPE/ INFO	DESCRIPTION	D.F [%]	CONN. LOAD [W]	DEMAND LOAD [W]	BKR [A]	CCT NO.	Φ	CCT NO.	BKR [A]	DEMAND LOAD [W]	CONN. LOAD [W]	D.F [%]	DESCRIPTION	TYPE/ INFO
REC	Receptacles High Bay Lab - 113	100	300	300	20	**1**	**A**	**2**	20	300	300	100	Lab Lighting	LTS
REC	Receptacles High Bay Lab - 113	100	300	300	20	**3**	**B**	**4**	20	300	300	100	Lab Lighting	LTS
REC	Receptacles High Bay Lab - 113	100	300	300	20	**5**	**C**	**6**	20	300	300	100	Lighting - Machine Room	LTS
REC	Receptacles High Bay Lab - 113	100	300	300	20	**7**	**A**	**8**	20	150	150	100	Gas Shut off	D.C
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	20	**9**	**B**	**10**	3P	300	300	100		
REC	Receptacles High Bay Lab - 113	100	300	300	20	**11**	**C**	**12**	↓	300	300	100	Fume Hood 208V Equipment	REC
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	20	**13**	**A**	**14**	30	300	300	100	High Bay Lab - 113	
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	20	**15**	**B**	**16**	20	300	300	100	Fume Hood Receptacle High Bay Lab - 113	REC
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	20	**17**	**C**	**18**	3P	300	300	100		
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	20	**19**	**A**	**20**	↓	300	300	100	Fume Hood 208V Equipment	REC
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	2	**21**	**B**	**22**	30	300	300	100	High Bay Lab - 113	
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	2	**23**	**C**	**24**	20	150	150	100	Fume Hood Receptacle High Bay Lab - 113	REC
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	20	**25**	**A**	**26**				100	Space	REC
	Spare	100	300	300	20	**27**	**B**	**28**	20	300	300	100	Receptacles - Lab Entry 113.1	REC
	Spare	100	300	300	20	**29**	**C**	**30**	20	300	300	100	Receptacles - Lab Entry 113.1	REC
REC	Receptacles - Lab Entry 113.1	100	300	300	20	**31**	**A**	**32**	20	300	300	100	Receptacles - Lab Support 113.2	REC
REC	Receptacles - Lab Entry 113.1	100	300	300	20	**33**	**B**	**34**	20	300	300	100	Receptacles - Lab Support 113.2	REC
GFCI	Receptacles - Lab Entry 113.1	100	300	300	20	**35**	**C**	**36**	20	300	300	100	Receptacles - Lab Support 113.2	REC
REC	Receptacles - Lab Support 113.2	100	300	300	20	**37**	**A**	**38**	20	300	300	100	Receptacles - Lab Support 113.2	REC
REC	Receptacles - Lab Support 113.2	100	300	300	20	**39**	**B**	**40**	20	300	300	100	Receptacles - Lab Support 113.2	REC
REC	Receptacles (GFCI)	100	300	300	20	**41**	**C**	**42**				100	Space	
	Spare	100	150	150	20	**43**	**A**	**44**				100	Space	
REC	Receptacles - Lab Bench High Bay Lab - 113	100	150	150	20	**45**	**B**	**46**				100	Space	
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	20	**47**	**C**	**48**	3P	300	300	100		
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	20	**49**	**A**	**50**	↓	300	300	100	Fume Hood 208V Equipment	
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	20	**51**	**B**	**52**	30	300	300	100		
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	20	**53**	**C**	**54**	3P			100		
REC	Receptacles High Bay Lab - 113	100	300	300	20	**55**	**A**	**56**	↓			100	Overhead Door	M
REC	Receptacles High Bay Lab - 113	100	300	300	20	**57**	**B**	**58**	20			100		
REC	Receptacles High Bay Lab - 113	100	300	300	20	**59**	**C**	**60**	3P	300	300	100		
REC	Receptacles High Bay Lab - 113	100	300	300	20	**61**	**A**	**62**	↓	300	300	100	208V Equipment	
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	20	**63**	**B**	**64**	30	300	300	100		
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	20	**65**	**C**	**66**	3P	300	300	100		
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	20	**67**	**A**	**68**	↓	300	300	100	208V Equipment	
REC	Receptacles - Lab Bench High Bay Lab - 113	100	300	300	20	**69**	**B**	**70**	30	300	300	100		
	Spare	100	300	300	20	**71**	**C**	**72**				100	Space	
	Spare	100	300	300	20	**73**	**A**	**74**				100	Space	

PANEL: RP-1G
PROJECT NAME: NRC MISSISAUGA
PROJECT #: 16158.E.000

LOCATION: LAB CORRIDOR 119

FED FROM: PP-1A

Smith + Andersen

TYPE/ INFO	DESCRIPTION	D.F [%]	CONN. LOAD [W]	DEMAND LOAD [W]	BKR [A]	CCT NO.	Φ	CCT NO.	BKR [A]	DEMAND LOAD [W]	CONN. LOAD [W]	D.F [%]	DESCRIPTION	TYPE/ INFO
		100	300	300	3P	**75**	**B**	**76**	3P	300	300	100		
	Fume Hood 208V Equipment	100	300	300	↓	**77**	**C**	**78**	↓	300	300	100	Fume Hood 208V Equipment	
	High Bay Lab - 113	100	300	300	30	**79**	**A**	**80**	30	300	300	100		
	Spare	100	300	300	20	**81**	**B**	**82**				100	Space	REC
	Spare	100	300	300	20	**83**	**C**	**84**				100	Space	REC

PANEL OPTIONS:

2	:CSA ENCLOSURE RATING	☐	FLUSH
☐	FEED THROUGH	☒	SURFACE
☐	SUB-FEED	☒	BOLT-ON BREAKER
☐	MAIN BREAKER	☐	SPD
☐	200% RATED NEUTRAL BUS	☐	
☐	ISOLATED GROUND BUS	☐	

LOAD A [KW]:	9
LOAD B [KW]:	9.45
LOAD C [KW]:	9.15
TOTAL [KW]:	27.6
CURRENT A [A]:	75
CURRENT B [A]:	79
CURRENT C [A]:	76

PHASE VOLTAGE [V]:	120
LINE VOLTAGE [V]:	208
PHASE:	3Φ
WIRE:	4
MAINS [A]:	225
MAIN BREAKER [A]:	
I.C. [kA]:	10

LEGEND:

BAS-Building Automation System	R.C-Relay Controlled	LTS-Lighting
GFCI-Ground Fault Circuit Interrupter	M-Motor	HID-High Intensity Discharge Lighting Breaker
AFCI-Arc Fault Circuit Interrupter	D.F-Demand Factor	
SPD - Surge Protection Device	REC-Receptacle	D.C-Direct Connection
BLO-Breaker Lock-On Device		

NOTES:

1. Panel Enclosure To Be Sprinklerproof.
2. Panels greater than 66 circuits to be double tub.
3. Surge Protection Device (SPD) to be in a separate barriered enclosure with separate cover.
4. Terminate circuits for BAS in 4"x4" junction box 10' from panel.

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 be 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 Nothwithstanding 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 that 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.

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 or 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 "superintendant" 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 ths 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 o 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 proved 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 GC303.3 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, ar 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 wiring 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 that

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 n 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

IC 1 Proof of Insurance
IC 2 Risk Management
IC 3 Payment of Deductible
IC 4 Insurance Coverage

GENERAL INSUANCE COVERAGES

GCI 1 Insured
GIC 2 Period of Insurance
GIC 3 Proof of Insurance
GIC 4 Notification

COMMERCIAL GENERAL LIABILITY

CGL 1 Scope of Policy
CGL 2 Coverages/Provisions
CGL 3 Additional Exposures
CGL 4 Insurance Proceeds
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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 Contactor.

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 INSUANCE 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 a t 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.

Government of Canada / Gouvernement du Canada

Contract Number / Numéro du contrat	
Security Classification / Classification de sécurité UNCLASSIFIED	

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
NRC	Your C/B/I RPPM
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

Make required modifications to Mechanical & Electrical systems for the asset under construction located at 2620 Speakman dr. , Mississauga, Ontario.

5. a) Will the supplier require access to Controlled Goods? Le fournisseur aura-t-il accès à des marchandises contrôlées?	✔ No / Non	☐ 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?	✔ No / Non	☐ 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)	✔ No / Non	☐ 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.	✔ No / Non	☐ 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?	✔ No / Non	☐ 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 ✔	**NATO / OTAN** ☐	**Foreign / Étranger** ☐

7. b) Release restrictions / Restrictions relatives à la diffusion

No release restrictions Aucune restriction relative à la diffusion ✔	All NATO countries Tous les pays de l'OTAN ☐	No release restrictions Aucune restriction relative à la diffusion ☐
Not releasable À ne pas diffuser ☐		
Restricted to: / Limité à : ☐	Restricted to: / Limité à : ☐	Restricted to: / Limité à : ☐
Specify country(ies): / Préciser le(s) pays :	Specify country(ies): / Préciser le(s) pays :	Specify country(ies): / Préciser le(s) pays :

7. c) Level of information / Niveau d'information

PROTECTED A / PROTÉGÉ A ☐	NATO UNCLASSIFIED / NATO NON CLASSIFIÉ ☐	PROTECTED A / PROTÉGÉ A ☐
PROTECTED B / PROTÉGÉ B ☐	NATO RESTRICTED / NATO DIFFUSION RESTREINTE ☐	PROTECTED B / PROTÉGÉ B ☐
PROTECTED C / PROTÉGÉ C ☐	NATO CONFIDENTIAL / NATO CONFIDENTIEL ☐	PROTECTED C / PROTÉGÉ C ☐
CONFIDENTIAL / CONFIDENTIEL ☐	NATO SECRET / NATO SECRET ☐	CONFIDENTIAL / CONFIDENTIEL ☐
SECRET / SECRET ☐	COSMIC TOP SECRET / COSMIC TRÈS SECRET ☐	SECRET / SECRET ☐
TOP SECRET / TRÈS SECRET ☐		TOP SECRET / TRÈS SECRET ☐
TOP SECRET (SIGINT) / TRÈS SECRET (SIGINT) ☐		TOP SECRET (SIGINT) / TRÈS SECRET (SIGINT) ☐

PART A *(continued)* / PARTIE A *(suite)*

8. Will the supplier require access to PROTECTED and/or CLASSIFIED COMSEC information or assets? ☑ No / Non ☐ Yes / Oui
Le fournisseur aura-t-il accès à des renseignements ou à des biens COMSEC désignés PROTÉGÉS et/ou CLASSIFIÉS?
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? ☑ No / Non ☐ Yes / Oui
Le fournisseur aura-t-il accès à des renseignements ou à des biens INFOSEC de nature extrêmement délicate?

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

☐ RELIABILITY STATUS COTE DE FIABILITÉ	☐ CONFIDENTIAL CONFIDENTIEL	☐ SECRET SECRET	☐ TOP SECRET TRÈS SECRET
☐ TOP SECRET– SIGINT TRÈS SECRET – SIGINT	☐ NATO CONFIDENTIAL NATO CONFIDENTIEL	☐ NATO SECRET NATO SECRET	☐ COSMIC TOP SECRET COSMIC TRÈS SECRET
☑ SITE ACCESS ACCÈS AUX EMPLACEMENTS			

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? ☐ No / Non ☑ Yes / Oui
Du personnel sans autorisation sécuritaire peut-il se voir confier des parties du travail?

If Yes, will unscreened personnel be escorted? ☐ No / Non ☑ Yes / Oui
Dans l'affirmative, le personnel en question sera-t-il escorté?

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? ☑ No / Non ☐ Yes / Oui
Le fournisseur sera-t-il tenu de recevoir et d'entreposer sur place des renseignements ou des biens PROTÉGÉS et/ou CLASSIFIÉS?

11. b) Will the supplier be required to safeguard COMSEC information or assets? ☑ No / Non ☐ Yes / Oui
Le fournisseur sera-t-il tenu de protéger des renseignements ou des biens COMSEC?

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? ☑ No / Non ☐ Yes / Oui
Les installations du fournisseur serviront-elles à la production (fabrication et/ou réparation et/ou modification) de matériel PROTÉGÉ et/ou CLASSIFIÉ?

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? ☑ No / Non ☐ Yes / Oui
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?

11. e) Will there be an electronic link between the supplier's IT systems and the government department or agency? ☑ No / Non ☐ Yes / Oui
Disposera-t-on d'un lien électronique entre le système informatique du fournisseur et celui du ministère ou de l'agence gouvernementale?

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 A	 B	 C	CONFIDENTIAL CONFIDENTIEL	SECRET	TOP SECRET TRES SECRET
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?
La description du travail visé par la présente LVERS est-elle de nature PROTÉGÉE et/ou CLASSIFIÉE?

☑ No / Non ☐ Yes / Oui

If Yes, classify this form by annotating the top and bottom in the area entitled "Security Classification".
Dans l'affirmative, classifier 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?
La documentation associée à la présente LVERS sera-t-elle PROTÉGÉE et/ou CLASSIFIÉE?

☑ No / Non ☐ Yes / 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, classifier le présent formulaire en indiquant le niveau de sécurité dans la case intitulée « Classification de sécurité » au haut et au bas du formulaire et indiquer qu'il y a des pièces jointes (p. ex. SECRET avec des pièces jointes).

Government of Canada / Gouvernement du Canada

Contract Number / Numéro du contrat	
Security Classification / Classification de sécurité UNCLASSIFIED	

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
Masood JahanMir	Project Manager	

Telephone No. - N° de téléphone	Facsimile No. - N° de télécopieur	E-mail address - Adresse courriel	Date
613 291 7671		masood.jahanmir@nrc-cnrc.gc.ca	July 21, 2020

14. Organization Security Authority / Responsable de la sécurité de l'organisme

Name (print) - Nom (en lettres moulées)	Title - Titre	Signature
Tori Pelletier	Analyst, Security in Contracting	

Telephone No. - N° de téléphone	Facsimile No. - N° de télécopieur	E-mail address - Adresse courriel	Date
613-998-7352	613-990-0946	Tori.Pelletier@nrc-cnrc.gc.ca	

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?

☑ No / Non ☐ Yes / Oui

16. Procurement Officer / Agent d'approvisionnement

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

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