Request for Services #26-031 Issued by Waterloo Regional Health Network (WRHN), issued as a Second-Stage Invitational Process Under the MMC Agreement NO. CW21906 for General Contractors.

Waterloo Regional Health Network (WRHN)

Positron Emission Tomography (PET) CT Scanner

PROJECT SPECIFICATIONS MANUAL

September 2026

mcCallumSather

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1.0 CONTRADICTIONS BETWEEN PRESCRIPTIONS

.1 If contradictions between prescriptions in different technical sections and Division 1 sections occurs, Division 1 sections take procedure. Following specification on contradictions between contractual documents according to documents on different public contracts by CCDC.

.1 Order of priority, first to last, as following:

.1 Agreement between Owner and Contractor;

.2 Definitions;

.3 Additional or Supplementary Conditions;

.4 General Conditions;

.5 Division1 of descriptive specifications;

.6 Technical specifications;

.7 material and finishing schedules;

.8 Drawings.

.2 Large scale drawings prevail on small scale drawings bearing same date.

.3 In drawings, dimensions specified prevail to measured dimensions or dimensions scaled from drawings.

.4 amended or later dated documents shall govern over earlier documents of the same type.

.5 Noted materials and annotations shall govern over graphic indications

END OF SECTION

1.1 Document Responsibility

.1 Refer to Project Manual, Section 00 01 10 - Table of Contents, for indication of document responsibility (DR). Abbreviations for entity responsible for document preparation are as follows:

a. A - Denotes documents prepared by Architect.
b. C - Denotes documents prepared by Civil Engineer.
c. E - Denotes documents prepared by Electrical Engineer.
d. M - Denotes documents prepared by Mechanical Engineer.
e. O - Denotes documents prepared by Owner.
f. S - Denotes documents prepared by Structural Engineer.

.2 Professional seals if applied next to company names in the project directory (below) govern only those specification sections and schedules identified by the corresponding document responsibility (DR) abbreviation in Section 00 01 10.

a. With regard to Section 00 31 00: The architect's seal governs only Section 00 31 00 proper, and not the documents listed therein.
b. With regard to Section 00 73 00: The architect's seal governs only Section 00 73 00 proper, and not the Supplementary Conditions included therein.

1.2 Project Directory

.1 Project Address:
WRHN @ Midtown
835 King St. W., Kitchener, ON

.2 Owner:
WRHN @ Midtown
835 King St. W., Kitchener, ON

.3 Architect (the *Consultant*) & Mechanical Engineer:
McCallum Sather Architects Inc.
003-128A Sterling Road, ON M6R 2B7

.4 Mechanical Engineer
McCallum Sather Architects Inc.
003-128A Sterling Road, ON M6R 2B7

.5 Electrical Engineer:
Seguin Engineering
12 Argyle St. N., Caledonia, Ontario, N3W 1B6

.6 Structural Engineer:
Tacoma Engineers
155 Frobisher Drive, Suite F220
Waterloo, Ontario N2V 2E1

END OF SECTION

PART 1 GENERAL

1.1 LIST OF PREQUALIFIED BIDDERS

.1 Amico Infrastructure Inc.

Area Construction

Basekamp Construction Corporation

BDA Inc.

Buttcon Limited

Gen-eer Construction Limited

Harbridge & Cross Limited

Merit Contractors Niagara

Michael + Clark Construction Inc.

MJ Dixon Construction Limited

Newgen Construction Corporation

Norlon Builders London Limited

PCL Constructors Canada Inc.

REA Construction

Tonda Construction Limited

END OF DOCUMENT

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Appendix A: Planned Work ICRA Matrix Form: by Waterloo Regional Health Network, consisting of 9 pages.

Appendix B: Contractor Policy: by Grand River Hospital dated October 2015, consisting of 35 pages.

Appendix C: Appendix C- COVID-19 Vaccine Policy and Vendor Attestation: by Waterloo Regional Health Network (WRHN), consisting of 7 pages

Appendix D: Contractor Requirements – Respectful Workplace Policy by Waterloo Regional Health Network (WRHN), consisting of 3 pages.

Appendix E: Designated Substance Report for WRHN (GRH).

Appendix F: WRHN milestone schedule. By WRHN.

END OF SECTION

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Submission Instructions for Suppliers

Please follow these instructions to submit via our Public Portal.

1. Prepare your submission materials:

Requested Information

Name	Type	# Files	Requirement
Supplementary Qualification Form (Document 00 42 13)-completed in full and signed	File Type: PDF (.pdf)	1	Required
CCDC 11 (2019) completed in full for the General Contractor, demonstrating a minimum of ten (10) years' experience in healthcare construction	File Type: PDF (.pdf)	1	Required
Letter from the Bidder's bonding company (licensed surety) confirming bonding capacity for the Project and total bonding limit with amount currently in use	File Type: PDF (.pdf)	1	Required

Name	Type	# Files	Requirement
Signed Certificate of Insurance from a duly licensed Canadian insurer confirming intention to provide coverage in accordance with Bid Document requirements	File Type: PDF (.pdf)	1	Required
Letter from the Bidder's financial institution confirming sound credit standing, with written authorization for the Owner to procure a credit report	File Type: PDF (.pdf)	1	Required
Bidder's current WSIB Clearance Certificate (Workplace Safety & Insurance Board)	File Type: PDF (.pdf)	1	Required
Current WSIB CAD 7 Report, MAP Program or WISR statement; or equivalent documentation for Bidders operating outside Ontario	File Type: PDF (.pdf)	1	Required
CSA infection control certifications (most recent): Fundamentals of Infection Control During Construction, Renovation and Maintenance of	File Type: PDF (.pdf)	1	Required

Name	Type	# Files	Requirement
Healthcare Facilities AND Effective Implementation and Practical Applications of Infection Control During Construction, Renovation and Maintenance of Health Care Facilities			
Document 00 41 13 - Base Bid Form	File Type: PDF (.pdf)	1	Required
Document 00 41 16 - Bid Breakdown Form	File Type: PDF (.pdf)	1	Required
Document 00 43 23 - Supplementary Bid Form - Alternative Prices	File Type: PDF (.pdf)	1	Required
Document 00 43 25 – Supplementary Bid Form – Labour Rates	File Type: PDF (.pdf)	1	Required
Bid bond in the amount of ten percent (10%) of the Bid Price	File Type: PDF (.pdf)	1	Required
Agreement to bond in the amount of fifty percent (50%) of the Bid Price	File Type: PDF (.pdf)	1	Required
Preliminary project schedule in the form of a gantt chart (or	File Type: Any (.csv, .pdf, .xls, .xlsx, .ppt, .pptx, .bmp, .gif,	Multiple	Required

Name	Type	# Files	Requirement
other industry standard software) detailing major project milestones, product lead times and approach. Include a narrative describing overall project approach.	.jpeg, .jpg, .jpe, .png, .tiff, .tif, .txt, .text, .rtf, .doc, .docx, .dot, .dotx, .word, .dwg, .dwf, .dxf, .mp3, .wav, .avi, .mov, .mp4, .mpeg, .wmv, .zip)		
Domestic Supply Chain Plan (DSCP) - complete template and submit with bid	File Type: Any (.csv, .pdf, .xls, .xlsx, .ppt, .pptx, .bmp, .gif, .jpeg, .jpg, .jpe, .png, .tiff, .tif, .txt, .text, .rtf, .doc, .docx, .dot, .dotx, .word, .dwg, .dwf, .dxf, .mp3, .wav, .avi, .mov, .mp4, .mpeg, .wmv, .zip)	1	Required
Key Personnel Form (if applicable, complete and submit with bid)	File Type: PDF (.pdf)	1	Optional
Agreement to Bond Form – complete and submit with bid.	File Type: PDF (.pdf)	1	Required
Supporting Documents (use if required)	File Type: Any (.csv, .pdf, .xls, .xlsx, .ppt, .pptx, .bmp, .gif, .jpeg, .jpg, .jpe, .png, .tiff, .tif, .txt, .text, .rtf, .doc, .docx, .dot, .dotx, .word, .dwg, .dwf, .dxf, .mp3, .wav, .avi, .mov, .mp4, .mpeg, .wmv, .zip)	Multiple	Optional

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Requested Documents:

Please note the type and number of files allowed. The maximum upload file size is 1000 MB.

Please do not embed any documents within your uploaded files, as they will not be accessible or evaluated.

2. Upload your submission at:

https://grhosp.bonfirehub.ca/opportunities/private/f1e06a67b6d40382cffe21dad8dcdfbf

The Question period for this opportunity starts Sep 28, 2026 12:00 PM EDT. The Question period for this opportunity ends Oct 06, 2026 4:00 PM EDT. You will not be able to send messages after this time.

Your submission must be uploaded, submitted, and finalized prior to the Closing Time of **Oct 19, 2026 3:00 PM EDT.** We strongly recommend that you give yourself sufficient time and **at least ONE (1) day** before Closing Time to begin the uploading process and to finalize your submission.

Important Notes:

Each item of Requested Information will only be visible after the Closing Time.

Uploading large documents may take significant time, depending on the size of the file(s) and your Internet connection speed.

You will receive an email confirmation receipt with a unique confirmation number once you finalize your submission.

Minimum system requirements: Microsoft Edge, Google Chrome, or Mozilla Firefox. Javascript must be enabled. Browser cookies must be enabled.

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Need Help?

Waterloo Region Health Network uses a Euna Procurement portal for accepting and evaluating proposals digitally. Please contact Euna Procurement at support.procurement@eunasolutions.com for technical questions related to your submission. You can also visit their help forum at https://procurement-help.eunasolutions.com/hc/en-us

1.2 BID CONTRACT

.1 The Bidder acknowledges that by submitting a compliant Bid, it has accepted an offer by the Owner to enter into a Bid Contract for the evaluation of Bids and the award of the Contract, if an award is made. The Bidder acknowledges that the terms of the Bid Contract are represented by the Bid Documents.

1.3 PRE-QUALIFICATION

.1 Refer to Document 00 01 06, List of Bidders for the list of invited General Contractors.

.2 Bids received from Bidders which have not been invited shall be returned unopened.

.3 The Owner reserves the right to issue an addendum naming additional pre-qualified general Contractors and additional pre-qualified Subcontractors and Suppliers.

1.4 OVERVIEW OF THE BID PROCESS

.1 This brief summary of the Bid Process is provided solely as a convenience. Read the Bid Documents, including the Contract, carefully and thoroughly to understand all of the terms and conditions and requirements of this Bid Process. Failure to fulfill procedural or content requirements that are stipulated in the Bid Documents may have a negative effect on the evaluation of a Bid or may result in a Bid being declared non-compliant or rejected.

.2 The instructions for completing and submitting Bids are set out in this document. The criteria for evaluating Bids and selecting the successful Bidder are also set out herein. The evaluation of Bids will be carried out in two stages. In the first stage, Bids will be reviewed to determine compliance with the technical, mandatory and administrative requirements set out in the Bid Documents. Only those Bids deemed compliant, and which also obtain a score of 70% (or higher) in the first stage will proceed to the second stage. In the second stage, the Contract will be awarded to the Bidder that has submitted the lowest priced Bid among those Bids determined to be compliant and complete. Subject to the provisions of the Bid Documents, it is the Owner's intent to enter into a Contract with such Bidder.

.3 Bidders are encouraged to ask questions or request clarification with respect to any Bid Documents or any part of this Bid Process which appears to be unclear. All questions and requests for clarification, including questions regarding the Contract, are to be made in the manner described herein and addressed to the Bid Coordinator. Bidders are not to contact any other member of the Owner's staff or personnel or any other member of the Evaluation Team in relation to this Bid Process.

.4 Bidders shall understand that a Bid which contains any exceptions, revisions, conditions or qualifications may be deemed non-compliant.

1.5 BID TIMETABLE

.1 The following timetable sets out the key dates for this Bid Process. All dates are subject to change at the sole discretion of the Owner. In the event a change is made, an addendum will be issued to all Bidders.

Event	Date	Time	Location
Bid Documents Issued	**Monday, September 28, 2026**	**12:00PM**	**Bonfire**
Mandatory Pre-Bid Site Visit	**Thursday, October 1, 2026**	**1:00PM**	**835 King Street West, Kitchener - meet in the front lobby**
Questions from Bidders due	**Tuesday October 6, 2026**	**4:00PM**	
Addenda Issued with Responses	**Friday October 9, 2026**	**4:00PM**	
Bid Submissions Closing – ***Both Stage 1 (Mandatory/Technical) and Stage 2 (Financials) are required to be submitted on this date.***	**Monday, October 19, 2026**	**3:00PM**	**Bonfire**
Shortlisted Bidders Announced Following Mandatory Pass/Fail and Technical Evaluation	**No later than Wednesday, October 21, 2026**	**By 4:00PM**	
Public Opening (Stage 2) – Financial Submission (not mandatory to attend)	**Thursday October 22, 2026**	**1:00PM**	**835 King Street West, Kitchener (Midtown Site) - location TBD**
Contract Award	**Monday, November 30, 2026**	**N/A**	

1.6 DEFINITIONS

.1 Except as otherwise defined in these Instructions to Bidders, the defined terms in these Bid Documents are taken from the CCDC 2 Stipulated Price Contract, 2020 version as amended.

.2 The following Definitions shall apply to these Instructions to Bidders:

.1 "Base Bid Price" means the Bid Price based on the criteria described in the Bid Documents.

.2 "Bid Contract" means the process Contract described herein for the evaluation of Bids and the execution of the Contract, if any.

.3 "Bid Coordinator" means the sole individual designated herein responsible for answering questions arising during the Bid Period.

.4 "Bid Documents" has the meaning set out herein.

.5 "Bid Form" means the Base Bid Form or any of the Supplementary Bid Forms listed herein.

.6 "Bid" means the Bid Form or Bid Forms and all other documents submitted by a Bidder in accordance with these Instructions to Bidders.

.7 "Bidder" means a pre-qualified General Contractor who submits a compliant Bid and participates in this Bid Process.

.8 "Bid Period" means the duration between original issuance of the Bid Documents by the Owner and the Submission Deadline during which Bids will be solicited.

.9 "Canadian-Made Good" means a good that meets any one of the following criteria:

- wholly manufactured or originating in Canada;
- at least 51% of the total direct costs of producing or manufacturing the good have been incurred in Canada; or
- labelled as "Made in Canada" or "Product of Canada".

.10 "Canadian Service" means a service wholly provided by individuals (natural persons) located in Canada.

.11 "Conflict of Interest" has the meaning set out herein.

.12 "Consultant" has the meaning set out in Document 00 73 00, Amendments to Definitions.

.13 "Contract" means the written Agreement to be signed between the Owner and the successful Bidder in the form of CCDC 2, 2020 stipulated price Contract, as amended by the supplementary conditions.

.14 "Available Information" has the meaning set out herein. Where the Work involves existing buildings, structures, facilities, plant or equipment, it includes any reports, data or as-built drawings concerning such buildings, structures, facilities, plant or equipment.

.15 "Designated Substances" has the meaning set out herein.

.16 “Domestic Supply Chain Plan” or “DSCP” – refers to the plan that would be included as part of a bid for capital infrastructure procurement. It outlines the major goods and/or services, where they are sourced, and the value of the major goods and/or services.

.17 “Evaluation Score” has the meaning set out herein.

.18 “Evaluation Team” means the committee or team appointed to guide, monitor and direct this Bid Process and evaluate Bid Prices.

.19 "Electronic Bid Site" means the Consultant’s or Owner’s server onto which the Bid Documents will be posted for the Bidders’ reference. For greater clarity, the Electronic Bid Site is Euna Procurement (Bonfire).

.20 "Irrevocability Period" means the period identified herein during which the Bids will remain valid and the Owner reserves the award the Contract to any of the Bidders.

.21 “Local Time” means the time as measured by the recipient’s clock at the Submission Location.

.22 “Mandatory Requirements” has the meaning set out herein.

.23 “Major Goods” – means durable materials, systems or components that are essential to ensuring the operational readiness or performance of the deliverable, including but not limited to:

.1 Structural materials: Concrete, steel and other metals, lumber, stone, aggregates

.2 Building envelope components: Windows, glass, roofing systems, bricks

.3 Mechanical and electrical systems: HVAC units, generators, elevators

.4 Specialty items: Prefabricated panels, major fixtures

.5 Fixtures, furniture and equipment

.6 Transit fleet vehicles

.24 “Ontario-Made Good” means a good that meets any one of the following criteria:

- it is wholly manufactured or originating in Ontario; or

- at least 51% of the total direct costs of producing or manufacturing the good have been incurred in Ontario.

.25 “Ontario Service” means a service wholly provided by individuals (natural persons) located in Ontario.

.26 “Ontario Supplier” means the business is a supplier, manufacturer or distributor of any business structure that conducts its activities on a permanent basis in Ontario. The business either has it’s headquarters or main office in Ontario; or, has at least

250 full-time employees in Ontario at the time of the applicable procurement process.

.27 “Request for Clarification and Additional Information” has the meaning set out herein.

.28 "Submission Deadline" means the time before which the Bids must be received and the Submission Location identified herein where the Bids must be received.

.29 "Submission Location" means the place identified herein where the Bids must be received.

.30 “Site Meeting Log” means the Consultant’s or the Owner’s record of attendance of Bidders at the mandatory site meeting.

.31 "Owner" has the meaning set out in the Contract CCDC 2-2020, Stipulated Price Contract.

1.7 BID DOCUMENTS

.1 The following documents form the basis of this Bid Process and shall constitute the Bid Documents:

.1 Document 00 21 13 - Instructions to Bidders;

.2 Bid Forms which comprise:

.1 Document 00 41 13, Base Bid Form;

.2 Document 00 41 16 – Base Bid Breakdown Form

.3 Document 00 42 13 - Supplementary Qualification Form

.4 Document 00 43 23 – Supplementary Bid Form – Alternative Prices

.5 Document 00 43 25 – Supplementary Bid Form – Schedule of Labour Rates

.3 Document 00 70 00 - The Agreement, Definitions and General Conditions of the CCDC-2 – 2020 are incorporated herein by reference and form part of the Contract Documents. These documents are issued separately and are not physically bound within the Specifications

.4 Document 00 73 10 – WRHN CCDC-2 Supplementary Conditions. These documents are issued separately and are not physically bound within the Specifications.

.5 Document 00 65 37 - Statutory Declaration Forms

.6 Document 00 73 63 - Contract Performance Security

.7 Document 01 21 00 – Allowances

.8 WRHN Positron Emission Tomography (PET) CT Scanner – Project Specifications Manual, including all Divisions and Appendices

.9 List of Drawings;

.1 Architectural Drawing Set – Issued for Tender February 27, 2026

.2 Electrical Drawing Set – Issued for Tender September 02, 2026

.3 Mechanical Drawing Set – Issued for Tender April 10, 2026

.4 Structural Drawing Set – Issued for Tender December 15, 2025

.10 Domestic Supply Chain Plan (DSCP)

.11 No Bid Form

.12 Agreement to Bond Form

.13 Key Personnel Form

.14 Supplier Performance Scorecard

.15 Addenda issued during Bidding period, if any.

.2 Bid Documents are made available only for purpose of obtaining offers for this Project. Their issue does not confer a license or grant for other purposes.

.3 All supplemental or available information provided to or obtained by Bidders in connection with this Bid Process, including all Available Information (reports, data and other documents), are and shall remain the property of the Owner and must be treated as confidential whether the Contract is awarded or not. Such confidentiality obligations shall survive after the termination of the Bid Process, and such information is not to be used for any purpose other than submitting a Bid.

.4 Check Bid Documents for completeness upon receipt. Inform Bid Coordinator immediately:

.1 should any documents be missing or incomplete;

.2 upon finding any discrepancies or omissions.

.5 Availability of Bid Documents:

.1 Bid documents will be made available in electronic format only on the Electronic Bid Site. No documents will be distributed in printed form. Bidders shall bear all costs associated with printing and distribution of bid documents.

1.8 OWNER

.1 For purposes of this Bid, Owner is identified as:

Waterloo Regional Health Network
WRHN @ Midtown
835 King Street West
Kitchener, Ontario
N2G 1G3

1.9 CONDITIONS OF THE PLACE OF THE WORK

.1 The Place of The Work is located at 835 King Street West, Kitchener, ON N2G 1G3 (Midtown Site).

.2 Refer to Section 01 10 00, Summary of Work, for scope of work covered by Contract Documents.

.3 Before submitting a Bid, investigate the Place of The Work to fully ascertain existing conditions, circumstances and limitations affecting The Work.

1.10 INFORMATION AVAILABLE TO BIDDERS

.1 Refer to WRHN Positron Emission Tomography (PET) CT Scanner – Project Specifications Manual including all Appendices for Reports and other documents prepared or obtained with respect to the Place of The Work.

.2 Designated Substances:

.1 The term "Designated Substances" has the meaning given in the Occupational Health and Safety Act (Ontario) ("OHSA ") and includes without limitations materials such as lead, mercury, silica, asbestos containing materials (“ACM”), benzene, arsenic, and similar substances.

.2 If applicable, a list and/or report indicating the condition and location of any Designated Substances, present at the Place of The Work, will be provided to Bidders by the Owner and/or the Consultant.

.3 Unless The Work of the Contract is intended to handle or handle and remove Designated Substances, in carrying out The Work under the Contract, Bidders shall ensure they do not handle, deal with, disturb or remove any Designated Substance identified in the list or indicated in the report.

.4 Should a Bidder determine, prior to The Submission Deadline, that The Work cannot be completed without handling, dealing with, disturbing or removing any Designated Substance identified in either the list or the report, it shall immediately notify the Owner and the Consultant in writing so that, if necessary, instructions and/or clarifications may be issued in the form of Addenda.

1.11 BIDDERS’ EXPENSES

.1 The Owner shall not be responsible for, and every Bidder shall bear, all costs and expenses incurred relating to any aspect of its participation or intended participation in this Bid Process including, without limitation, all costs and expenses related to its involvement in:

.1 due diligence, investigations, and information gathering processes;

.2 attendances and/or participation at any meetings;

.3 preparation and submission of a Bid, including responding to Requests for Clarifications and Additional Information

1.12 MANDATORY PRE-BID SITE MEETING

.1 A Mandatory site meeting is scheduled on the date set out in the Bid Timetable at the following location:

.1 **Waterloo Regional Health Network – WRHN @ Midtown, 835 King Street West, Kitchener, ON, N2G 1G3 - Meet in the Main Lobby.**

.2 Due to site access logistics, all Bidders interested in attending the mandatory site meeting shall be required to confirm their attendance by contacting the Bid Coordinator via email, not less than 48 hours prior to the scheduled mandatory site meeting.

.3 Bidders and subcontractors shall attend and shall be required to sign the Site Meeting Log to confirm their attendance. Promptness is required.

.4 Attendance at the mandatory site visit shall be limited to a maximum of three (3) representatives per Bidder. The Owner reserves the right to restrict attendance or refuse entry to any additional representatives beyond this limit.

.5 Bids received from Bidders who failed to attend the mandatory site meeting, as determined from records of the Site Meeting Log, shall be disqualified through the Electronic Bid platform.

.6 Inspect existing conditions and limitations, within the Place of The Work, including but not limited to:

.1 means of access and egress;

.2 obstacles;

.3 examining surrounding, adjacent public and private properties outside the Place of The Work for existing conditions and limitations including, but not limited to, rights and interests of other parties which may be interfered with during construction;

.4 determining municipal department requirements.

.2 Bidders will be allowed to take measurements, photographs (no patients, staff, or confidential information to be included in photos) and confirm the amount of work involved.

.3 No adjustments to deadline for completion nor to Contract Price will be made for difficulties encountered due to conditions, features and peculiarities of the Place of The Work which are evident at time of Bid submission.

.4 No allowances will be made for additional costs, and no claims will be entertained in connection with conditions which could reasonably have been ascertained by such investigation or other due diligence prior to submitting Bid.

1.13 BID AND PERFORMANCE SECURITY

.1 Each Bid shall be accompanied by Bid security in the form of a Bid bond in the amount of ten percent (10%) of the Bid Price naming the Owner as obligee and issued by a surety licensed to conduct surety and insurance business in Ontario. The Bid security is for the benefit of the Owner and stands as security that the Bidder, if awarded the Contract, will deliver the performance security and evidence of insurance and other documents required by these Instructions to Bidders or by the Contract, and will execute the Contract. The Bid security shall remain valid for the duration of the Irrevocability Period as measured from the date of Bid submission. No other form of Bid security is acceptable.

.2 The Bid security of the Bidder whose Bid is accepted will be retained by the Owner to compensate the Owner for the damages it will suffer should the successful Bidder fail to execute the Contract and/or fail to Provide the specified performance security and/or evidence of insurance and other documents required by these Instructions to Bidders or by the Contract.

.3 The Bid security of the Bidder whose Bid is accepted will be returned after the delivery of the specified performance security and evidence of insurance and other documents required by these Instructions to Bidders or by the Contract, and after the execution of the Contract. The Bid security of all other Bidders will be returned after the execution of the Contract or after the expiry of this Bid Process without an award of Contract or after the rejection of all Bids.

.4 Each Bid shall be accompanied by an agreement to bond issued by the same surety company that provides the Bid bond, undertaking to Provide a fifty percent (50%) performance bond and a fifty percent (50%) labour and material payment bond, both to be delivered to the Owner if the Bidder is awarded the Contract.

.5 Bids not accompanied by the required Bid security and the required agreement to bond will be declared non-compliant and rejected.

.6 Include the cost of all bonds in the Bid Price.

1.14 BID INQUIRIES, QUESTIONS, COMMUNICATIONS AND AMENDMENTS TO BID DOCUMENTS

.1 Address direct questions arising during the Bidding period to the Bid Coordinator, via email:

.1 **Waterloo Regional Health Network @ Midtown**
Sarah Renforth – Sourcing Specialist
Tel: 226-751-6153
Email: sarah.renforth@wrhn.ca

.2 The Bid Coordinator is the sole contact for Bidding on this Project. A Bid may be disqualified where contact is made with any person other than the Bid Coordinator.

.3 Responses to Bidders' queries, instructions, clarifications or amendments which affect the Bid Documents will be made only by addendum. Answers, clarifications, instructions or

information provided orally or by any other means, in whatever context or setting, are not binding on the Consultant and are not to be relied upon by any Bidder.

.4 If Bidders find discrepancies, omissions, errors, departures from building by-laws, codes or good practice, and points considered to be ambiguous or conflicting, they shall bring them to the attention of the Bid Coordinator **by e-mail no later than Tuesday October 6, 2026 @ 4:00PM (Bidder Question Deadline)** so that the Bid Coordinator may, if the Bid Coordinator deems it necessary, issue instructions, clarifications or amendments by addendum to all Bidders prior to the Submission Deadline date. The Bid Coordinator will endeavor to issue such addenda by **Friday, October 9, 2026 @ 4:00PM (Addenda Issued with Responses)** as outlined in the Bid Time Table.

.5 In responding to questions the Bid Coordinator may answer similar questions from different Bidders only once, may edit or rephrase the questions for purposes of clarity, and may ignore questions which, in the Bid Coordinator's opinion, do not require a response.

.6 Addenda issued during the Bidding period shall become part of the Bid Documents and their receipt shall be acknowledged in the space provided in the Bid Form. Addenda shall be sent to all Bidders.

1.15 PROHIBITION ON LOBBYING / COLLUSION

.1 Bidders, and/or any representatives employed or retained by them, are strictly prohibited from engaging in conduct which is, or could reasonably be considered as, any form of political or other lobbying, or as an attempt to influence the outcome of this Bid Process.

.2 A Bidder shall not discuss or communicate directly or indirectly with any other Bidder any information whatsoever regarding the preparation of a Bid. Bidders shall prepare and submit Bids independently and without any communication, knowledge, comparison of information, or arrangement, directly or indirectly, with any other Bidder.

.3 Failure of any Bidder to comply with this requirement may result in the disqualification of the Bidder and the rejection of its Bid.

1.16 CONFLICT OF INTEREST

.1 Bidders shall disclose all perceived, potential and actual Conflicts of Interest. For the purposes of this Bid Process, Conflict of Interest is defined as:

.1 any situation or circumstance where, in relation to this Bid Process and/or the Contract, the Bidder's other commitments, relationships or financial interests could, or could be perceived to, exercise an improper influence over the objective, unbiased and impartial exercise of independent judgment by any member of the Evaluation Team, the Consultant, or the Owner;

.2 any situation or circumstance where any person(s) employed by the Consultant in any capacity, or any member of the Owner:

.1 has a direct or indirect financial interest in the award of the Contract to any Bidder;

.2 is currently employed by, or is a Subcontractor or a consultant to a Bidder;

.3 is negotiating or has an arrangement concerning future employment or contracting with any Bidder;

.4 has an ownership interest in, or is an officer or director of, any Bidder.

.2 If a Bidder discovers, at any time, any perceived, potential or actual Conflict of Interest, the Bidder shall promptly disclose the perceived, potential or actual Conflict of Interest by sending a written statement in the manner described herein. Failure of any Bidder to comply with this section may result in the disqualification of the Bidder and the rejection of its Bid.

.3 Without limiting the generality of the Owner's Right described herein, the Owner may, in its sole discretion:

.1 exclude any Bidder and its Bid on the grounds of Conflict of Interest;

.2 waive any and all perceived, potential or actual Conflicts of Interest upon such terms and conditions as the Owner, in its sole discretion, requires to satisfy itself that the Conflict of Interest has been appropriately managed, mitigated and minimized.

1.17 TAXES

.1 The Harmonized Sales Tax (HST) shall not be included in the Bid Price. All other eligible taxes shall be included in the Bid Price. Any taxes or increases in taxes announced prior to the date of the issuance of the Bid Documents and scheduled to come into effect subsequent to such date shall be taken to be included in the Bid Price.

1.18 BID COMPLETION

.1 Fill in all blank spaces on the Bid Forms in handwritten ink, typewritten, or electronically, providing all information requested. Ensure that an authorized person signs all forms where indicated. Failure to provide all requested information on the Bid Forms and failure to fill in all blank spaces may result in a Bid being declared non-compliant.

.2 Use only the Bid Forms issued as part of the Bid Documents for the Project. If any or all pages of the Bid Forms are amended by addendum, only the amended pages shall be used to submit a Bid.

.3 Information provided by Bidders on the Bid Forms may be amended prior to The Submission Deadline.

.4 Bids that are unsigned, improperly signed, incomplete, conditional or illegible, may be declared non-compliant.

1.19 BID PRICE

.1 The Bid Price shall be provided in numbers only.

.2 Where the Bidder is required to Provide a breakdown of the Bid Price, the Bid Price shall govern in the case of conflict or ambiguity between the Bid Price and the sum of the breakdown of the Bid Price.

.3 Submit Base Bid Price:

.1 Including cash allowances;

.2 Including assigned work and services;

.3 Excluding Harmonized Sales Tax (HST);

.4 Excluding Alternative Prices;

.5 Excluding escalation clauses or other qualifications;

.6 Including Product requirements specified

.4 Base Bid Price is deemed to be based on specified Products. Do not include unspecified Product substitutions in Base Bid Price.

.5 Bidders are not considered staff and therefore are not covered by staff business expense policies. Bidders will only be reimbursed for expenses explicitly agreed to by the Bidder and the Owner and as detailed in the Contract. In no circumstances will hospitality, incidental or food expenses be considered allowable expenses for Bidders and contractors under this policy or in any Contract between the Owner and a consultant or contractor. Therefore, they cannot be reimbursed for such expenses, including:

.1 Meals, snacks and beverages

.2 Gratuities

.3 Laundry or dry cleaning

.4 Valet services

.5 Dependents' care

.6 Home management

.7 Personal telephone calls

.6 All costs shall be included in the quoted Bid Price. Hourly rates and total fees shall be inclusive of all expenses. The Owner will not be responsible for any costs or charges not identified by the Bidder in the Bid. Any additional requirements provided to the Owner shall be at no additional charge unless identified by the Bidder in the Bid submission. In the event of any discrepancy in the pricing, the lowest unit price submitted shall prevail.

.7 All pricing should be quoted in Canadian dollars exclusive of applicable Canadian Federal or Provincial sales and value-added taxes, and shall include all applicable customs duties, tariffs, overhead, profit, permits, licenses, delivery costs, fuel costs, transportation, labour, carriage insurance, and warranties, and further shall not be subject to adjustment for fluctuation in foreign exchange rates.

.8 If the Bidder does not provide Bid in Canadian dollars, the Owner has the right to convert the Bidder's Bid to Canadian dollars using the Bank of Canada exchange rate in effect on the Bid Closing Date.

1.20 UNIT PRICES

.1 Where required by the Bid Documents, a Bidder shall submit a Supplementary Bid Form – Unit Prices.

.2 Unit prices shall be in effect for the duration of the Contract and may be used to calculate the cost of additional work under the Contract.

.3 The Owner reserves the right to accept or reject any or all unit prices submitted, and such prices shall remain in effect for the duration of the Contract. Failure to submit a unit price where required may result in the Bid being declared non-compliant.

1.21 ITEMIZED AND ALTERNATIVE PRICES.

.1 Where required by the Bid Documents, submit a Supplementary Bid Form – Itemized and Alternative Prices.

.2 Itemized Prices for work, if any, shall be included in the Bid Price.

.3 The Owner reserves the right to accept or reject any or all alternative prices submitted.

1.22 LISTING OF SUBCONTRACTORS

.1 Where required by the Bid Documents (00 41 16 - Bid Breakdown Form – PET) List Subcontractors the Bidder proposes to engage to perform items of The Work called for by the Contract.

.2 Where the Owner has pre-qualified one or more Subcontractors and/or Suppliers to perform or Supply an item of The Work called for by the Contract Documents, Bidders shall select only a pre-qualified Subcontractor or Supplier to perform or Supply that item of work. Failure to do so shall result in the Bid being declared non-compliant. The following Subcontractors / Suppliers must be carried for the specific scopes of work as noted below (refer to drawing A2.2 for contact information):

.1 **Nurse Call – KR Communications**

.2 **BAS Programming – EHM Solutions**

.3 **Fire Alarm System - Siemens**

.4 **Interior Partitions (Injection Room Space ONLY – ALTERNATIVE PRICE) – Falkbuilt**

.5 **Ceiling Lift – Arjo**

.6 **Fire Protection (Sprinkler) - Everding**

.7 **Medical Gas – Class 1**

.8 **Roofing – Flynn**

.3 Failure of the Bidder to list Subcontractors, where required, or the listing by a Bidder of more than one Subcontractor to perform or Supply an item of work listed, may result in the Bid being declared non-compliant.

.4 Where a Bidder lists "own forces" in lieu of a Subcontractor, the Bidder shall carry out such item of The Work with its own forces. Where "own forces" have been listed by a Bidder, the Owner reserves the right to obtain information from the Bidder and from third parties respecting the qualifications and experience of the Bidder's "own forces" for such item of The Work. If the Owner, acting reasonably, determines that the Bidder's "own forces" are not sufficiently qualified or sufficiently experienced to undertake such item of The Work, it may reject the Bid.

1.23 BID SUBMISSION REQUIREMENTS

.1 Bids shall be submitted electronically via the Electronic Bid Site at: https://grhosp.bonfirehub.ca/opportunities/private/f1e06a67b6d40382cffe21dad8dcdfbf

.2 The Q&A period opens and closes on the dates set out in the Bid Timetable. Questions will not be accepted after the Q&A closing date.

.3 The Bid submission shall be uploaded, submitted, and finalized on the Electronic Bid Site prior to the Submission Deadline set out in the Bid Timetable. Bidders are strongly advised to allow sufficient time, and at least one (1) Business Day before the Submission Deadline, to complete the upload and finalize their submission.

.4 Important Notes:

.1 Upload times may vary depending on file size and connection speed. Bidders should allow adequate time accordingly.

.2 Bidders will receive an email confirmation receipt with a unique confirmation number upon finalizing their submission.

.3 Minimum system requirements: Internet Explorer 11, Microsoft Edge, Google Chrome, or Mozilla Firefox. Javascript and browser cookies must be enabled.

.5 Technical Support

.1 The Electronic Bid Site is administered by Bonfire. For technical questions related to submission, Bidders may contact Bonfire at Support@GoBonfire.com.

.2 Additional support resources are available at: https://bonfirehub.zendesk.com/hc

1.24 REQUESTED INFORMATION

.1 Document 00 41 13 - Base Bid Form

.2 Document 00 41 16 - Bid Breakdown Form

.3 Document 00 42 13 - Supplementary Qualification Form

.4 Document 00 43 23 - Supplementary Bid Form - Alternative Prices

.5 Document 00 43 25 – Supplementary Bid Form – Labour Rates

.6 CCDC 11 (2019) completed in full for the General Contractor, demonstrating a minimum of ten (10) years' experience in healthcare construction

.7 Bid bond in the amount of ten percent (10%) of the Bid Price

.8 Agreement to bond in the amount of fifty percent (50%) of the Bid Price

.9 Bidder's current WSIB Clearance Certificate (Workplace Safety & Insurance Board)

.10 Preliminary project schedule in the form of a gantt chart (or other industry standard software) detailing major project milestones, product lead times and approach. Include a narrative describing overall project approach.

.11 Letter from the Bidder's bonding company (licensed surety) confirming bonding capacity for the Project and total bonding limit with amount currently in use.

.12 Certificate of Insurance from a duly licensed Canadian insurer confirming intention to provide coverage in accordance with Bid Document requirements.

.13 Letter from the Bidder's financial institution confirming sound credit standing, with written authorization for the Owner to procure a credit report.

.14 Current WSIB CAD 7 Report, MAP Program or WISR statement; or equivalent documentation for Bidders operating outside Ontario.

.15 CSA infection control certifications (most recent): Fundamentals of Infection Control During Construction, Renovation and Maintenance of Healthcare Facilities AND Effective Implementation and Practical Applications of Infection Control During Construction, Renovation and Maintenance of Health Care Facilities.

.16 Domestic Supply Chain Plan (DSCP) - complete and submit with bid.

.17 No Bid Form (*if applicable, complete and submit to Bid Administrator*). MMC tracks bid performance of the prequalified Contractors. Each Contractor that is invited through a second stage procurement process under this VOR and wishing not to submit a quote/proposal must ensure to complete and submit a no-bid form (**attached**) to respective bid administrator before the solicitation closing date. Failure to submit a no-bid form may result in suspension or removal from the VOR, at the discretion of MMC in consultation with a Purchaser.

.18 Key Personnel Form (*if applicable, complete and submit with bid*). Contractors will select from the Key Project Personnel (project manager, site superintendent, safety coordinator) as identified in their RFSQ proposal submission to be part of the project team for any project awarded under this VOR. If the identified Key Project Personnel is not available for a particular project, the Contractor will provide a replacement by submitting a completed “Key Personnel Form” (**attached**). New Key Personnel Forms will be evaluated on a pass/fail basis, as part of the “mandatory” evaluation process for each project.

.19 Agreement to Bond Form – complete and submit with bid. The Proponent must submit a completed Agreement to Bond (**attached**) with their submission.

1.25 BID IRREVOCABILITY PERIOD

.1 Bids shall be irrevocable and shall remain open for acceptance by the Owner for a period of 120 Days from the date of submission of the Base Bid Price (the Irrevocability Period), after which period the Bid expires.

1.26 BID OPENING

.1 Only Bids submitted on the Electronic Bid Site (by the Submission Deadline) will be opened.

.2 Stage 2 - Financial Bid Submissions - shall be opened in public at Waterloo Regional Health Network - Midtown Campus, location TBD, as per the Bid Time Table.

.3 For the purpose of Contract Execution, the Owner reserves the right, but has no obligation, to adjust all Bidders' Base Bid Prices by the amounts of any, all or none of the alternative prices, as the Owner decides in its sole and unfettered discretion.

1.27 BID EVALUATION

.1 The evaluation process will be conducted by the Evaluation Team, which may obtain the assistance of consultants and advisors as it may deem appropriate. However, and notwithstanding anything else contained in the Bid Documents, the award of the Contract, if any, may be subject to the approval of the Owner in its sole and unfettered discretion.

.2 Bidders shall have no claims whatsoever against the Owner or any member of the Evaluation Team or the Consultant arising out of the Owner's exercise of its authority, and/or in the event the Owner, in its sole and unfettered discretion, and for any or no reason, decides not to award the Contract.

.1 Step 1 – Perform mandatory compliance review (pass / fail).

.2 Step 2 – Score rated requirements of Stage 1- Technical Requirements.

.3 Step 3 – Verify any license requirements, certificates, permits (if applicable).

.4 Step 4 - Apply a 10% evaluation advantage to the bidder with the highest proportion of ON-made Goods and Services followed by CAD-made Goods and Services in their DSCP.

.5 Step 5 – All Bidders who achieve a minimum score of 70 per cent (%) will proceed to Step 6.

.6 Step 6 – Contact Bidder references to validate Preferred Bidder responses (optional). Rescore applicable sections of Bidders responses based on reference checks (if/as required). The Evaluation team will validate as many references provided by the Bidder as the Evaluation Team may deem appropriate, and such references may be conducted in-person, by telephone or electronic means as the Evaluation Team may determine in its sole discretion.

.7 Step 7 – All bidders who have a minimum score of 70% (or higher) will proceed onto Stage 2 – Financial Submission - Public Opening by WRHN (attendance not mandatory).

.8 Step 8 – Enter into Contract negotiations with the Bidder who had the lowest, complete financial bid.

.3 Mandatory Requirements:

.1 Only Bidders which submit Bids which the Evaluation Team determines meet all of the mandatory requirements set out in **Document 00 42 13 – Supplementary Qualification Form – Part 2 – Mandatory Requirements will** be eligible to be considered for an award of the Contract.

.4 Evaluation Criteria:

.1 Weighted Criteria: Owner will employ a multi-criteria decision making process. The major selection criteria should be applied:

Mandatory Requirements	**Pass or Fail**
Criteria – Stage 1 Technical	**Points Available**
Project Team	30
Construction Schedule / Accompanying Schedule Narrative	40
Company Experience - Relevant Healthcare/Similar Projects	30
Maximum Points Available	**100**
Apply a 10% evaluation advantage to the bidder with the highest proportion of ON-made Goods and Services followed by CAD-made Goods and Services in their DSCP.	
All bidders who achieve a minimum score of 70% (or higher) will proceed onto Stage 2 – Financial Submission - Public Opening by WRHN (attendance not mandatory).	
Criteria – Stage 2 Financials	**Points Available**
Lowest – Complete Financial Bid	Award

.5 Evaluation Methodology

.1 Tie breaking Methodology: If there are bidders who have the same Lowest Financial Bid in Stage 2 Financials, the Award will be given to the Bidder with the highest Technical Score.

.2 Scale Methodology (**Stage 1 Evaluation Score – Technical Criteria**): With this method each response will be scored using a 0 to 10 scale as outlined below.

Low Score 0 – 3	Medium Score 4 – 7	High Score 8 - 10
Incomplete Response Doesn't meet expectations Missing/mismatched attributes Poor level of detail in response Unsupported claims	Mostly complete response Partially meets expectations Partially fits desired attributes Medium level of detail in response Partially supported claims	Meets or exceeds expectations Strongly fits desired attributes High level of detain in response Well supported claims Other

Domestic Supply Chain Plan (DSCP) – Evaluated Approach

Apply 10% evaluation advantage to the bidder with highest proportion of ON-made Goods and Services, followed by CAD-made Goods and Services in their DSCP. See example below for illustrative purposes.

Bidder	Total Evaluation Score	Total Bid Price	Ontario Made ($)	Canadian Made ($)	Weighted Value (A•A•B)	Proportion (%)	Adjusted Score
Bidder 1	75	$1,000,000	$250,000	$150,000	$650,000	65%	No adjustment
Bidder 2	90	$950,000	$95,000	$200,000	$390,000	41%	No adjustment
Bidder 3	85	$1,040,000	$420,000	$100,000	$940,000	90%	93.5 (increased by 10 percent)

Formula: Weighted Domestic % = (Ontario + Ontario + Canadian) ÷ Total Bid Price × 100.

.3 **Stage 2 – Financial Submission**

.1 Enter into Contract negotiations with the Bidder who has the lowest, complete financial bid.

1.28 REQUESTS FOR CLARIFICATION AND ADDITIONAL INFORMATION

.1 After the Submission Deadline, The Bid Coordinator may contact any one or more Bidders to request Additional Information and Clarification without any obligation to contact other Bidders.

.2 Bidders shall respond, and Provide promptly to the Bid Coordinator, all requests for Clarification and Additional Information. Failure to do so may result in the Bid being rejected.

.3 Requests for Clarification and Additional Information shall not be construed as award of the Contract, acceptance of a Bid, or the rejection of a Bid.

.4 Information, prices, rates and documents submitted in response to a Request for Clarification and

Additional Information shall form part of a Bidder's Bid.

1.29 AWARD OF CONTRACT, EXECUTION OF THE CONTRACT AND DOCUMENTS TO BE DELIVERED

.1 If the Owner decides to award the Contract to a Bidder, it will issue a letter of Contract award.

.2 Prior to commencing The Work, the successful Bidder shall deliver to the Owner (at a minimum):

.1 the performance bond and the labour and material payment bond described in the Bid Documents, the form of such bonds to comply with the requirements of the Contract;

.2 certified true copies of the insurance policies required by the Bid Documents;

.3 a current Clearance Certificate issued by The Workplace Safety and Insurance Board.

.4 Schedule of unit rates, and labour rates for the duration of the work

.5 the Contractor's health and safety policy for the Project; and

.6 a copy of the notice of Project issued by the Ministry of Labour for the Project.

.7 The Contractor shall execute the final negotiated Contract and deliver the executed contract to the Owner within five (5) Working Days of receipt of Contract Award.

1.30 BID DEBRIEFING

Not later than sixty (60) Days following the date of posting of a Contract award notification in respect of the Bid Process, an unsuccessful Bidder may contact the Bid Coordinator in writing requesting a debriefing from Owner, and Owner will conduct such debriefing.

Any request that is not timely received will not be considered and the Bidder will be notified in writing.

Bidders should note that, regardless of the time of submission of a request by a Bidder, debriefings will not be provided until a Contract award notification has been posted.

1.31 OWNER'S RIGHTS

In addition to any other express rights or any other rights which may be implied in the circumstances, Owner reserves the right to:

.1 make public the names of any or all Bidders;

.2 request written clarification or the submission of supplementary written information from any Bidder and incorporate such clarification or supplementary written information into the Bidder's Bid, at Owner's discretion, provided that any clarification or submission of supplementary written information is not an opportunity for the Bidder to correct errors in its Bid or to change or enhance the Bidder's Bid in any material manner;

.3 waive formalities and accept Bids that substantially comply with the requirements of this Bid Process, in Owner's sole discretion;

.4 verify with any Bidder or with a third party any information set out in a Bid;

.5 check references other than those provided by Bidders;

.6 disqualify any Bidder whose Bid contains misrepresentations or any other inaccurate or misleading information, or any Bidder whose reasonable failure to cooperate with Owner impedes the evaluation process, or whose Bid is determined to be non-compliant with the requirements of the Bid Process;

.7 disqualify a Bid where the Bidder has previously breached a Contract with Owner, the Bidder has been charged or convicted of an offence in respect of a Contract with Owner, or the Bidder reveals a Conflict of Interest or Unfair Advantage in its Bid or a Conflict of Interest or evidence of any Unfair Advantage is brought to the attention of Owner;

.8 disqualify any Bid of any Bidder who has breached any Applicable Laws or who has engaged in conduct prohibited by this Bid Process, including where there is any evidence that the Bidder or any of its employees or agents colluded with any other Bidder, its employees or agents in the preparation of the Bid;

.9 identify a specific question, or specific questions, which require a Bidder to achieve a minimally acceptable score in order to qualify for the award;

.10 eliminate the Bidder with the lowest general evaluation score, or any Bidder whose general evaluation score is either in the bottom 50% of the general evaluation scores, or more than 15% below the average general evaluation score;

.11 eliminate the Bidder with the highest overall cost or any Bidder whose total cost is 10% or greater than average total cost;

.12 make changes, including substantial changes, to this Bid Process provided that those changes are issued by way of addenda in the manner set out in this Bid Process;

.13 accept or reject a Bid if only one Bid is submitted;

.14 reject a subcontractor proposed by a Bidder within a consortium;

.15 select any Bidder other than the Bidder whose Bid reflects the lowest cost to the Owner;

.16 cancel this Bid Process at any stage and issue a new Bid Process for the same or similar requirements, including where:

(i) Owner determines it would be in the best interest of Owner not to award an Agreement;

(ii) the Bid prices exceed the bid prices previously received by Owner for Services of a similar nature;

(iii) the Bid prices exceed the costs Owner would incur by doing the work, or most of the work, with its own resources;

(iv) the Bid prices exceed the funds available for the proposed Services; or

(v) the funding for the acquisition of the proposed Services has been revoked, modified, or has not been approved;

and where Owner cancels this Bid Process, Owner may do so without providing reasons, and Owner may thereafter issue a new Request for Tender, request for qualifications, sole source or do nothing;

.17 discuss with any Bidder different or additional terms to those contained in this Bid Process or in any Bidder's Bid;

.18 reject any or all Bids in its absolute discretion, including where a Bidder has launched legal proceedings against Owner or is otherwise engaged in a

dispute with Owner. By submitting a Bid, the Bidder authorizes the collection by Owner of the Information identified in this Bid Process, which Owner may request from any third party

1.32 DISPUTES

.1 In the event that a Bidder wishes to review the decision of Owner in respect of any material aspect of the Bid Process, and subject to having attended a debriefing, the Bidder must submit a protest in writing to Owner within ten (10) Days from such a debriefing.

.2 Any protest in writing that is not timely received will not be considered and the Bidder will be notified in writing.

.3 A protest in writing must include the following:

.1 a specific identification of the provision and/or procurement procedure that is alleged to have been breached;

.2 a specific description of each act alleged to have breached the procurement process;

.3 a precise statement of the relevant facts;

.4 an identification of the issues to be resolved;

.5 the Bidder's arguments and supporting documentation; and

.6 the Bidder's requested remedy.

.4 Response to Contract Award Dispute Claim: A formal written response will be provided to the Bidder within forty-five (45) Days of receipt of the original dispute claim indicating disposition of the matter, unless such time period is extended in order to obtain input from outside experts.

1.33 LIMIT OF LIABILITY

.1 The liability of a Bidder to the Owner for loss and damage arising out of the Bidder's breach of the Bid Contract shall be limited to the lesser of the actual loss suffered by the Owner and the amount of the Bid bond to be submitted as part of the Bid.

.2 The Owner shall not be liable to any Bidder for any claims arising out of this Bid Process including:

.1 claims arising from the Owner's negligence or other tortious conduct; and/or

.2 claims arising from the Owner's breach of the Bid Contract or any other Contract or other obligation that may arise as a result of a Bidder's participation in this Bid Process and/or submission of a Bid,

.3 reasonable cost to the Bidder of preparing its Bid.

1.34 CONFIDENTIAL INFORMATION OF OWNER

.1 All correspondence, documentation, and information of any kind provided to any Bidder in connection with or arising out of this Bid Process or the acceptance of any Bid:

.1 remains the property of Owner and will be removed from Owner premises only with the prior written consent of Owner;

.2 must be treated as confidential and will not be disclosed except with the prior written consent of Owner;

.3 must not be used for any purpose other than for replying to this Bid Process and for the fulfillment of any related subsequent agreement; and

.4 must be returned to Owner upon request.

1.35 CONFIDENTIAL INFORMATION OF THE BIDDER

.1 Except as provided otherwise in this Bid Process, or as may be required by Applicable Laws, Owner will treat the Bidders' Bids and any information gathered in any related process as confidential, provided that such obligation does not include any information that is or becomes generally available to the public other than as a result of disclosure by Owner.

.2 Notwithstanding any other provisions in this Bid Process regarding confidentiality, the CFTA requires the total value greater than $121,200 of any Agreement resulting from this Bid Process to be published in an award notice. By submitting a response to the bid, the Bidder agrees to the publishing of the total value of any Agreement should the Bidder be awarded work hereunder.

.3 During this Bid Process, none of Owner, or any of their representatives or agents, is under any obligation to execute a confidentiality agreement.

.4 In the event that a Bidder refuses to participate in any required stage of the bid (such as an oral presentation) because Owner has refused to execute any confidentiality agreement, the Bidder will receive no points for that particular stage of the evaluation process.

.5 Bidder's Submission

.1 All correspondence, documentation, and information provided in response to or because of this Bid Process may be reproduced for the purposes of evaluating the Bidder's Bid.

.2 If a portion of a Bidder's Bid is to be held confidential, such provisions must be clearly identified in the Bid.

.6 Personal Information

.1 Personal Information will be treated as follows:

.1 Submission of Information - The Bidder should not submit as part of its Bid any information related to the qualifications or experience of persons who will be

assigned to provide services unless specifically requested. All such information will be maintained for a period of seven (7) years from the time of collection. Should Owner request such information from a Bidder during the evaluation process to finalize any Agreement that may be awarded from this Bid Process, Owner will treat this information in accordance with the provisions of this section.

.2 Use - Any personal information as defined in the *Personal Information Protection and Electronic Documents Act*, S.C. 2005, c.5 that is requested from each Bidder by Owner will only be used to select the qualified individuals to undertake the work required by this Bid Process and to confirm that the work performed is consistent with these qualifications.

.3 Consent - It is the responsibility of each Bidder to obtain the consent of such individuals prior to providing the information to Owner. As set out in Section 1.36 (*Freedom of Information and Protection of Privacy Act* (Ontario)), Owner will consider that the appropriate consents have been obtained for the disclosure to and use by Owner of the requested information for the purposes described.

.7 Non-Disclosure Agreement

.1 Owner reserves the right to require any Bidder and relevant personnel of any Bidder to enter into a non-disclosure agreement satisfactory to Owner.

1.36 FREEDOM OF INFORMATION AND PROTECTION OF PRIVACY ACT (ONTARIO)

.1 The *Freedom of Information and Protection of Privacy Act* (Ontario) ("**FIPPA**") will apply to information provided by Bidders. Bids are received in confidence subject to the disclosure requirements of FIPPA. Each Bidder should identify any portions of its Bid that it believes constitutes a trade secret or scientific, technical, commercial, financial or labour relations information that would harm the Bidder's competitive position if disclosed. The confidentiality of such information will be maintained by the Purchaser, except as otherwise required by law or by order of a court or tribunal. Generally, only specific portions of your Bid should be identified.

.2 By submitting a Bid, including any Personal Information requested in this Bid Process, the Bidders agree to the use and disclosure of such information for the evaluation process, for any audit of this procurement process and for Contract management purposes. The Purchaser may assume that the Bidder has obtained any necessary consent in the event that any Personal Information is submitted.

.3 If a Bidder has any questions about the collection and use of Personal Information pursuant to this Bid Process, questions are to be submitted to the Bid Coordinator.

.4 All information provided by or obtained from the Owner in connection with this Bid Process is the sole property of the Owner and must be treated as confidential. Such information is not to be used for any purpose other than preparing a Bid.

.5 By submitting a Bid, the Bidder acknowledges that the contents of its Bid will be disclosed on a confidential basis to the Evaluation Team and may be disclosed to members of the Consultant's and/or Owner's staff, agents and advisors for the purpose of evaluating or participating in the evaluation of the Bids. The Owner will use reasonable efforts to protect pricing, commercial terms, and other sensitive and confidential information provided by the Bidders as part of a Bid; however, the Owner accepts no liability in the event that such information, or any part of it, is disclosed even if the Evaluation Team, the Owner, its staff, agents, advisors or any other person associated with the Consultant and its staff or the Owner and its staff may have been negligent with respect to such disclosure.

.6 Information provided in the Bids may be presented at the Owner's public meetings and may be disclosed to the public. In addition, the Owner may be required to disclose information provided in the Bids pursuant to the provisions of the Municipal Freedom of Information and Protection of Privacy Act or other legislation. By submitting a Bid each Bidder agrees to such disclosure and releases the Evaluation Team, the Owner, and the Consultant from any liability for the same.

1.37 EVALUATION OF SUPPLIER PERFORMANCE

a) Performance Scorecard

The Performance Scorecard ("Scorecard") is the form used for reporting performance and is **attached**. The Scorecard is used to ensure an objective assessment of the Contractor's performance, by applying established evaluation criteria that are aligned with Purchaser's project and business goals.

During the term of the Contract, the Purchaser will document all incidents of deficient performance and/or infractions by way of minutes of meetings, notices, warnings, and all related communications, which may later be used to support the Scorecard.

b) Timing of Performance Review

A Scorecard will be completed by the Purchaser at the end of the Contract, or a frequency mutually agreed to in writing between the Contractor and the Purchaser, or upon completion of specific deliverables as set out in the Contract.

When the term of a Contract exceeds twelve (12) months, an annual Scorecard will be completed and issued to the Contractor for feedback during the term of the Contract. This annual performance review will take place on the first anniversary of the Contract start date or such other time as the Purchaser consider appropriate. For multi-phase projects (e.g., complex projects), a Scorecard may be completed at the end of each phase of work.

The resulting performance review may involve senior stakeholders from the Contractor and Purchaser who will review:

- key performance indicators (KPIs), if applicable;
- any issues and/or disputes of Purchaser concern, including relevant litigation history;

• alignment of Contractor's performance with the Purchaser's goals and objectives for remaining term of Contract;

• general business trends; and

• assess the working relationship between the Contractor and Purchaser.

All annual Scorecard evaluations will be incorporated into the final Scorecard evaluation at the end of the Contract. This requirement should be clearly set out in the Request Documents and Contract.

c) Performance Ratings and Completion of Scorecard

The Supplier's performance will be rated, according to the following scale:

Consistently falls far below expectations	Frequently misses expectations	Room for Improvement - meets and misses expectations	Consistently meets expectations	Consistently Exceeds expectations
1	2	3	4	5

These ratings, used to complete the Scorecard, are based on the following descriptions:

5	Supplier has demonstrated a performance level in measurable excess of Contract requirements (e.g., provided tangible recommendations for improvement, proactively addressed issues before they arose, etc.).
4	There are no performance issues, and the Supplier has met the Contract requirements.
3	There are very minor performance issues, but Supplier has otherwise met the Contract requirements.
2	There are a number of performance issues that required Purchaser to provide additional oversight to ensure that Contract requirements were met.
1	Performance jeopardized the achievement of Contract requirements, despite additional oversight.

END OF SECTION

PART 1 GENERAL

1.1 BIDDER

.1 From (Name of Bidder): _____

.2 Address: _____

.3 Telephone: _____

.4 Fax: _____

1.2 BASE BID PRICE

.1 I/We the undersigned, having carefully examined the Bid Documents and having received, carefully examined and incorporated

Addenda No. _____to No._____

inclusive, having visited and investigated the Place of the Work, and having examined all conditions, circumstances and limitations affecting the Work, offer to enter into a Contract with the Owner to perform the Work required by the Bid Documents for the price of

CAD $_____. The price offered excludes the Harmonized Sales Tax (HST) but includes all other eligible taxes.

1.3 CASH ALLOWANCES

.1 I/We hereby state the Base Bid Price stated herein includes Cash Allowance amount identified in Section 01 21 00 which will be expended under the terms and conditions of the Contract.

1.4 ASSIGNED WORK

.1 The Undersigned hereby states that the Base Bid Price stated herein includes amounts for assigned work identified in Section 01 64 00 and further that all costs for supervision, administration, handling, management, expediting, scheduling, overhead and profit for handling and assuming full responsibility of the assigned Subcontractors are included in the Base Bid Price.

1.5 BID SECURITY

.1 Attached to this bid is a bid bond as required by the Bid Documents. No other form of bid security is acceptable.

1.6 PERFORMANCE BOND

.1 I/We agree to provide a Performance Bond as required by the Bid Documents.

1.7 LABOUR & MATERIAL PAYMENT BOND

.1 I/We agree to provide a Labour & Material Payment Bond as required by the Bid Documents.

1.8 AGREEMENT TO BOND

.1 I/We attach to this bid a Consent of Surety for undertaking to provide the bonds required by the Bid Documents.

1.9 SCHEDULE

.1 I/We the undersigned declare that:

.2 I/We agree to perform the Work, inclusive of mobilization time, in compliance with the Contract Documents and attain Substantial Performance of the Work within _____ weeks after award of the Contract;

.3 I/We agree to perform the Work, inclusive of mobilization time, in compliance with the Contract Documents and attain Ready-for-Takeover within _____ weeks after award of the Contract;

.4 I/We agree that the PET CT Room shall be ready to accept PET CT equipment delivery and installation on or before, but no later than **March 25, 2027.**

1.10 DECLARATIONS

.1 no person, firm or corporation other than the undersigned has any interest in this bid or in the proposed Contract for which this bid is made; and

.2 this bid is irrevocable and is open for acceptance by the Owner for the period specified in Document 00 21 13 Instructions to Bidders from the date of submission.

1.11 ADDRESS, LEGAL STATUS AND SIGNATURE OF BIDDER

.1 We hereby designate the address, given below as the legal address to which all notices, directions or other communications may be served or mailed:

Street_____

City_____ Province_____

Postal Code _____ Email: _____

.2 We hereby declare that the Bidder has legal status stated below:

Individual_____Partnership_____

Corporation incorporated under the laws of

_____Date_____

.3 This Base Bid Form is submitted under seal in the name:

_____

(Company Name - Typed)

By _____
(Signature)

Name _____
(Typed)

Title _____

Signed and sealed this _____ day of _____, 20____.

END OF SECTION

PART 1GENERAL

1.1 BIDDER

.1 From (Name of Bidder): _____

.2 Address: _____

.3 Telephone: _____

.4 Fax: _____

PART 2 - BID BREAKDOWN

2.1 BID BREAKDOWN

.1 I/We the undersigned submit this Bid Breakdown as a supplementary part of the Base Bid Form. The lump sum prices below represent the complete cost of each scope of work, inclusive of all labour, materials, equipment, supervision, overhead, and profit unless otherwise noted. All amounts exclude HST.

Scope of Work / Trade	**Subcontractor / Own Forces**	**Bid Price ($)**
General Conditions (mobilization, site setup / hoarding etc.).		
Demolition - Selective Demolition		
Demolition		
Metals		
Wood, Plastics and Composites		
Thermal and Moisture Protection		
Thermal and Moisture Projection - Joint Sealants		
Thermal and Moisture Protection - Firestopping / Smoke Seals		
Openings		
Finishes		

Finishes - Lead Backed Gypsum Wallboard		
Finishes - Resilient Sheet Flooring		
Finishes		
Specialties		
Specialties - Medical Headwall		
Specialties - Wall Protection - Corner Guards, Wall and Door Protection		
Equipment		
Furnishings		
Fire Suppression		
Plumbing		
Medical Gas		
Heating, Ventilating, Air Conditioning (HVAC)		
Controls and Instrumentation		
Electrical		
Communications		
Electronic Safety & Security		
Closeout – ***Closeout to be carried at $1,000.00 or 5% of total contract value to a maximum of $50,000.00***		
Total Base Bid (Excluding HST)		$_____

2.2 CASH ALLOWANCES

.1 I/We the undersigned submit this Bid Breakdown as a supplementary part of the Base Bid Form and hereby state the Base Bid Price stated herein includes Cash Allowance amounts identified in Section 01 21 00 which will be expended under the terms and conditions of the Contract

Description	Allowance Amount ($)	Included in Bid ($)
Cash Allowance – Testing & Inspections	$20,000.00	

2.3 TOTAL BASE BID

.1 **TOTAL BASE BID (Excluding HST)**

$ _____

PART 3 - SIGNATURE OF BIDDER

3.1 ADDRESS, LEGAL STATUS AND SIGNATURE OF BIDDER

.1 We hereby designate the address, given below as the legal address to which all notices, directions or other communications may be served or mailed:

Street_____

City_____
Province_____

Postal Code _____ Email: _____

.2 We hereby declare that the Bidder has legal status stated below:

Individual_____Partnership_____

Corporation incorporated under the laws of

_____Date_____

.3 This Bid Breakdown Form is submitted under seal in the name:

_____

(Company Name - Typed)

By _____
(Signature)

Name _____
(Typed)

Title _____

Signed and sealed this _____ day of _____, 20____.

END OF SECTION

PART 1 - GENERAL

1.1 BIDDER

.1 Legal Name of Bidder: _____

.2 Address: _____

.3 Telephone: _____

.4 Email: _____

1.2 ADDENDA

.1 I/We have carefully examined the Bid Documents and have received, carefully examined and incorporated the following Addenda.

Addenda No. _____ to No. _____

PART 2 - MANDATORY REQUIREMENTS

2.1 REQUIRED DOCUMENTATION

.1 The following mandatory documentation must be provided with the submission and will be evaluated on a **Pass / Fail** basis:

☐ Supplementary Qualification Form (Document 00 42 13)-completed in full and signed

☐ CCDC 11 (2019) completed in full for the General Contractor, demonstrating a minimum of ten (10) years' experience in healthcare construction

☐ Letter from the Bidder's bonding company (licensed surety) confirming bonding capacity for the Project and total bonding limit with amount currently in use

☐ Signed Certificate of Insurance from a duly licensed Canadian insurer confirming intention to provide coverage in accordance with Bid Document requirements

☐ Letter from the Bidder's financial institution confirming sound credit standing, with written authorization for the Owner to procure a credit report

☐ Bidder's current WSIB Clearance Certificate (Workplace Safety & Insurance Board)

☐ Current WSIB CAD 7 Report, MAP Program or WISR statement; or equivalent documentation for Bidders operating outside Ontario

☐ CSA infection control certifications (most recent): Fundamentals of Infection Control During Construction, Renovation and Maintenance of Healthcare Facilities AND Effective Implementation and Practical Applications of Infection Control During Construction, Renovation and Maintenance of Health Care Facilities

PART 3 - EVALUATION CRITERIA

The following submissions are required with the Bid and will be evaluated in accordance with the BID EVALUATION-STAGE 1 described in Document 00 21 13.

3.1 PROJECT TEAM - [30%]

.1 **Submission Requirements.** Submit the following for each of the proposed Contractor Project Team members:

.1 Project-specific resume clearly identifying healthcare renovation experience;

.2 Confirmation of employment status (employee of the GC vs. contract / subcontract);

.3 Number of years employed with the proposing General Contractor;

.4 Commitment statement confirming availability for the full project duration; and

.5 Confirmation of CSA Z317.13 training level obtained.

.2 Proposed Construction Manager (as applicable)

Name: _____

Years with Company: _____

Employment Status: _____

.3 Proposed Senior Project Manager (as applicable)

Name: _____

Years with Company: _____

Employment Status: _____

.4 Proposed Project Manager (as applicable):

Name: _____

Years with Company: _____

Employment Status: _____

.5 Proposed Project Coordinator (as applicable):

Name: _____

Years with Company: _____

Employment Status: _____

.6 Proposed Site Superintendent (as applicable):

Name: _____

Years with Company: _____

Employment Status: _____

.7 Proposed Assistant Site Superintendent / Field Coordinator (as applicable):

Name: _____

Years with Company: _____

Employment Status: _____

3.2 CONSTRUCTION SCHEDULE [40%]

The Project Schedule shall prioritize completion of the PET/CT scanner room / area in advance of the injection room areas. Completion of the PET/CT scanner room is a critical milestone to satisfy Ontario Health and Cancer Care Ontario funding requirements. The PET/CT scanner room shall be fully completed and ready to accept PET/CT equipment delivery and installation on or before, and in any event no later than March 25, 2027. The Owner reserves the right to proceed with delivery and installation of the PET/CT equipment upon completion of finishes in the PET/CT room, regardless of

remaining deficiencies or outstanding work in adjacent areas. The Contractor shall coordinate all remaining work, including deficiencies and system commissioning, with Owner-supplied equipment installers to maintain schedule and site access requirements.

.1 **Submission Requirements.** Submit the following:

.1 Detailed baseline project schedule in an industry-standard format (e.g., Gantt / CPM); and;

.2 Written narrative addressing the following:

.1 Logic and sequencing of all major phases;

.3 Shutdown coordination strategy (phasing, ICRA, infection control); and

.4 Commissioning and clinical turnover strategy.

3.3 COMPANY EXPERIENCE-RELEVANT HEALTHCARE / SIMILAR PROJECTS [30%]

.1 **Submission Requirements.** Submit the following:

.1 CCDC 11 (2019) for the General Contractor-completed in full;

.2 Narrative (maximum 2 pages) describing how the GC's past healthcare project experience directly enables delivery of this Project;

.3 Complete list of all proposed Sub-trades and major Suppliers.

.2 Bidders shall provide a minimum of three (3) similar projects completed within the last five (5) years. Projects will be evaluated relative to scope, size, type, and complexity.

Similar Project 1

Project Name & Location: _____

Owner / Client: _____

Architect / Consultant: _____

Construction Value ($): _____

Year Completed: _____

Scope / Description: _____

Role of Proposed PM: _____

Role of Proposed Supt.: _____

Owner / Architect Reference (Name & Contact): _____

Similar Project 2

Project Name & Location: _____

Owner / Client: _____

Architect / Consultant: _____

Construction Value ($): _____

Year Completed: _____

Scope / Description: _____

Role of Proposed PM: _____

Role of Proposed Supt.: _____

Owner / Architect Reference (Name & Contact): _____

Similar Project 3

Project Name & Location: _____

Owner / Client: _____

Architect / Consultant: _____

Construction Value ($): _____

Year Completed: _____

Scope / Description: _____

Role of Proposed PM: _____

Role of Proposed Supt.: _____

Owner / Architect Reference (Name & Contact): _____

PART 4 - DECLARATIONS

4.1 DECLARATIONS

.1 With respect to the above noted Submission, I/We confirm and certify as follows:

- I/We confirm my/our acceptance of the form of Contract specified in Document 00 21 13, Instructions to Bidders.
- I/We confirm that I/we have examined the Bid Documents and have received all pages of the Bid Documents.
- I/We have made all necessary inquiries with respect to Addenda issued by the Owner and have ensured that we have received and examined all Addenda to the Bid Documents.
- I/We affirm that the Project Team nominated herein will be committed to the Project for its full duration. Substitution of nominated personnel is not permitted without the express written agreement of the Owner.
- By submitting this Bid, the Bidder agrees to be bound by and to comply with the terms and conditions of the Bid Documents.
- I/We acknowledge and accept the confidentiality obligations set out in the Bid Documents.
- I/We acknowledge that we have not discussed or communicated, directly or indirectly, with any other Bidder any information regarding the preparation of our Bid in a manner that would contravene applicable legislation.
- I/We acknowledge that we have prepared and submitted our Bid independently and without connection, knowledge, comparison of information, or arrangement with any other Bidder.
- I/We give consent to the Owner to conduct reference checks with parties other than the references provided with our Bid.
- I/We confirm that we are able to meet all insurance obligations set out in the Bid Documents and that our pricing includes associated costs.
- I/We warrant that the goods and services proposed do not involve forced labour or child labour as defined under Canada's Fighting Against Forced Labour and Child Labour in Supply Chains Act.
- I/We declare the foregoing information to be true and accurate.

4.2 ADDRESS, LEGAL STATUS AND SIGNATURE OF BIDDER

Supplementary Qualification Form

.1 We hereby designate the address given below as the legal address to which all notices, directions or other communications may be served or mailed:

Street _____

City _____ Province _____

Postal Code _____ Email _____

.2 We hereby declare that the Bidder has legal status stated below:

Individual _____ Partnership _____

Corporation incorporated under the laws of

_____

Date _____

.3 This Form is submitted under seal in the name:

_____

(Company Name - Typed)

By _____

(Signature)

Name _____

(Typed)

Title _____

Signed and sealed this _____ day of _____, 20____.

END OF SECTION

PART 1 - GENERAL

1.1 PROJECT INFORMATION

.1 From (Name of Bidder):

_____

.2 To (Owner):

_____

1.2 ALTERNATIVE PRICES

.1 I/We the undersigned offer the Alternative Prices described below.

.2 I/We agree that:

.1 All prices submitted take into consideration and allow for changes and adjustments in other work as may be necessary to provide a finished and functional result, unless specifically indicated otherwise.

.3 Alternative Prices are amounts stipulated by bidders for solicited alternatives which can be stated as additions, deductions or no change to the Bid Price. Without limiting its rights under the Instructions to Bidders, the Owner reserves the right to accept or reject any of the Alternative Prices. Acceptance of Alternative Prices is subject to the earlier acceptance of the bid or the Bid Expiry Period. Prices listed hereunder do not include The Harmonized Sales Tax (HST) but include all other eligible taxes. These amounts shall be irrevocable for the Bid Expiry Period provided in the Instructions to Bidders

.4 Alternative Price No.1: **INTERIOR PARTITIONS (Injection Room Only) - FALKBUILT**

.1 Base Bid Description:

.2 Alternative Description:

.3 Increase in the Schedule: Weeks:_____

.4 Decrease in the Schedule: Weeks:_____

.5 Add to Base Bid Price: $_____

.6 Deduct from Base Bid Price: $_____

.5 The List of Alternative Prices is an integral part of the Bid Documents.

1.3 ADDRESS, LEGAL STATUS AND SIGNATURE OF BIDDER

.1 We hereby designate the address, given below as the legal address to which all notices, directions or other communications may be served or mailed:

Street _____

City_____ Province_____

Postal Code _____

.2 We hereby declare that the Bidder has legal status stated below:

Individual_____Partnership_____

Corporation incorporated under the laws of _____

Date_____

.3 This Supplementary Bid Form is submitted under seal in the name:
(Company Name - Typed)

_____

By_____ (Signature)

Name_____ (Typed)

Title_____

Signed and sealed this _____day of _____, 20___.

END OF SECTION

PART 1 - GENERAL

1.1 PROJECT INFORMATION

.1 From (Name of Bidder):

_____

.2 To (Owner):

_____

1.2 LABOUR RATES

.1 I/We the undersigned, herby submit the Labour Rates described herein.

.2 The Labour Rates provided shall apply when pricing changes to the Work as requested and approved by the Owner and Consultant. These prices and rates shall be used solely as a basis for evaluating additions, deletions, and changes to the Contract Price and shall not form part of the Base Bid Price.

.3 Labour rates shall be fully burdened and inclusive of all wages, payroll burdens, statutory remittances, union contributions (where applicable), benefits, small tools, travel, supervision, overhead, profit, and all other direct and indirect costs associated with the performance of the Work.

.4 The Bidder acknowledges that the labour rates submitted herein shall remain firm for the duration of the Contract and may be used by the Owner and Consultant in the valuation of contemplated changes, additions, deletions, and other adjustments to the Contract Price.

.5 The Owner reserves the right to request supporting documentation substantiating the labour classifications, wage rates, collective agreements, or other information used in establishing the submitted labour rate

.6 Description of Labour Classifications and Time

Provide details defining Regular Hours, Overtime Hours, and Premium Hours, including the applicable days, times, and circumstances under which each rate applies. Clearly identify the periods during which Regular Hours, Overtime Hours, and Premium Hours are in effect.

Labour Classification	Regular Time ($/hr)	Regular hours – please state	Overtime ($/hr)	Overtime hours – please state	Premium Time ($/hr)	Premium hours – please state
General Contractor – Project Manager						
General Contractor – Site Supervisor						
General Contractor – Project Coordinator						
General Contractor – Foreperson						
General Contractor - Labourer						
General Contractor – Carpenter						
Electrician – Journeyperson						
Electrician – Apprentice						
Mechanical Technician						
HVAC Technician						
Plumber						
Sheet Metal Worker						
Controls Technician						
Commissioning Technician						
Others (Specify)						

1.3 ADDRESS, LEGAL STATUS AND SIGNATURE OF BIDDER

.1 We hereby designate the address, given below as the legal address to which all notices, directions or other communications may be served or mailed:

Street _____

City_____ Province_____

Postal Code _____

.2 We hereby declare that the Bidder has legal status stated below:

Individual_____Partnership_____

Corporation incorporated under the laws of_____

Date_____

.3 This Supplementary Bid Form is submitted under seal in the name:

_____

(Company Name - Typed)

By_____ (Signature)

Name_____ (Typed) Title_____

Signed and sealed this _____day of _____, 20___.

END OF SECTION

PART 1 - GENERAL

1.1 LIST OF CONTENTS

.1 Following list of Documents are supplementary Documents to be used during execution of Work and form part of Contract Documents unless otherwise amended.

REFERENCE	TITLE
CCDC 9A-2018	Statutory Declaration to be made by Contractor when applying for release of holdback, security deposit, or both, upon Substantial Performance of The Work or Completion of the Contract
CCDC 9A-2018	Statutory Declaration to be made by Contractor or Subcontractor to accompany the second and subsequent progress claims
CCDC 9B-2018	Statutory Declaration to be made by Subcontractor when applying for re-lease of hold back, security deposit, or both, upon Substantial Performance of The Work or Completion of the Contract
CCA 8A	Waiver of Lien - Mortgage Fund Use -
CCA 8B	Waiver of Lien - General Purpose Form -

END OF SECTION

PART 1 GENERAL

1.1 PERFORMANCE BOND

.1 Provide security for performance of the Contract in the form of a Performance Bond for 50% of the Contract Price.

.2 Bond shall be in accordance with the latest edition of the Canadian Construction Documents Committee (CCDC) Standard Form of Performance Bond, CCDC 221.

.3 Bond shall be issued by a duly licensed surety company authorized to transact the business of suretyship in the province or territory of the Place of the Work.

.4 Bond shall name Owner as the obligee and shall be signed, sealed, and dated by both Contractor and surety company.

.5 Submit bond to Owner within 15 calendar days after contract award.

1.2 LABOUR AND MATERIAL PAYMENT BOND

.1 Provide security for payment of labour and material provided in the performance of the Work in the form of a Labour and Material Payment Bond for 50% of the Contract Price.

.2 Bond shall be in accordance with the latest edition of the Canadian Construction Documents Committee (CCDC) Standard Form of Labour and Material Payment Bond, CCDC 222.

.3 Bond shall be issued by a duly licensed surety company authorized to transact the business of suretyship in the province or territory of the Place of the Work.

.4 Bond shall name Owner as the obligee and shall be signed, sealed, and dated by both Contractor and surety company.

.5 Submit bond to Owner within 15 calendar days after contract award.

END OF SECTION

PART 1 GENERAL

1.1 PROJECT SUMMARY

.1 The intent of this project is to renovate the existing vacant diagnostic imaging space to receive a new PET CT scan machine and renovate an existing shell space for support spaces – injection rooms, office, supply closet and EVS room.

.2 Access to WRHN roof, second floor and ground floor will be required for mechanical & electrical scope of work. Contractor is responsible to coordinate with all trades and with facility representative(s) to obtain access, minimize disruption to ongoing operations, provide hoarding as required, and patch/repair as required.

.3 Anticipated Construction Schedule: as per the milestone schedule.

a. TBD when WRHN provides an updated schedule.

1.2 LANGUAGE OF THE CONTRACT

.1 The use of the words “include” or “including”, or variations thereof, within the Contract Documents is not limiting.

.2 The Specifications are directed at the Contractor. Sentences written in the imperative form apply to the Contractor.

.3 “Supply” means: deliver to the Site and place as directed by the Contractor.

.4 “Install” means: accommodate in the Work, receive, store, uncrate, assemble, adjust, trim, and fit as necessary, locate as per the documents as adjusted by the Architect, affix to the Work and connect to services as per manufacturer’s instructions and as required by the documents in conformance with Shop Drawings and as required for full operation or service and make final trimming and adjustment, test, clear, make fully operational, provide operating and reference data required by Section 01300, warrant and demonstrate use to the Owner.

.5 “Provide” means: supply and install.

.6 “Make Good” means: To remove and replace, repair, patch, trim, sand and paint, as necessary, all affected items and surfaces using materials and procedures to match adjacent materials and finishes.

.7 Not in Contract: The means by which something shown or specified shall be indicated as not being in the Contract is by the use of the initials “NIC” or the words “not in (the) Contract”, “by Owner” or “by another Contractor”.

.8 Number: In all cases where a device or part of the equipment is referred to in the Specifications in the singular number, it is intended that such reference shall apply to as

many such devices as are required to complete the installation. The word “all”, whether used or not, is intended to apply to all products and cases (events) mentioned in the Specifications, unless the context clearly and specifically provides otherwise.

1.3 THE CONTRACT DOCUMENTS

.1 The Contract Documents have been arranged into various divisions, sections, drawings, and schedules for the purpose of presenting the Work in a logical and organized form and to enable ease of reference and interpretation, and are not intended to be an arrangement of precise and independent Subcontractors, or jurisdiction of responsibility for the various parts of the Work. The Contractor shall be solely responsible for coordinating the execution of the Work of this Contract in accordance with the requirements of the Contract Documents.

.2 As a result, the Consultant shall not be required to decide on questions arising with regard to agreements or contracts between the Contractor and Subcontractors or Suppliers, nor to the extent of the parts of the Work assigned thereto.

.3 Further, no extra will be allowed as a result of the failure to coordinate and allocate the Work such that the Work is Provided in accordance with the Contract Documents.

.4 This section coordinates, relates, and governs the work of other sections of the specifications.

1.4 LAWS, NOTICES, PERMITS AND FEES

.1 The building code - Ontario Regulation 332/12, and CSA Z8000 including amendments, shall govern the Work.

.2 Comply with codes, by-laws, and regulations of authorities having jurisdiction over the Place of the Work. Codes and regulations form an integral part of the Contract Documents.

.3 Owner or Consultant shall apply and pay for the building permit, and pick up building permit from the municipal department having jurisdiction at the Place of the Work. Obtain and pay for all other permits, licenses, deposits and certificates of inspection as part of the Work.

.4 Owner or Consultant shall arrange for inspection contemplated under allowance, testing and acceptance of the Work required by the authorities having jurisdiction. Owner responsible for testing and if testing fails contractor is responsible for Re-Testing. Be responsible for necessary preparations, provisions and pay costs.

.5 Owner or Consultant to obtain permits required to execute work on municipal rights of way. Obtain damage deposits for sidewalks, roads and services, unless otherwise indicated.

.6 It is the responsibility of the Contractor to schedule notifications and inspections required by authorities having jurisdiction such that notifications can be properly received and that

inspections can be properly undertaken without causing a delay in the Work. The Contractor, at no additional cost to the Owner, shall be solely responsible for any delay in the Work caused by failure to properly schedule required notifications and inspections.

.7 The Contractor shall provide to the chief building official or the registered code agency, where a registered code agency is appointed under the Ontario Building Code Act in respect of the construction to which the notice relates, the required notices set out in Division C – Sub-section 1.3.5. of the Ontario Building Code, O. Reg. 332/12 as amended. The Contractor shall be present at each site inspection by an inspector or registered code agency as applicable under Division C – Sub-section 1.3.5. of the building code.

a. It is the responsibility of the Contractor to schedule notifications to the chief building official or the registered code agency such that the inspection pertaining to the notifications can be made within the time frame as required under Division C – Sub-section 1.3.5. of the Ontario Building Code, O. Reg. 332/12 as amended, without causing a delay in the Work. The Contractor, at no additional cost to the Owner, shall be solely responsible for any delay in the Work caused by failure to properly schedule required notifications and inspections.

1.5 EXAMINATION OF THE PLACE OF THE WORK, DOCUMENTS, SURFACES AND CONDITIONS BY THE CONTRACTOR

.1 Carefully examine the Place of the Work and investigate matters relating to the nature of the Work, means of access and egress, obstacles, rights and interests of other parties which may be interfered with during the execution of the Work, conditions and limitations including obstructions, existing structures or facilities, local conditions, actual levels, character and nature of the Work, and other consideration which may affect performance of the Work.

.2 Carefully examine the extent of work to be performed and matters which are referred to in the Contract Documents prior to start of the Work.

.3 Examine work to which work is to be applied, anchored or connected, and relevant as-built conditions.

.4 Each work operation following on a previous work operation of a differing Subcontractor, as in the case of finishing and surfacing work, shall include a thorough examination of the condition of the previous work. Conditions found unacceptable, either for the commencement of the new work or its satisfactory completion, shall be reported in writing to the Consultant.

.5 Do not commence work until unsatisfactory conditions are corrected. Commencement of work implies acceptance of surfaces and conditions and existing conditions will not be accepted as a contributing factor to subsequent failure or acceptability of the Work.

1.6 QUANTITY OF ITEMS

.1 Where a component, device, item or part of materials or equipment is referred to in the singular number, such reference shall require the provision of as many components, devices, items or parts of material or equipment necessary to complete the Work.

1.7 STANDARDS AND CODES

.1 Contract forms, codes, specifications, standards, manuals and installation, application and maintenance instructions referred to in these specifications, unless otherwise specified, amended or date suffixed, shall be latest published editions at Contract date.

1.8 DISCREPANCIES AND CLARIFICATIONS

.1 Advise Consultant of discrepancies discovered in requirements of the Contract Documents and request clarification in written form.

.2 Advise Consultant when clarifications are required pertaining to meaning or intent of requirements of Contract Documents and request clarification from Consultant in written form.

.3 Do not proceed with related work until written clarification is provided by Consultant.

.4 Failure to notify Consultant shall result in Contractor incurring responsibility for resulting deficiencies and expense at no additional cost to the Owner.

.5 Written instructions issued by Consultant for the purpose of clarification, implicitly supersede applicable and relevant aspects of the Contract Documents irrespective of whether or not these documents are explicitly or specifically cited in clarification requests or clarification instructions.

1.9 SETTING OUT THE WORK

.1 Assume full responsibility for and execute complete layout of the Work to required locations, lines and elevations.

.2 Arrange meeting with Consultant to discuss critical setting out assumptions for the Work and establish limiting conditions for setting out the Work. Consultant shall chair and prepare minutes of the meeting, and prepare and submit sketches recording understanding of key setting out principles.

.3 Provide devices needed to lay out and construct the Work.

1.10 DOCUMENTS AT THE PLACE OF THE WORK

.1 Maintain at the Place of the Work, one copy of each of following:

a. Contract Documents including drawings, specifications, addenda, and other modifications to the Contract.

b. 'Reviewed' or 'Reviewed as Modified' shop drawings.

c. Construction and submittal schedules.

d. Supplemental Instructions, Proposed Change Orders, Change Orders, and Change Directives.

e. Field Test Reports.

f. Consultant's field review reports and deficiency reports.

g. Reports by authorities having jurisdiction.

h. Building and other applicable permits, and related permit documents.

i. Daily log including:

1. Number of workers actively working at the Place of the Work by each subcontract.
2. Subcontractors working at the Place of the Work.
3. Parts of the Work being worked on.
4. Working hours worked at the Place of the Work.
5. Activities with intermittent progress.
6. Time lost and explanation for such time lost.
7. Difficulties (work scheduled to start but did not with the reason why, delays, labour inefficiencies, labour shortage).
8. Products and materials delivered.
9. Equipment mobilized and/or demobilized.
10. Demolition conditions.
11. Start and finish date of each part of the Work.

j. As-built drawings recording as-built conditions, instructions, changes for structure, equipment, wiring, plumbing, and the like, as called for in Section 01 77 00 and Divisions 21, 22, 23, 25 and Divisions 26, 27, and 28, prior to being concealed.

.2 Make above material available to Consultant upon request.

1.11 OVERLOADING

.1 Protect the existing building from loads which may cause permanent deformation.

.2 Protect the Work from loads which may cause permanent deformation.

1.12 INSERTS, ANCHORS AND FASTENERS

.1 Use only factory made, threaded or toggle type inserts as required for supports and anchors, properly sized for load to be carried.

.2 Where inserts cannot be placed, use factory made expansion shields for light weights only.

.3 Supply and locate inserts, holes, anchor bolts and sleeves during placement or fabrication of structural elements.

.4 Fasteners stressed in withdrawal are not acceptable, except where otherwise indicated.

.5 Metal fastenings shall be uniform to metals materials and components being anchored or of a metal which will not set up a galvanic action causing damage to the fastening or metal component under moist conditions.

.6 Fastenings for prefinished materials shall be of concealed type unless otherwise indicated, and when exposed finish is required, of matching pre-finishing materials.

.7 Metal fastenings and accessories shall be same texture, colour and finish as material on which they occur, as selected by Consultant.

.8 Power actuated fasteners:

a. Power actuated fasteners: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E1190-95(2007) conducted by a qualified independent testing agency.

b. Do not use power actuated fasteners which are stressed in withdrawal in finished work.

c. Do not use power actuated fasteners within 100 mm (4") of the edge of concrete or masonry, unless otherwise accepted in writing by Consultant.

d. Do not use power actuated fasteners in post-tensioned concrete.

1.13 PENETRATIONS

.1 Holes or voids created in assemblies or partitions for penetrating mechanical, electrical, or sprinkler service items, shall be of sufficient size to accommodate the penetrating item as well as additional required fill materials, such as sealants, firestopping and smoke sealants, insulation, and the like, without exceeding the maximum opening allowable by the manufacturer of the additional required fill material.

.2 Abandoned holes & penetrations must be filled with material to match existing adjacent and thickness. Minimize disruptions below by infilling from above. Refer to section 01 73 29 Cutting and Patching.

1.14 CONCEALED SERVICES

.1 Conceal all services, including but not limited to; wiring, conduit, pipes and ductwork in finished areas, unless otherwise indicated.

1.15 TRADEMARK AND LABELS

.1 Trademarks and labels, including applied labels, shall not be visible in finished work in finished areas, unless otherwise accepted or indicated by Consultant.

.2 The exceptions to this requirement are trademarks and labels which are essential to identify materials, systems, assemblies, and equipment for maintenance and replacement purposes, and for life safety, fire resistance and temperature rise ratings.

1.16 WASTE AUDITS PLANS FOR WASTE REDUCTION

.1 Comply with requirements of jurisdictional authorities.

.2 Deliver to nearest appropriate depot materials accepted for recycling by region or municipality having jurisdiction over the Place of the Work, including but not limited to cardboard, paper, plastic, aluminum, steel, and glass. Deliver to nearest appropriate depot scrap and excess gypsum wallboard for recycling of this material. Costs for this work are included in the Contract Price.

1.17 INTERFERENCES

.1 Coordinate placement of equipment to ensure that components will be properly accommodated within spaces provided prior to commencement of the Work.

.2 Take complete responsibility for remedial work that results from failure to coordinate aspects of work prior to its fabrication/installation.

.3 Ensure that accesses and clearance required by jurisdictional authorities and/or for easy maintenance of equipment are provided in layout of equipment and services; notify Consultant if indicated clearances are in conflict.

1.18 ITEMS SUPPLIED BY OWNER

.1 NIC (Not in Contract) shall be used to designate various items of equipment that require coordination for installation although are not Provided as part of the Work.

.2 SBO (Supplied by Owner) shall be used to designate various items of equipment that will be supplied by the Owner for installation by the Contractor as part of the Work.

a. Install items indicated as supplied by Owner (SBO) during the Work. Coordinate shipping and delivery with the Owner. Store items supplied by Owner at the Place of the Work and protect from damage. Install completely, and leave in full operating condition, in accordance with manufacturer's directions.

1.19 SEISMIC DESIGN AND REQUIREMENTS

.1 Design building components, assemblies and systems of the Work, as applicable, and comply with requirements of jurisdictional authorities.

.2 Post-Disaster Building: Conform to building code requirements for building classification, 'Post-Disaster Building'. Elements of structures, non-structural components and equipment shall be designed in accordance with building code requirements for seismic design, connections, and seismic restraint for 'Post-Disaster Buildings'.

.3 Vibrating equipment shall receive seismically designed vibration isolation. Only non-vibrating equipment are permitted to be secured to the structure. Structural connection shall be by means of direct connection to the structure by bolting, using rigid seismic restraints, or taught cable restraints. Connection to structure shall occur only at locations capable of withstanding the forces applied.

.4 The proposed connections and general design of Products, equipment and systems shall be described in shop drawing format with identification and location of forces imposed on the structure. The shop drawings shall be stamped by a Professional Engineer licensed to practice in the Place of the Work and have the appropriate understanding of the issues at hand. The shop drawings shall be submitted for review to the Consultant prior to putting the work in hand. The Consultant shall review these shop drawings for loads imposed on the structure.

.5 Professional Engineer responsible for preparation of seismic engineered submittal shall review the Work and shall submit letters of general conformity for those parts of the Work in accordance with engineered submittal requirements of Section 01 33 00.

1.20 SECURITY

.1 Be responsible for security of the Place of the Work and material from time the Work commences until completion of the Work.

.2 Provide and maintain signs, hoardings, guard-rails, barriers, warning lights and other protection as required by authorities having jurisdiction for safety of the Place of the Work. Be responsible for adequacy of protection.

1.21 PUBLICITY RELEASES AND PHOTOGRAPHS

.1 No press or publicity releases will be permitted without prior written approval of the Owner.

.2 No photographs of the Place of the Work or of any portion of the Work will be permitted without written approval of the Owner, except as provided by the Contract Documents.

1.22 SMOKING POLICY

.1 Smoking in the Owner's premises is prohibited.

.2 Smoking at the Place of the Work is prohibited.

1.23 ELECTRONIC FILES

.1 AutoCAD base files are available from the Consultant. Fee for all required project files for architectural drawings is $500.00; refer to Common Work Results and General Instructions in respective specification sections regarding fees for sub-consultants' drawings.

1.24 DOCUMENTS TO ACCOMPANY APPLICATIONS FOR PROGRESS PAYMENTS

.1 In addition to items listed in the General Conditions, as amended, the following shall accompany all applications for progress payments:

a. Current RFI log (refer to Section 01 32 16).

b. Current construction schedule (refer to Section 01 32 16).

c. Current log of Contemplated Change Orders, Change Orders, Change Directives, and Supplemental Instructions.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 Cash allowances.

1.2 REFERENCES

.1 Refer to the General Conditions and the Supplementary Conditions for cash allowances in the construction contract.

.2 Refer to the General Conditions and the Supplementary Conditions for contingency allowance in the construction contract.

.3 Section 00 41 16 Bid Breakdown Form.

1.3 CASH ALLOWANCES

.1 Cash Allowances are shown in the 00 41 16 Bid Breakdown Form and described in the Contract Documents.

.2 Included in Contract Price are Cash Allowances to be carried in Subcontracts for work specified in respective specification Sections. Coordinate to ensure no omission or duplication.

.3 Prior to execution of the Cash Allowance Work, the Contractor will review the Cash Allowance tender documents for scope and administrative compatibility with the Contract and provide a recommendation for use of the Cash Allowance to the Owner & Consultant. Acceptance will be at the Owner's discretion.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 General administrative and procedural requirements for Prices in the *Contract Documents*.

1.2 RELATED REQUIREMENTS

.1 Section 01 21 00 Allowances

.2 Section 01 10 00 General Instructions

1.3 GENERAL

.1 Prices included in the Agreement shall be complete for the applicable work, and shall constitute the full consideration, payment, compensation and remuneration to the Contractor for all such. For greater certainty, but without limitation to the foregoing, such prices will constitute full and complete consideration, payment, compensation and remuneration to the Contractor for the following (subject to adjustment only as specified in the Contract Documents):

a. Expenditures for wages and for salaries of workmen, engineers, superintendents, draftsmen, foremen, timekeepers, accountants, expeditors, clerks, watchmen and other such personnel as may be approved, employed directly under the Contractor and while engaged on the applicable work at the site and expenditures for travelling and board allowances of such employees when required by location of the applicable work or when covered by trade agreements and when approved; provided, however, that nothing shall be included for wages or salary of the Contractor's firm if the Contractor is a firm or the salary of any officer of the Corporation if the Contractor is a corporation, unless otherwise agreed to in writing;

b. Expenditures for material used in or required in connection with the construction of the applicable work including material tests and mix designs required by the laws or ordinances of any authority having jurisdiction and not included under Subparagraph .9 (or paid from a cash allowance in Section 01 21 00);

c. Expenditures for preparation, inspection, delivery, installation and removal of materials, plant, tools, and supplies;

d. Temporary facilities as required for the applicable work;

e. Travelling expenses properly incurred by the Contractor in connection with the inspection and supervision of the applicable work in connection with the inspection of materials prepared or in course of preparation for the applicable work and in expediting their delivery;

f. Rentals of all equipment whether rented from the Contractor or others, in accordance with approved rental agreements including any approved applicable insurance premiums thereon and expenditures for transportation to and from the site of such equipment, costs of loading and unloading, cost of installation, dismantling and removal thereof and repairs of replacements during its use on the applicable work, exclusive of any repairs which may be necessary because of defects in the equipment when brought to the work or appearing within thirty (30) days thereafter;

g. The cost of all expendable materials, supplies, light, power, heat, water and tools (other than tools customarily provided by tradesmen) less the salvage value thereof at the completion of the applicable work;

h. Assessments under the Workers' Compensation Act, the Unemployment Insurance Act, Canada Pension Act, statutes providing for government hospitalization, vacations with pay or any similar statutes; or payments on account of usual vacations made by the Contractor to his employees engaged on the applicable work at the site, to the extent to which such assessments or payments for vacations with pay relate to the work covered by the specified price; and all sales taxes or other taxes where applicable;

i. The amounts of all Subcontracts related to the specified price;

j. Premiums on all insurance policies called for under this Contract;

k. Royalties for the use of any patented invention on the applicable work;

l. Fees for licenses and permits in connection with the applicable work;

m. Duties/taxes imposed on applicable work;

n. Such other expenditures in connection with the applicable work as may be approved;

o. Provided always that except with the consent of the Owner, the above items of cost shall be at rates comparable with those prevailing in the locality of the work.

.2 The above noted list together with the list provided in paragraph 6.3.7 of the Agreement (CCDC 2-2008) shall be used to determine the itemized accounting for any quotation or a Change Directive.

1.4 PROJECT RECORD DOCUMENTS

.1 Contractor’s as-built and record drawings shall show the quantity/extent of work executed under Prices.

END OF SECTION

PART 1 GENERAL

1.1 APPROVED ALTERNATES AND APPROVED EQUALS

.1 Named *Products* alternates or equals, indicated by the phrases "or approved alternate by XYZ Manufacturing" or "or approved equal by XYZ Manufacturing", shall be interpreted to mean that named *Product* alternate or equal, if selected for use in lieu of indicated or specified *Product*, meets or exceeds performance, appearance, general arrangement, dimensions, availability, code and standards compliance, and colour of specified *Product*. Be responsible for costs and modifications associated with the inclusion of named *Product* alternate or equal at no additional cost to the *Owner*.

.2 The process for proposing and approving alternates or equals shall be the same process as for proposing and approving substitutions (refer to paragraph 1.2 below).

.3 Confirm delivery of specified items prior to proposing alternates or equals.

1.2 SUBSTITUTIONS

.1 Submission of substitutions:

a. Proposals for substitutions of *Products* and materials must be submitted in accordance with procedures specified in this section.

b. *Consultant* may review submissions, if directed by *Owner,* but in any case with the understanding that the *Contract Time* will not be altered due to the time required by the *Consultant* to review the submission and by the *Contractor* to implement the substitution in the *Work*.

.2 Submission requirements:

a. Description of proposed substitution, including detailed comparative specification of proposed substitution with the specified *Product*.

b. Manufacturer’s *Product* data sheets for proposed *Products*.

c. Respective costs of items originally specified and the proposed substitution.

d. Confirmation of proposed substitution delivery, in writing by *Product* manufacturer.

e. Compliance with the building codes and requirements of authorities having jurisdiction.

f. Affect concerning compatibility and interface with adjacent building materials and components.

g. Compliance with the intent of the *Contract Documents*.

h. Effect on *Contract Time*.

i. Reasons for the request.

j. Confirm that the warranty coverage period will be the same or greater than originally specified, and provide detailed information on the availability of maintenance services, replacement parts, associated costs, and time frames

.3 Substitutions submitted on shop drawings without following requirements of this section prior to submission of the affected shop drawings will cause the shop drawings to be rejected.

.4 Proposed substitutions shall include costs associated with modifications necessary to other adjacent and connecting portions of the *Work*.

.5 *Consultant's* decision concerning acceptance or rejection of proposed substitutions is final. Should it appear to the *Consultant* that the value of services required to evaluate the substitution exceeds the potential reduction, the *Consultant* will advise the *Owner* that the substitution does not merit consideration before proceeding with a full evaluation. If the substitution will produce a reduction commensurate with or exceeding the value of the *Consultant's* services to evaluate the substitution, the *Consultant* will request the *Owner's* direction to proceed with evaluation.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 General administrative and procedural requirements for Changes, Payments and Certificates in the *Contract Documents*.

1.2 RELATED REQUIREMENTS

.1 Section 00 73 00 Supplementary Conditions

.2 Section 01 10 00 General Instructions

.3 Section 01 24 03 Prices

1.3 GENERAL

.1 All submissions under this section shall bear the project name, Owner's name and Project No., Consultant Project No., and date.

.2 Where a Certificate of Clearance from the Workplace Safety and Insurance Board (WSIB) is requested, the Certificate submitted shall clearly show that the Contractor is in good standing with the WSIB

.3 WSIB “independent operator” status for any Contractor is not acceptable.

.4 Contractor is solely responsible for ensuring that each of the Contractor’s personnel, including but not limited to employees, directors, officers, principals and executives of the Contractor, are covered by WSIB insurance.

.5 Contractor warrants and certifies to the Owner that each of the Contractor’s personnel, including but not limited to employees, directors, officers, principals and executives of the Contractor, are covered by WSIB insurance.

.6 Contractor shall defend, indemnify and hold harmless the Owner against any and all claims made due to failure to pay WSIB premiums or provide WSIB coverage for any person engaged by the Contractor, directly or indirectly, for Work of this Contract.

.7 Obtain a valid WSIB Certificate of Clearance from each Subcontractor or Supplier prior to releasing payment to the subcontractor or Supplier. Indemnify and hold harmless the Owner against any failure of the Contractor to obtain valid Subcontractor’s or Supplier’s

WSIB Certificate of Clearance prior to releasing payment to respective Subcontractor or Supplier.

.8 All applications for payment after the first shall be accompanied by CCDC Statutory Declaration 9A-2018, duly executed. CCDC Statutory Declaration 9A is acceptable only where it bears an original CCDC Statutory Declaration 9A-2018 copyright seal.

.9 Payments due to the Contractor shall be made in accordance with the Construction Act and will be made electronically to the Contractor based on the electronic funds transfer (EFT) information provided by the Contractor

1.4 INVOICE

.1 A proper invoice must include the following information:

a. Firm – name, address, contact information
b. HST Registration Number
c. Project information – name, address
d. Project number
e. Invoice Number
f. Period covered
g. Original contract value
h. Approved changes
i. Totals
j. Current $ Value of Work
k. Holdback Amounts
l. Previously paid amounts
m. Invoice Total
n. Applicable Taxes
o. Total Payment

.2 Additionally, a proper invoice must include the following attachments:

a. Contract Breakdown
b. Summary of change orders and change directives
c. Sub-contractors invoices
d. Statutory Declaration

.5 WSIB Certificate of Clearance

a. Up-to-date project schedule

b. Written Declaration signed by an authorized representative of DB, stating there has been no delay in the progress of work except as identified in the monthly schedule report

1.5 INVOICING PERIODS

.1 Submit monthly progress invoices. Invoices shall be dated last working day of each month. Submit final invoice within 45 days of Completion of Contract as defined in applicable lien legislation. Failure to submit invoices within schedule voids Owner's obligations to pay invoices

1.6 SCHEDULE OF VALUES

.1 Refer to CCDC 2 - 2020, GC 5.2. .

.2 Costs of temporary facilities and utilities shall be amortized over the duration of the Work. Claims for 'mobilization', 'bidding costs' or similar lump sums at or before start of work not acceptable.

.3 Include as separate line items in the Schedule of Values, the following:

a. Submittals
b. Final Cleaning – by a professional cleaning service
c. Commissioning, valued at 1% of the overall contract value. The Commissioning Authority (CxA) will review the construction draws from a commissioning perspective and provide recommendations to the Prime Consultant and the University.
d. Deficiency resolution.

.4 Project Close-out documentation at $50,000.00 or 5% of overall contract value, whichever is greater

.5 Value Added Tax

1.6 APPLICATIONS FOR PAYMENT AND FOR CERTIFICATES

.1 In addition to other requirements of the Contract, the following information applies to applications for payments, and applications under the Construction Act.

.2 Progress applications:

a. Progress applications for payment shall indicate the value complete of each item in the Schedule of Values, percentage complete to date of application, value

previously certified for payment by the Consultant, and value of work remaining. Refer to Section 01 29 03 for sample progress invoice format. All values shall be exclusive of Value Added Tax (GST or HST), except that Value Added Tax shall be applied to the total amount claimed, and the value of Value Added Tax indicated on the application.

b. Include a summary of changes with application for payment, showing values complete.
c. No payment will be made for Products ordered or manufactured, but not yet delivered to the Place of the Work.
d. Include evidence to support claims for Products delivered to the Place of the Work, but not yet incorporated into the Work, as the Consultant may require to establish the value and delivery of the products.
e. Products delivered to the Place of the Work are the property of the Owner and shall not be removed without the Owner's consent, except where rejected as defective products or removed as legitimate debris. Any Products delivered to the Place of the Work but not yet incorporated into the work shall remain at the risk of the contractor not withstanding that title has passed to the Owner.
f. In addition to other requirements, progress applications shall indicate the cost of the following items as separate items:
    1. Bonds;
    2. Insurances;
    3. Temporary facilities and controls;
    4. Contract closeout, record and as-built drawings, maintenance and operating manuals;
    5. Value Added Tax.

.3 Applications for a Certificate of Substantial Performance:

a. Applications for a Certificate of Substantial Performance, release of holdback, and Statement of Completion shall be completed in accordance with OAA/OGCA Document 100 Takeover Procedures (latest edition) In Document 100, substitute "Consultant" for "Architect", and "review" for inspection where it appears in relation to the Consultant's assessment of the Work.
b. The Contractor shall make written application to the Consultant or the Payment Certifier for the certificate
c. The application shall also include:
    1. Statements that the contract is substantially performed;
    2. A statement that all required submissions have been made;
    3. Statements of completion with a cost value for deficiencies, outstanding documentation, work that can not be performed and which is beyond the

Contractor's control, and any work which is to be completed at a later date as agreed to by the Owner; and

4. A2 separate invoice showing the amount of holdback to be released.

.4 If the Consultant finds the application to be complete, the Consultant will visit the Place of the Work to verify the validity of the application.

.5 If the application is approved by the Consultant, the Consultant will issue a certificate of substantial Performance to the Owner and to the Contractor.

.6 Progress applications claiming monies against cash allowances shall be accompanied by true copies of all invoices and statements from suppliers or subcontractors furnishing products, etc., purchased under a cash allowance.

.7 A WSIB Certificate of Clearance, valid for the date on which payment of the progress claim is likely to be made, shall accompany all applications for payment.

.8 All applications shall be accompanied by an update project schedule.

.9 All applications shall be accompanied by CCDC Statutory Declaration 9A2018, duly executed, with a copyright seal. CCDC Statutory Declaration 9A is acceptable only where it bears an original CCDC Statutory Declaration 9A-2018 copyright seal.

.10 Provide originals of all documents for invoicing, except that WSIB material may be facsimile copy.

1.7 RELEASE OF HOLDBACK

.1 Holdback monies will be released in accordance with applicable legislation. Once the lien period has expired and the holdback monies are no longer held in trust, the Owner may withhold sufficient funds to protect himself from loss on account of any of the following;

a. Defective work not remedied.
b. Delay in performance of the work.
c. Delay in submission of documentation.
d. Claims filed or reasonable evidence indicating probable filing of claims.
e. Overpayment for completed work.
f. Damaged work caused by Contractor, Subcontractors or Suppliers.

.2 When all conditions for which money has been withheld have been remedied, the Consultant will immediately issue (a) certificate(s) for the amount(s) withheld.

.3 A Certificate for Payment of substantial performance holdback will only be made upon receipt by the Consultant of proof of publication of the Certificate of Substantial Performance from the public or trade publication.

.4 Where the Contractor does not publish the Certificate of Substantial Performance within 10 calendar days of the Consultant's issuance of the Certificate, the Owner may, at the Owner's sole discretion, publish the Certificate of Substantial Performance, deducting the cost of the publication from the Contract Price. Cost of publication will include the advertising fees, plus Owner's and Consultant's labour costs charged at regular hourly rates for time involved in arranging publication. Where there are no regular hourly rates, costs shall be charged at hourly salary or wages multiplied by 3.

1.8 FINAL PAYMENT

.1 When all deficiencies have been corrected and the work completed, the Contractor will request that the Consultant visit the Place of the Work for a further review.

.2 Upon being satisfied that all deficiencies have been corrected and that all other conditions listed under 1.6.1 above have been satisfied, all to the satisfaction of the Owner, the Consultant will so inform both the Contractor and the Owner.

.3 Upon receipt of the Contractor’s invoice, the Consultant will issue a certificate for final payment.

.4 If a subsequent site review(s) is (are) required to verify 100% completion of deficiencies, the Contractor will be expected to compensate the Owner, by way of a change order to the Contract, for the time and travel expenses incurred by the Consultant for any subsequent review(s). The rates for time and travel are outlined in an agreement between the Consultant and the Owner.

.5 If the deficiencies are not completed within a reasonable period of time, as agreed to by all parties, the Owner make invoke the requirements of CCDC 2020, GC 7.1 – Owners Right to Perform Work or Stop the Work or Terminate the Contract.

1.9 FIELD/SITE INSTRUCTIONS AND SUPPLEMENTAL INSTRUCTIONS

.1 Field Instructions, Site Instructions and/or Supplemental Instructions (hereinafter called Supplemental Instructions) are issued only for the purpose of recording any clarifications or interpretation of the Contract Documents or giving direction on field conditions. These instructions are subject to the provisions of the Contract Documents and unless stated herein and specifically co-authorized by the Owner, will not affect the Contract Price or Contract Time.

.2 If in the opinion of the Contractor a Supplemental Instruction involves an increase in the Contract Price or Contract Time, the Contractor shall within 7 working days of receipt of the Supplemental Instruction advise the Consultant in writing accordingly, complete with an itemized proposal. Failure to provide written notification within time stipulated shall be deemed acceptance of Supplemental Instruction by the Contractor without any increase to the Contract Price or Contract Time.

.3 Where the Contractor requests a change in Contract Time or Contract Price due to the provisions of Supplemental Instruction, the Contractor shall not proceed with any work of the Supplemental Instructions until directed. If the Owner accepts the proposal, the Supplemental Instructions will be issued as a Change Order.

.4 Where, in the reasonable opinion of the Consultant or the Owner, the Supplemental Instruction involves a decrease in the Contract Price or Contract Time, the Consultant or the Owner through the Consultant shall advise the Contractor of such opinion, including the details of the proposed adjustment, in writing prior to the final payment being made. The Contractor shall provide satisfactory evidence that an adjustment is not warranted, failing which the Owner shall proceed to deduct the applicable amount from final payment or adjust the Contract Time, as the Case may be. Where, in the opinion of the Consultant or the Owner the Supplemental Instruction warrants a decrease in Contract Time or Contract Price, the Consultant or the Owner through the Consultant shall so advise the Contractor prior to release of final payment.

1.10 VALUATION OF CHANGES IN THE WORK

.1 Further to CCDC 2 – 2020, Part 6, the method to be used in determining the value of a change to the Work, by either Change Order or Change Directive, shall be:

a. Estimate and acceptance in a lump sum, unless the Consultant otherwise determines that the method shall be one of:
b. Unit prices set out in the Contract.
c. Cost and a fee.

.2 Where methods .1 or .2 (from 1.9.1 above) are used the Contractor shall provide the Consultant with a detailed cost analysis of the contemplated change indicating:

a. quantity of each material.
b. unit cost of each material.
c. time involved.
d. subtrade quotations including a complete analysis of costs.

e. cost of approved changes to bonding requirements.
f. markups, if applicable.
g. value of Value Added Tax as applicable.
h. proposed change in Contract Time.

.3 Where method .3 (from 1.9.1 above) is used, propose a fee, and a method for determining cost, and any proposed change in Contract Time.

1.12 TAX RECOVERY

.1 When an exemption or recovery of government sales taxes, duties or excise taxes is applicable to the Contract, the Contractor shall at the request of the Owner assist, join in, or make application for an exemption, recovery or refund of all such taxes and duties. All amounts recovered or exemptions obtained shall be for the sole benefit of the Owner. The Contractor agrees to endorse over to the Owner any cheques received from the federal or provincial governments as may be required to implement the foregoing failing which the Owner is authorized to deduct the amount from any Contract payment that is then or may thereafter become due to the Contractor.

.2 Maintain accurate records, tabulating equipment and component costs showing all respective taxes and duties or excise taxes. At the request of the Owner, assist, join in, or at Owner's expense, make application on behalf of the Owner for any exemption, recovery or refund, and provide the Owner with copies, or where required originals of records, invoices, purchase orders or other documentation as may be necessary to support such application.

1.13 APPLICATION FOR CERTIFICATION OF COMPLETION OF A SUBCONTRACT AND EARLY RELEASE OF HOLDBACK

.1 Certification of completion of a subcontract will not be made.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL

.1 *Provide* the *Work* in accordance with the *Contract Documents* and be responsible for delays or costs resulting from failure to properly inspect or coordinate the *Work*, and for replacement or corrective work required.

1.2 IDENTIFICATION OF SYSTEMS

.1 *Provide* identification of electrical and mechanical system installations and other automated systems or equipment in compliance with *Contract Documents*.

1.3 COMMISSIONING AND SYSTEMS DEMONSTRATIONS

.1 Provide testing, adjusting, balancing and certification and commissioning of mechanical and electrical installations and other automated systems or equipment in accordance with Section 01 77 00.

.2 Instruct *Owner's* designated representatives in operation and maintenance of mechanical and electrical installations and other automated systems or equipment, in accordance with Section 01 77 00.

1.4 SUPERINTENDENCE

.1 Provide superintendent and necessary supporting staff personnel in attendance at the *Place of the Work* while *Work* is being performed, with proven experience in erecting, supervising, testing and adjusting projects of comparable nature and complexity.

.2 Appoint a competent supervision at the *Place of the Work* who shall have overall authority at the *Place of the Work* and shall speak for the *Contractor* and represent the *Contractor's* interest and responsibilities at meetings at the *Place of the Work* and in dealings with the *Consultant* and the *Owner*.

1.5 DIMENSIONS

.1 Verify dimensions at the *Place of the Work* before commencing shop drawings. Before fabrication commences report discrepancies to *Consultant* in writing. Incorporate accepted variances on shop drawings and as-built records.

1.6 COORDINATION

.1 Coordinate and ensure workers, *Subcontractors*, and *Suppliers* cooperate to ensure that the *Work* will be carried out expeditiously and in proper sequence.

.2 Allow Site Access to Testing and Inspection companies personnel. Coordinate with related subtrades.

1.7 BUILDING DIMENSION, TEMPLATES, BUILT-INS, AND COORDINATION

.1 Take necessary dimensions for the proper execution of the *Work*. Assume complete responsibility for the accuracy and completeness of such dimensions, and for coordination.

.2 *Provide* forms, templates, anchors, sleeves, inserts and accessories required to be fixed to or inserted in the *Work* and set in place or instruct separate *Subcontractors* as to their location.

.3 Supply items to be built in, as and when required together with templates, measurements, shop drawings and other related information and assistance.

.4 Pay the cost of extra work and make up time lost as a result of failure to provide necessary information and items to be built in.

.5 Verify that the *Work*, as it proceeds, is executed in accordance with dimensions and positions indicated which maintain levels and clearances to adjacent work, as set out by requirements of the *Contract Documents*, and ensure that work installed in error is rectified before construction resumes.

.6 Check and verify dimensions referring to interfacing of services. Verify such dimensions with interconnected portions of the *Work*.

.7 Do not scale directly from drawings. Obtain clarification from *Consultant* if there is ambiguity or lack of information.

.8 Details and measurements of any work which is to fit or to conform with work installed shall be taken at the *Place of the Work*.

.9 Advise *Consultant* of discrepancies and omissions in the *Contract Documents*, that affect aesthetics, or that interfere with services, equipment or surfaces. Do not proceed with work affected by such items without clarification from *Consultant*.

.10 Prepare and submit setting drawings, templates and other information necessary for the location and installation of material, holes, sleeves, inserts, anchors, accessories, fastenings, connections and access panels.

.11 *Subcontractors* shall direct related *Subcontractors* on site of specific locations required for sleeves and openings.

END OF SECTION

PART 1 GENERAL

1.1 ADMINISTRATIVE

.1 The *Contractor* shall schedule on site bi-weekly or weekly meetings (as determined by the owner) both virtual and onsite when necessary.

.2 The *Contractor* shall prepare agendas for meetings specified herein.

a. Agendas shall include, as a minimum, the agenda items specified in the *Contract Documents*.

.3 The *Contractor* shall distribute written notice of each meeting specified herein, complete with meeting agenda, 4 *Working Days* in advance of meeting date to the *Consultant* and the *Owner* and other affected parties.

.4 The *Contractor* shall chair and record the minutes of meetings specified herein.

a. Distribute copies of minutes to the *Owner*, the *Consultant*, and all others in attendance within 3 *Working Days* after date of meeting.

.5 Representatives of parties attending meetings shall be authorized to act on behalf of the parties they represent.

.6 *Subcontractors* and *Suppliers* shall not attend meetings unless authorized by the *Consultant* and the *Owner*.

.7 The *Contractor* shall prepare, and distribute to the *Consultant* and the *Owner* 4 days in advance of next progress meeting date, the following:

a. Monthly progress reports containing updated schedules, shop drawing logs, requests for interpretation logs, submittals and budget.

1.2 CONTRACT START-UP MEETING

.1 Within 5 days after award of *Contract*, request a meeting of parties in *Contract* to discuss and resolve administrative procedures and responsibilities prior to the commencement of the *Work*.

.2 The *Owner*, the *Consultant*, the *Contractor*, site superintendent(s), and inspection and testing company will be in attendance.

.3 Agenda to include the following:

b. Owner's guidelines and policies.
c. Appointment of official representative of participants in the *Project*.

d. Status of permits, fees and requirement of authorities having jurisdiction. Action required.
e. Establishing a schedule for progress meetings.
f. Requirements for *Contract* modification and interpretation procedures, including, but not limited to: requests for interpretation, contemplated change orders, *Change Orders*, *Change Directives*, *Supplemental Instructions*, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, and administrative requirements.
g. Schedule of submission of samples, colour chips, and items for *Owner* s and/or *Consultant's* consideration.
h. Construction schedule and progress scheduling.
i. Delivery schedule of specified equipment & materials.
j. Appointment of inspection and testing agencies or firms.
k. Requirements for notification for reviews. Allow a minimum of 48 hours' notice to *Consultant* for review of the *Work*.
l. Requirements for temporary facilities, signs, offices, storage sheds, utilities, fences, and temporary use of existing facilities.
m. Security requirements at and for the *Place of the Work*.
n. *Owner* supplied *Products*.
o. Record drawings.
p. Maintenance manuals.
q. Take-over procedures, acceptance, warranties.
r. Progress claims, administrative procedures, holdbacks.
s. Insurances, transcripts of policies.
t. *Contractor's* safety procedures.
u. Workplace Safety and Insurance Board Certificate.

1.3 PRE-INSTALLATION MEETINGS

.1 During the course of the *Work* prior to *Substantial Performance of the Work*, schedule pre-installation meetings as required by the *Contract Documents* and coordinated with the *Consultant*.

.2 As far as possible, pre-installation meetings shall be scheduled to take place on the same day as regularly scheduled progress meetings.

.3 Agenda to include the following:

a. Owner's guidelines and policies.
b. Appointment of official representatives of participants in the *Project*.
c. Review of existing conditions and affected work, and testing thereof as required.

d. Review of installation procedures and requirements.
e. Review of environmental and site condition requirements.
f. Review of infection prevention and control procedures.
g. Schedule of the applicable portions of the *Work*.
h. Schedule of submission of samples, colour chips, and items for *Consultant's* consideration.
i. Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences.
j. Requirements for notification for reviews. Allow a minimum of 48 hours' notice to *Consultant* for review of the *Work*.
k. Requirements for inspections and tests, as applicable. Schedule and undertake inspections and tests.
l. Delivery schedule of specified equipment.
m. Special safety requirements and procedures.

.4 The following shall be in attendance:

a. *Contractor*.
b. *Subcontractors* affected by the work for which the pre-installation meeting is being conducted.
c. *Consultant*.
d. Infection control representative.
e. Manufacturer's representatives, as applicable.
f. Inspection and testing company, as applicable.

1.4 PROGRESS MEETINGS

.1 During the course of the *Work* prior to *Substantial Performance of the Work*, schedule progress meetings as directed by the *Consultant*.

.2 Attendees at progress meetings shall include the following:

a. *Contractor*.
b. *Contractor's* site superintendent(s).
c. *Consultant*.
d. *Owner*.

.3 Tracking documents:

a. Contractor to prepare and bring to each progress meeting current copies of the following documents:
    1. RFI log.
    2. .2 C.C.O., C.O., R.F.C.O. logs.

3. Submittals logs.
4. Schedule CD.
5. S.I. log.
6. Minutes of the previous progress meeting.
7. Daily worker counts

.4 Agenda to include the following:

a. Owner's guidelines and policies.
b. Review, approval of proceedings of previous meeting.
c. Review of items arising from proceedings.
d. Review of progress of the *Work* since previous meeting and *Contractor's* monthly progress report.
e. Field observations, problems, conflicts.
f. Update construction schedule.
g. Problems that impede compliance with construction schedule.
h. Review of off-site fabrication delivery schedules.
i. Review material delivery dates/schedule.
j. Corrective measures and procedures to regain construction schedule.
k. Revisions to construction schedule.
l. Progress, schedule, during subsequent period of the *Work*.
m. Review submittal schedules.
n. Review status of submittals.
o. Review of infection prevention and control procedures.
p. Maintenance of quality standards.
q. Pending changes and substitutions.
r. Review of *Contract* modifications and interpretations including, but not limited to: requests for interpretation and log, contemplated change orders, *Change Orders*, *Change Directives*, *Supplemental Instructions*, for effect on construction schedule and on *Contract Time*.
s. Review of status of as-built documents.
t. Other business.

1.5 PRE-TAKEOVER MEETING

.1 Prior to application for *Substantial Performance of the Work*, schedule a pre-takeover meeting.

.2 Agenda to include the following:

a. Review, approval of proceedings of previous meeting.

b. Review of items arising from proceedings.
c. Review of procedures for *Substantial Performance of the Work*, completion of the Contract, and handover of the *Work*.
d. Field observations, problems, conflicts.
e. Review of outstanding *Contract* modifications and interpretations including, but not limited to: requests for interpretation and log, contemplated change orders, *Change Orders*, *Change Directives*, *Supplemental Instructions*, for effect on construction schedule and on *Contract Time*.
f. Problems which impede *Substantial Performance of the Work*.
g. Review of procedures for deficiency review. Corrective measures required.
h. Review of arrangements for hydro, heating, and other services.
i. Progress, schedule, during succeeding period of the *Work*.
j. Review submittal requirements for warranties, manuals, and all demonstrations and documentation required for *Substantial Performance of the Work*.
k. Review of keying and hardware requirements.
l. Review of status of as-built documents and record drawings.
m. Status of commissioning and training.
n. Review *Contractor's* deficiency list and status.
o. Cleaning for occupancy.
p. Other business.

1.6 POST-CONSTRUCTION MEETING

.1 Prior to application for completion of *Contract*, schedule a post-construction meeting. Four days prior to date for meeting, *Consultant* shall confirm a date for meeting based on evaluation of completion requirements.

.2 Agenda to include the following:

a. Review, approval of proceedings of previous meeting.
b. Confirmation of completion of the *Contract*, and handover of reviewed documentation from the *Consultant* to the *Owner*.
c. Confirmation of completion of contemplated change orders, *Change Orders*, *Change Directives*, and *Supplemental Instructions*.
d. Problems that impede *Contract* completion.
e. Identify unresolved issues or potential warranty problems.
f. Confirmation of completion of deficiencies.
g. Corrective measures required.
h. Confirm submittal requirements for warranties, manuals, and demonstrations and documentation for *Contract* completion are in order.
i. Review of procedures for communication during post-construction period.

j. Handover of reviewed record documents by the *Consultant* to the *Owner*.
k. Handover of *Contract* completion insurance policy transcripts by *Contractor*.
l. Submission of final application for payment.
m. Review and finalize outstanding claims, pricing, and allowance amounts.
n. Status of commissioning and training.
o. Demobilization and the *Place of the Work* restoration.
p. Review of requests for interpretation log.
q. Other business.

1.6 SPECIAL MEETINGS

.1 *Owner* and/or *Consultant* reserve the right to require special meetings which may be held on short notice and at which attendance by *Contractor* and representatives of affected *Subcontractors* and *Suppliers* is mandatory. *Contractor* shall keep detailed and accurate meeting notes and distribute copies promptly to all in attendance and those affected by agreements made at such meetings.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL

.1 Schedules Required:

a. Construction schedule.

b. Product delivery schedule.

c. Inspection and testing schedule.

.2 Format:

a. Develop Construction Schedule utilizing Microsoft Project 2003 (or later version). Include a separate bar for each trade or operation. Provide PDF copy for review for those without program.

b. Include horizontal time scale identifying the first Working Day of each week.

c. Format for listings: The chronological order of the start of each item or part of the Work.

d. Identification of listings: By systems description.

e. Upon request by the Consultant, submit a digital copy of the construction schedule to the Consultant. The digital copy shall be in a pdf file format. In case of discrepancy between a digital-copy of the construction schedule and the corresponding hard-copy of the construction schedule, the hard-copy of the construction schedule bearing the latest date, and that has been formally submitted and reviewed in accordance with the requirements of Section 01 32 16 shall govern.

.3 Construction schedule:

a. Include the complete sequence of construction activities, including provision for climate and weather.

b. Include the dates for the commencement and completion of each major element of the Work parallel to the sections of the specifications.

c. Show projected percentage of completion for each item as of the first Working Day of each week.

d. Submit draft schedule for review, and incorporate responses to comments identified by Consultant and/or Owner.

e. Show dates for the commencement and completion of inspection and testing.

f. At each date of submission of schedule, indicate progress of each activity.

1. Show changes occurring since previous submission of the construction schedule:
   - Major changes in scope.
   - Change Orders and Change Directives.
   - Activities modified since previous submission.
   - Revised projections of progress and completion.
   - Other identifiable changes.
2. Include a narrative report to define:
   - Problem areas, anticipated delays, and the impact on the schedule.
   - Corrective action recommended and its impact on the schedule.

g. Submit revised construction schedule with each application for payment.

.4 Product delivery schedule:

a. Include dates for delivery of Products, equipment, finish items, and factory-finished manufactured items. Show last dates for order, shipment, and delivery in order to meet construction schedule.

.5 Inspection and testing schedule:

a. Prepare schedule for inspection and testing by advance discussion with the selected inspection and testing company to determine the time required for the inspection and testing company to perform its tests and to issue each of its, findings, and allow for required time in the construction schedule.

b. Refer to Section 01 45 00 for additional requirements for inspection and testing scheduling.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL

.1 Provide photographic documentation in digital format and in accordance with procedures and submission requirements specified in this section.

1.2 DIGITAL PHOTOGRAPHS

.1 Equipment: Provide photographs using minimum 10 megapixel digital camera.

.2 Submit the required photographs to the Consultant and to the Owner.

.3 Supply date stamped maximum resolution colour photos to Consultant in JPEG format.

.4 Each photo shall include a caption indicating the location of the photo (room number), the direction faced, and the date it was taken.

.5 Number of photos required:

a. Prior to demolition: Minimum 50 photos.

1. Provide necessary number of photographs, as required to document existing conditions and verify damage to adjacent installations which may or may not have occurred during demolition.

b. Prior to construction/after demolition: Minimum 50 photos.

1. Provide necessary number of photographs, as required to document conditions after demolition but prior to commencing subsequent new work. Photos to be used to verify damage to adjacent installations which may or may not have occurred during construction.

c. Each progress draw: Minimum 24 photos.

1. Submit construction photographs each month to accompany each application for progress draw to document the stage of the Work from points selected by the Consultant showing as much as possible of the Work installed during the previous month.

d. Completion:

1. When the Work is completed, arrange to take final photographs of the Work. Minimum of 24 points of view.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Submit submittals as requested by the Contract Documents, as specified herein, and in accordance with the conditions of the Contract.

a. Submit submittals required as a complete, single package per section of the specifications or per each part of the Work where multiple sections bear on a particular assembly or installation. Where it is not possible to submit a complete submittal package, the Contractor shall provide, in the transmittal letter specified below in this section, an explanation of what submittal components have not been included in the submissions and the reasons why, along with an indication of when the missing components will be submitted. The Consultant shall have the right to withhold their review of the submittal package until all components have been submitted, at the Consultant's sole discretion.

.2 In addition to submittals specifically requested by the Contract Documents, submit other submittals as may be reasonably requested by the Consultant, or as are required to coordinate the Work and to provide the Owner with choices available, within the scope of Contract Documents.

.3 Procedures and requirements for Contract closeout submittals shall be in accordance with the following sections:

a. Section 01 77 00 - Contract Closeout Procedures and Submittals.

b. Section 01 78 36 - Warranties.

.4 Contractor's review of submittals:

a. Review submittals for conformity to Contract Documents before submitting to Consultant. Submittals shall bear stamp of Contractor and signature of a responsible official in Contractor's organization indicating in writing that such submittals have been checked and coordinated by Contractor. Contractor's review shall be performed by qualified personnel who have detailed understanding of those elements being reviewed and of the conditions at the Place of the Work proposed for installation.

b. Check and sign each submittal and make notations considered necessary before submitting to Consultant for review. Where submittal is substantially and obviously in conflict with requirements of Contract Documents, reject submittal without submitting to Consultant and request resubmission. Note limited number of reviews of each submittal covered under Consultant's services as specified below.

c. Contractor shall assume sole responsibility for any conflicts occurring in the Work that result from lack of comparison and coordination of submittals required for the Work.

d. Submittals must be in PDF format and allow for digital document and text searching.

e. Submittals that have not been reviewed, checked, and coordinated by Contractor prior to submission to Consultant, will be rejected.

f. Notify Consultant in writing of changes made on submittals from Contract Documents. Consultant's review of submittals shall not relieve Contractor of responsibility for changes made from Contract Documents not covered by written notification to Consultant.

.5 Consultant's review of submittals:

a. Review of submittals by Consultant is for the sole purpose of ascertaining conformance with the general design concepts and the general intent of the Contract Documents. This review shall not mean that Consultant approves the detail design inherent in the submittals, responsibility for which shall remain with the Contractor. Such review shall not relieve the Contractor of responsibility for errors or omissions in the submittals, or responsibility for meeting requirements of Contract Documents.

b. Contractor shall be responsible for dimensions to be confirmed and correlated at the Place of the Work for information that pertains solely to fabrication processes or to techniques of construction and installation, and for coordination of the Work.

c. As part of their scope of work, Consultant shall review shop drawings no more than twice. Should three or more reviews be required due to reasons of Contractor omissions causing resubmission requests, then Contractor shall reimburse the Consultant for time expended in these extra reviews. Time shall be invoiced to the Owner (to be deducted from monies due to the Contractor and paid to Consultant by Owner) at rates recommended by Consultant's professional association and disbursements shall be invoiced at Consultant's cost. The Contractor shall cover directly costs and administration associated with courier services and the like for these extra shop drawing reviews.

    1. In the case of non-conforming or incomplete submittals, the Contractor shall also be solely responsible for additional project costs and/or schedule delays at no additional cost to the Owner.

d. Consultant's review and markings on submittals do not authorize changes in the Work or the Contract Time, and will be accommodated at no additional cost to the

Owner. If, in the opinion of the Contractor, the Consultant's markings on submittals constitute a change in the Work or will effect a change in the Contract Time, then the Contractor shall so notify the Consultant in writing and request an interpretation following the procedures for requests for interpretation in accordance with Section 01 26 00. If the Consultant finds that the Consultant's markings on submittals do constitute a change in the Work or will effect a change in the Contract Time, then a Change Order will be prepared therefore. The time taken to process such a request for interpretation shall not, in and of itself, constitute a change in the Work nor increase the Contract Time.

e. Submittals which are not required by the Contract Documents or not requested by the Consultant will not be reviewed by the Consultant.

f. Make submittals with reasonable promptness and in an orderly sequence so as to cause no delay in the Work. Be responsible for delays, make up time lost and pay added costs, at no additional cost to the Owner, incurred because of not making submittals in due time to permit proper review by Consultant.

g. Submittals that contain substitutions will be rejected. Substitutions are permitted only on substitution submittals as specified in Section 01 25 00.

h. Do not proceed with work affected by a submittal, including ordering of Products, until relevant submittal has been reviewed by Consultant.

i. Prepare submittals using the system of measurement employed in the Contract Documents (metric or imperial units).

j. Contractor's responsibility for errors and omissions in submittals is not relieved by Consultant's review of submittals.

k. Contractor's responsibility for deviations in submittal from requirements of Contract Documents is not relieved by Consultant's review of submittal, unless Consultant gives written acceptance of specific deviations.

l. Engineered submittals:

    1. Submittals for items required to be sealed by professional engineer (engineered) shall be duly prepared, sealed, and signed under the direct control and supervision of a qualified professional engineer registered in the Place of the Work, having in force, professional liability insurance with minimum limit of liability of $1,000,000 per claim.

    2. Include with engineered submittal, proof of insurance identifying insurer, policy number, policy term, and limit of liability, on duly signed letterhead and/or certificate of insurance.

3. Design includes life safety, sizing of supports, anchors, framing, connections, spans, and as additionally required to meet or exceed requirements of applicable codes, standards, regulations, authorities having jurisdiction, and design requirements of the Contract Documents.
4. Engineered submittals shall include design calculations, complete with references to codes and standards used in such calculations, supporting the proposed design represented by the submittal. Prepare calculations in a clear and comprehensive manner so that they can be properly reviewed.
5. Professional engineer responsible for the preparation of engineered submittals shall undertake periodic field review, including review of associated mock-ups where applicable, at locations wherever the work as described by the engineered submittal is in progress, during fabrication and installation of such work, and shall submit a field review report after each visit. Field review reports shall be submitted to the Consultant, to authorities having jurisdiction as required, and in accordance with the building code.
6. Field reviews shall be at intervals as necessary and appropriate to the progress of the work described by the submittal to allow the engineer to be familiar with the progress and quality of such work and to determine if the work is proceeding in general conformity with the Contract Documents, including reviewed shop drawings and design calculations.
7. Upon completion of the parts of the Work covered by the engineered submittal, the professional engineer responsible for the preparation of the engineered submittal and for undertaking the periodic field reviews described above, shall prepare and submit to the Consultant and authorities having jurisdiction, as required, a letter of general conformity for those parts of the Work, certifying that they have been Provided in accordance with the requirements both of the Contract Documents and of the authorities having jurisdiction over the Place of the Work.
8. Costs for such field reviews and field review reports and letters of general conformity are included in the Contract Price.

m. Keep copies of reviewed submittals at the Place of the Work in a neat, orderly condition. Only submittals that have been reviewed by the Consultant and are marked with Consultant's review stamp, as applicable, are permitted at the Place of the Work.

n. The Work shall conform to reviewed submittals subject to the requirements of this section. Remove and replace materials or assemblies not matching reviewed

submittals at no increase in the Contract Time and at no additional cost to the Owner.

1.2 SCHEDULE OF SUBMITTALS

.1 Before commencement of the Work, submit to the Consultant a detailed schedule of submittals required by the Contract Documents.

a. Schedule shall be accompanied by a checklist, correlated to each of the schedule of submittals, the construction schedule (specified under Section 01 32 16), the Product delivery schedule (specified under Section 01 32 16), and the schedule of inspections and tests (specified under Sections 01 32 16 and 01 45 00), listing the following:

1. Installation and/or product data.
2. Shop drawings.
3. Samples.
4. Mock-ups.
5. Reviews, tests and inspections by:
   - Manufacturers.
   - Authorities having jurisdiction.
   - The Owner.
   - The Consultant.
   - Inspection and testing companies.
6. Demonstration and training.

.2 Indicate dates for submitting, review time, resubmission time, float time, and last date for meeting construction schedule.

.3 Consultant will review submittal schedule and advise Contractor if volume and timing of submittals will permit timely review and response. Consultant may require modifications to submittals schedule in order to allow adequate time for review of submittals. Adjust submittals schedule and construction schedule as required to comply with Consultant's needs.

.4 Make provisions in schedule for at least 10 Working Days for Consultant's review of submittals. When submittals have to be reviewed by one or more of Consultant's sub-consultants, add 5 more Working Days for a total 15 Working Day review period.

.5 If the Consultant requires resubmission of submittals, allow for an additional 5 Working Days review for each resubmission.

.6 If, at any time, the Contractor submits a large enough number of submittals such that the Consultant cannot process these submittals within 10 Working Days, the Consultant, in consultation with the Contractor within 3 Working Days of receipt of such submittal, will provide the Contractor with an estimate of the time necessary for processing same. The Contractor shall accommodate such necessary time at no increase in the Contract Time and at no additional cost to the Owner.

.7 The Contractor shall periodically resubmit the submittal schedule to correspond to changes in the construction schedule. Such resubmissions shall maintain the minimum 10 Working Day period for the Consultant's review.

.8 Schedule submissions of submittals well in advance of scheduled dates for installation, to provide lead time for reviews and possible resubmissions and for placing orders and securing delivery so as to avoid delays in the Work.

.9 Submittal schedule will be reviewed by the Owner to identify submittals requiring Owner review/comment.

1.3 SUBMISSION PROCEDURES

.1 Coordinate each submittal with requirements of the Work and Contract Documents. Individual submittals shall include related information.

.2 Distribute copies of submittals to parties whose work is affected by submittals except Consultant and Owner before final submission for review by Consultant.

.3 Accompany submittals with transmittal letter, in duplicate, containing:

a. Date.

b. Project title and number.

c. Contractor's name and address.

d. Identification and quantity of each submittal.

e. Other pertinent data.

f. Transmittal letter shall bear stamp of Contractor and signature of a responsible official in Contractor's organization indicating in writing that such submittals have been checked and coordinated by Contractor.

.4 Each submittal shall be identified numerically by relevant specification section number with a numeric indicator for multiple submittals by that section followed by revisions number, and a brief worded description, for example 04 05 19-01-R0 – Brick Ties.

.5 Make any changes in submittal that Consultant may require, consistent with Contract Documents, and resubmit as directed by Consultant.

.6 Notify Consultant, in writing, when resubmitting, of any revisions other than those requested by Consultant.

.7 After Consultant's review, distribute copies to affected parties.

1.4 PRODUCT DATA SHEETS

.1 Submit Product data sheets as 1 electronic copy in pdf format to the Contractor. The Product data sheet files must be named as per the naming standards below and they must include on the front cover or on large format drawings - in the bottom right hand corner – a space for the Contractor's stamp, and spaces for each of the reviewing consultants stamps.

.2 The Contractor shall issue the electronic copy via email to the primary consultant for the trade (e.g. the structural steel drawings will go first to the structural engineer, then to the architect, and then back to the Contractor).

.3 If the electronic file is too large to issue via email the Contractor is to provide a portal site (e.g. ftp site) where the file can be downloaded by the Consultant and upload by the Consultant following their review.

.4 Submit Product data sheets as called-for by the Contract Documents or as the Consultant may reasonably request where shop drawings will not be prepared due to a standardized manufacture of a Product. Manufacturers' catalogue cuts will be acceptable in such cases, providing that they are 213 mm x 275 mm (8-1/2" x 11") originals, and that they indicate choices including sizes, colours, model numbers, options and other pertinent data, including installation instructions. Submissions showing only general information are not acceptable.

.5 Where requirements of Contract Documents are more stringent than design proposed on Product data sheets, the requirements of the Contract Documents take priority.

.6 Upon completion of review by Consultant, 1 marked set of Product data sheets will be returned to Contractor for reproduction and distribution.

.7 Retain 1 complete set of prints of reviewed Product data sheets for issuance to Owner immediately prior to Substantial Performance of the Work, in an acceptable, bound manner and in accordance with Section 01 77 00.

1.5 SHOP DRAWINGS

.1 Submit shop drawings as follows:

a. Except for engineered submittals:

1. Submit 1 electronic copy in pdf format of the shop drawings to the Contractor. The shop drawings must be named as per the naming standards

below and they must include on the front cover or on large format drawings - in the bottom right hand corner – a space for the Contractor's stamp, and spaces for each of the reviewing consultants stamps.

b. For engineered submittals:

1. Submit 1 electronic copy in pdf format of the shop drawings to the Contractor. The shop drawings must be named as per the naming standards below and they must include on the front cover or on large format drawings - in the bottom right hand corner – a space for the Contractor's stamp, and spaces for each of the reviewing consultants stamps.

.2 The Contractor shall issue the electronic copy via email to the primary consultant for the trade (e.g. the structural steel drawings to the structural engineer and cc'd to the architect, and then be returned to the Contractor).

.3 If the electronic file is too large to issue via email the Contractor is to provide a portal site (e.g. ftp site) where the file can be downloaded by the Consultant and upload by the Consultant following their review.

.4 Lettering on shop drawings shall be not less than 3 mm (1/8") high.

.5 Where requirements of Contract Documents are more stringent than design proposed on shop drawings, the requirements of the Contract Documents take priority.

.6 Consultant markings and resulting action required:

a. Shop drawings requiring no changes will be marked 'REVIEWED', and shall be submitted for as-built drawings purposes.

b. Shop drawings requiring several changes will be marked 'REVIEWED as NOTED' and shall be revised and submitted for as-built drawings purposes.

c. Shop drawings requiring substantial changes will be marked 'REVISE AND RE-SUBMIT' and shall be revised and resubmitted until Consultant stamps drawings with 'REVIEWED' or 'REVIEWED as NOTED'.

.7 Shop drawing size shall be multiple of 213 mm and 275 mm (8-1/2" and 11") excluding 38 mm (1-1/2") binding margin and not larger than 838 mm x 1117 mm (33" x 44"). Leave minimum 150 mm x 100 mm (6" x 4") clear space for Consultant's comments.

.8 Upon completion of review by Consultant, 1 marked set of shop drawings will be returned to Contractor for reproduction and distribution.

.9 Retain 1 complete set of prints of reviewed shop drawings for issuance to Owner immediately prior to Substantial Performance of the Work, in an acceptable, bound manner and in accordance with Section 01 77 00.

.10 Submit copies of reviewed shop drawings to authorities having jurisdiction as required.

.11 Shop drawings shall include:

a. Fabrication and erection dimensions.

b. Plans, sections, elevations, arrangements and sufficient full size details which indicate complete construction, components, methods of assembly as well as interconnections with other parts of the Work.

c. Design calculations prepared by professional engineer, as required, substantiating sizes for members and connections based on design loads.

d. Clear definition of the division of responsibility for the work described thereon. No Products, items or equipment, or description of work, shall be indicated to be supplied, or work to be done, “By Others” or “By Purchaser”. Shop drawings marked with either of these phrases will be rejected without having been reviewed by the Consultant.

e. Location and type of exposed anchors, attachments and locations and types of fasteners, including concealed reinforcements to accept mounted fasteners.

f. Adhesives, joinery methods and bonding agents.

g. Kinds and grades of materials, their characteristics relative to their purpose, detailed description of finishes and other fabrication information.

h. Configurations, types and sizes required; identify each unit type on drawing and on Product.

i. Descriptive names of equipment and mechanical and electrical characteristics when applicable.

j. Data verifying that superimposed loads will not affect function, appearance and safety or work shown on shop drawings, as well as other interconnected work.

k. Assumed design loadings, dimensions of elements and material specifications for load-bearing members.

l. Proposed chases, sleeves, cuts and holes in structural members.

m. Wall thicknesses of metals.

n. Location and types of welds. For structural welds use AWS symbols and clearly show net weld lengths and sizes.

o. Materials, gauges, and sizes being supplied including connections, attachments, reinforcement, anchorage and locations of exposed fastenings.

p. Installation instructions and details for Products to be installed by separate Subcontractors, including function of each part.

q. A list of Products covered by, or included on, the shop drawing. List of Products shall be complete and show manufacturer's name, Product name, generic description,

standard certification where specified, manufacturer's complete installation data and precautions against wrong installation, operation and maintenance.

r. Refer to individual sections of the specifications for more particular requirements for shop drawings.

.12 Compatibility statement: Include with each shop drawing a statement that each Product and material indicated on the shop drawing is compatible with each Product and material with which it comes into contact.

1.6 CERTIFICATES AND CERTIFICATION SUBMITTALS

.1 Certificates and certifications submittals: Provide a statement that includes signature of entity responsible for preparing certification.

1.7 SAMPLES

.1 Submit a minimum of 3 samples unless a greater amount is specified.

.2 Deliver samples to the following location with expenses, including carrying costs, prepaid, unless otherwise instructed:

a. Consultant’s office.

.3 Identify samples or assemblies by Project number and name, name of Consultant, Contractor and Subcontractor, and date of submission. Identify location, specified material reference and any other pertinent information. Show construction by layered method if necessary, clearly displaying textures and patterns.

.4 Resubmit samples until written acceptance is obtained from Consultant.

1.8 MOCK-UPS

.1 Provide field or shop erected example of work complete with specified materials and workmanship.

.2 Erect mock-ups at locations as specified and as acceptable to Consultant. Do not proceed with work for which mock-ups are required prior to Consultant’s review of mock-ups.

.3 Protect and maintain mock-ups until directed to be removed. Commence work demonstrated in mock-up only after review and acceptance of workmanship. If possible, mock-up may become part of finished work, at sole discretion, and with prior written acceptance of Consultant.

.4 Reviewed and accepted mock-ups will become standards of workmanship and material against which installed work will be compared.

.5 Remove and replace materials or assemblies not matching reviewed mock-ups.

.6 Resubmit mock-ups until written acceptance is obtained from Consultant.

a. Each Subcontractor whose work is affected by the information presented on the coordination and interference drawings shall sign-off on the drawings prior to submission to the Consultant and thereby agrees to coordinate their parts of the Work to preserve the coordination and interference guidelines represented by the coordination and interference drawings.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

.1 General administrative and procedural requirements for quality assurance and quality control as specified elsewhere in the Contract Documents.

1.2 RELATED REQUIREMENTS

.1 Pre-installation meetings: in accordance with Section 01 31 19.

.2 Materials and workmanship quality assurance and reference standards: in accordance with Section 01 60 00.

.3 Balancing and testing of systems – under Divisions 21, 22, 23, 25, 26, 27, and 28.

1.3 INSPECTION AND TESTING

.1 Inspection and testing services will be used to verify compliance with requirements of the Contract Documents. These services do not relieve the Contractor of responsibility for compliance with the Contract Documents.

a. Specified tests, inspections, and related actions do not limit the Contractor's other quality assurance and control procedures that facilitate compliance with the Contract Documents requirements.

b. Requirements for the Contractor to provide quality control services required by Consultant, Owner, or authorities having jurisdiction are not limited by provisions of this section.

.2 Unless otherwise specified, the Owner will appoint inspection and testing agencies, representing, reporting and responsible to the Owner. Unless otherwise specified, payment will be by Owner.

.3 Additional testing services required because of changes in materials, proportions of mixes requested by Contractor or Subcontractors as well as additional testing services for materials occasioned by lack of identification or by failure of such materials being replaced to meet requirements of the Contract Documents or testing of structure or elements including load testing, shall be carried out at no additional cost to the Owner.

.4 Inspection and testing required by codes or ordinances, or by an authority having jurisdiction, and made by a legally constituted authority, shall be the responsibility of the Contractor and shall be paid for by the Contractor and not be paid by Owner, unless otherwise specified in the Contract Documents.

.5 Inspection or testing performed exclusively for Contractor's convenience shall be sole responsibility of Contractor, and will not be paid by Owner.

.6 Inspection and testing shall be performed by qualified and/or certified personnel under professional supervision or performed directly by a professional engineer qualified in conformance with applicable codes and certification programs.

.7 Requirements of regulatory agencies:

a. Testing shall be conducted in accordance with requirements of the building code.

b. Obtain certification where required by the building code and standards.

.8 Cooperation with inspection and testing agencies:

a. Provide inspection and testing agencies with materials and installation information as required and/or requested.

b. Provide access to the Work for representatives of inspection and testing agencies.

c. Cooperate with inspection and testing agencies and give adequate notification of any changes in source of supply, additional work shifts and other proposed changes.

d. Permit access to the Work for inspection and testing agencies wherever the Work is in progress, or wherever Products, materials, or equipment are stored prior to shipping.

e. Supply labour required to assist inspection and testing agencies in sampling and making tests.

f. Repair work damaged as a result of inspection and testing work.

g. Inspection and testing agency services do not relieve the Contractor of responsibility for normal shop and site inspection, and quality control of manufacturing and installation.

.9 Where evidence exists that defective workmanship may have occurred, or that the Work may have been carried out incorporating defective materials, or tests demonstrate that installed conditions do not comply with the requirements of the Contract Documents, the Consultant reserves the right to have appropriate inspections, tests, and surveys performed, analytical calculation of structural strength made and the like in order to help determine the extent of defect and whether such work must be replaced. Inspections, tests, and surveys carried out under these circumstances will be made at the Contractor's expense, and will not be paid by Owner, unless the results indicate that the work so tested, inspected or surveyed is not defective or that, in Consultant's opinion, the work so tested, inspected, or surveyed may be accepted, in which case tests, inspections or surveys will be paid by Owner.

.10 Prepare schedule for inspection and testing agency services in accordance with Section 01 33 00 and as follows:

a. Establishing schedule:

1. By advance discussion with the selected inspection or testing agency, determine the appropriate time necessary to perform the required services and to issue related reports.
2. Allow for required time within construction schedule.

b. Adherence to schedule:

1. Contractor shall advise inspection and testing agencies in advance when inspection and testing of the Work is required.
   - Amount of advance notice shall be as required by the inspection and testing company, but shall be no less than 2 Working Days.
   - When inspection and testing agency is ready to perform inspection and testing according to predetermined schedule, but is prevented from inspection and testing or taking specimens due to incompleteness of the parts of the Work scheduled for inspection and testing, extra costs for inspection and testing attributable to the delay may be back-charged to Contractor at no additional cost to the Owner.
2. Notify inspection and testing agency at least 3 Working Days before work required to be inspected commences, and arrange for a meeting at the Place of the Work, to be held 1 Working Day before the work starts with the following present:
   - The Contractor, and the Subcontractor responsible for the work to inspected and/or tested, the inspection and testing agency representatives, the product manufacturer's representative when required, and the Consultant.
3. Give 2 Working Days prior notice to inspection and testing agency of the commencement of each phase of the Work requiring inspection and provide inspection and testing agency with materials and installation information.

.11 Reports and documents:

a. Inspection and testing agencies shall submit shop inspection and site inspection reports within 5 Working Days of each inspection.

b. Distribute reports with copies to Owner and Consultant (as applicable).

c. Inspection and testing agencies shall submit a written report for each inspection or test, including pertinent data such as conditions at the Place of the Work, dates, test references, locations of tested materials, actual Product identification, testing methodology, procedures, and descriptions, site instructions given, recommendations and/or any other information required by standard applicable to reporting of tests and inspections.

1. Report shall clearly indicate failure of Product or procedures to meet applicable standards, give recommendations for retesting or correction. Inspector shall contact Contractor and Consultant immediately when Product or Product assembly fails to meet requirements of the Contract Documents.

d. Upon completion of portions of the Work subject to independent inspection and testing, submit to the Consultant duplicate certificates of acceptance of the installation issued by the independent inspection and testing company.

.12 Inspection and test specimens:

a. Inspection and testing will, generally, consist of procedures listed in the following paragraphs, but additional tests may be performed as required to verify conformance to Contract Documents.

b. Specimens and samples for testing, unless otherwise specified in the Contract Documents, will be taken by the inspection and testing agency; sampling equipment and personnel will be provided by the inspection and testing agency; and deliveries of specimens and samples to the testing agency will be performed by the testing agency unless otherwise specified.

c. Inspection and testing agency shall take samples necessary to verify quality as specified. Taking of samples shall not endanger the structure or life safety, and shall be taken so as to best represent the Work as a whole.

d. Samples shall be handled, packaged, stored and delivered in accordance with specified tests. Sample handling where required shall duplicate conditions at the Place of the Work (such as site-cured concrete cylinders).

1.4 MANUFACTURER'S FIELD REVIEW

.1 Where manufacturer's field review is specified, manufacturer's representative shall review the relevant parts of the work at the Place of the Work, or wherever such affected work is in progress, to ensure that work is being executed in accordance with manufacturer's written recommendations.

.2 Manufacturer's field review is to ensure that the Products specified are being used in the Work and are being applied on surfaces prepared in accordance with their recommendations and the requirements of the Contract Documents.

.3 Unless otherwise indicated, manufacturer's representative shall undertake a minimum of 1 field review, with additional reviews as deemed necessary by the manufacturer, to determine that the work of such sections is in accordance with the manufacturer's written recommendations.

.4 Manufacturer's representative shall submit a type-written report on manufacturer's letterhead within 2 Working Days after each field review. Report shall document manufacturer's representative's field observations and recommendations.

.5 Manufacturer's field review reports shall be prepared and distributed following the procedures specified for preparation and submittal of inspection and testing reports given above.

.6 List of proposed Inspection and Testing:

a. Structural steel inspections.

b. Roofing – including waterproof membrane below metal roofing.

c. Air/vapour barriers, thermal clip installation and insulation.

.7 Contractor to confirm ITP Requirements.

END OF SECTION

PART 1 GENERAL

1.1 AVAILABILITY OF PRODUCTS

.1 In the event of delays in supply of Products, and should it subsequently appear that the Work may be delayed for such reason, Consultant reserves the right to substitute more readily available Products of similar character, at no additional cost to the Owner.

1.2 PRODUCT HANDLING

.1 Handle and store Products in a manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturers and Supplier's recommendations and so as to ensure preservation of their quality and fitness for the Work, and protect from vandalism and theft.

.2 Store packaged or bundled Products in original and undamaged condition with manufacturer's seals and labels intact, facing to outside. Do not remove from packaging or bundling until required in the Work.

.3 Store materials susceptible to environmental damage in a weather tight enclosure raised clear of ground so that they are protected from weather, dampness and deterioration. Do not use such materials which have been damaged by exposure to moisture.

.4 Keep sand, when used as ingredients for grout, mortar or similar mixed materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.

.5 Store sheet materials, lumber and other Products susceptible to deterioration on flat, supports and keep clear of ground or slab. Slope to shed moisture.

.6 Handle materials to preclude damaging existing surfaces and work of others.

.7 Remove damaged Products and replace with new undamaged Products.

.8 Transportation:

a. Pay cost of transportation of Products required in performance of Work.

b. Transportation cost of Products supplied by Owner will be paid for by Owner. Unload, handle and store such Products at the Place of the Work.

c. Reject Products damaged during transport.

d. Transportation of Products must be undertaken to suit construction schedule. Contractor is responsible for determining mode of transport to ensure delivery, obtaining shop drawings, placement of orders, and on-time premium costs, air freight, and the like.

PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS AND QUALITY

.1 Products used for temporary facilities may have been previously used, providing they are sound in structural qualities.

.2 Specified options: The Work is based on materials, Products and systems specified by manufacturer's catalogued trade names, references to standards, by prescriptive specifications and by performance specifications.

a. Where only one manufacturer's trade name is specified for a Product, the Product is single sourced and shall be supplied by the specified manufacturer.

b. Where more than one manufacturer's trade name is specified for a Product, supply one Product from list of Products specified.

c. When a Product is specified by reference to a standard, select one Product from manufacturer that meets or exceeds the requirements of the standard and manufacturer's written application directions.

d. When a Product or system is specified by prescriptive or performance specifications, Provide one Product or system which meets or exceeds the requirements of the prescriptive or performance specifications and manufacturer's written application directions.

e. The onus is on the Contractor to prove compliance with governing published standards, prescriptive specifications and with performance specifications.

f. Visual selection specification:

1. Where specifications include the phrase "as selected by Consultant from manufacturer's full range" or similar phrase, select a product that complies with requirements. Consultant will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

g. Visual matching specification:

1. Where specifications require "match Consultant's sample", provide a product that complies with requirements and matches Consultant's sample. Consultant's decision will be final on whether a proposed product matches.

.3 Products, materials, equipment and articles (referred to as Products throughout the Contract Documents) incorporated in the Work shall be new, not damaged or defective, and of the quality standards specified, for the purpose intended. If requested, furnish evidence as to type, source and quality of Products Provided.

.4 Where Contract Documents list acceptable Products or acceptable manufacturers, select as applicable, one Product meeting performance of specifications and manufacturer's written application directions.

.5 Where Contract Documents require design of a Product or system, and minimum material requirements are specified, the design of such Product or system shall employ materials specified within applicable section. Where secondary materials or components are not specified, augment with materials meeting applicable code limitations, and incorporating compatibility criteria with adjacent work.

.6 Defective Products, whenever identified prior to completion of the Work, will be rejected, regardless of previous reviews. Review of the Work by the Consultant or inspection and testing companies does not relieve the Contractor of the responsibility for executing the Work in accordance with the requirements of the Contract Documents, but is a precaution against oversight or error.

.7 Should dispute arise as to quality or fitness of Products, the decision rests strictly with Consultant based upon the requirements of the Contract Documents.

.8 Unless otherwise indicated in the Contract Documents, maintain uniformity of Product and manufacturer for any like item, material, equipment or assembly for the duration of the Work.

.9 Products exposed in the finished work shall be uniform in colour, texture, range, and quality, and be from one production run or batch, unless otherwise indicated.

.10 Permanent labels, trademarks and nameplates on Products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical, electrical, machinery or like rooms.

.11 Owner retains right to select from choices available within specified Products for colours, patterns, finishes or other options normally made available. Submit full range of Product options in accordance with 01 33 00 for such selection.

.12 Quality control:

a. Implement a system of quality control to ensure compliance with Contract Documents.

b. Notify Consultant of defects in the Work or departures from intent of Contract Documents that may occur during construction. Consultant will recommend appropriate corrective action in accordance with requirements of the Contract.

.13 Exposed to weather: Products and materials in environments not protected by the building's HVAC and/or climate control systems shall be considered exposed to weather.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Unless otherwise indicated in the Contract Documents, install or erect Products in accordance with manufacturer's printed instructions. Do not rely on labels or enclosures supplied with Products. Obtain printed instructions directly from manufacturers.

.2 Notify Consultant in writing, of conflicts between the Contract Documents and manufacturer's instructions.

.3 Improper installation or erection of Products, due to failure in complying with these requirements, authorizes Consultant to require removal and re-installation at no additional cost to the Owner.

.4 Manufacturers' representatives shall have access to the Work at all times. Contractor shall render assistance and facilities for such access in order that the manufacturers' representatives may properly perform their function.

3.2 GALVANIC/DISSIMILAR METAL CORROSION

.1 Insulate dissimilar metals from each other by suitable plastic strips, washers or sleeves to prevent galvanic corrosion where conductive liquid or electrolyte (rainwater or condensation) exists.

3.3 WORKMANSHIP

.1 General:

a. Execute the Work using workers experienced and skilled in the respective duties for which they are employed.

b. Do not employ an unfit person or anyone unskilled in their required duties.

c. Decisions as to the quality or fitness of workmanship in cases of dispute rest solely with Consultant, whose decision is final.

d. Upon request by the Consultant, submit proof, in the form of CCDC 11 - Contractor's Qualification Statement, of qualifications of Subcontractors to verify Subcontractor's qualifications and experience meet or exceed the requirements of the Contract Documents.

1. If, upon review of the Contractor's Qualification Statement, it is found that the Subcontractor does not meet the qualification requirements specified in the Contract Documents pertaining to the parts of the Work for which the Subcontractor has been retained, the Contractor shall replace the unqualified Subcontractor with a qualified Subcontractor, satisfactory to the

Contractor and the Owner, at no additional cost to the Owner and at no increase in the Contract Time.

e. Remove Products or materials that have been broken, chipped, cracked, discoloured, abraded, or damaged during construction period and Provide undamaged Products or materials meeting the requirements of the Contract Documents.

.2 Coordination:

a. Ensure cooperation of workers in layout of the Work. Maintain efficient and continuous supervision.

b. Be responsible for coordination and placement of openings, sleeves and accessories.

.3 Concealment:

a. In finished areas, conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.

b. Before installation, inform Consultant of any contradictory situation. Install as directed by Consultant.

.4 Cutting and remedial work:

a. Perform cutting and remedial work required to make parts of the Work come together. Coordinate the Work to ensure this requirement is maintained. Obtain permission from Consultant before commencing any cutting. Refer also to requirements of Section 01 73 29.

.5 Location of fixtures:

a. Consider location of fixtures, access panels, outlets and mechanical and electrical items indicated as approximate only. Locate fixtures, and the like approximately; Architectural drawings will relate these items to known dimensions, such as ceiling tile grid or wall locations and the like.

b. Obtain Consultant's acceptance for precise locations of fixtures, access panels, outlets, mechanical, and electrical items. Contractor is responsible to coordinate all disciplines for ideal locations of services & devices.

c. Consultant reserves the right to relocate electrical outlets and mechanical fixtures at a later date, but prior to installation, without cost, provided that the relocation per outlet does not exceed 3050 mm (10') from the original location.

d. Inform Consultant of conflicting installations. Install only as directed by Consultant.

.6 Fastenings:

a. Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.

b. Prevent electrolytic action and corrosion between dissimilar metals and materials.

.7 Protection of work in progress:

a. Take reasonable and necessary measures, including those required by authorities having jurisdiction, to Provide protection.

b. Adequately protect parts of the Work completed or in progress. Parts of the Work damaged or defaced due to failure in providing such protection is to be removed and replaced, or repaired, as directed by the Consultant, at no additional cost to the Owner.

c. Prevent overloading of any part of the building. Do not cut, drill or sleeve any load bearing structural member without written permission of Consultant, unless specifically indicated. Refer also to Section 01 73 29.

d. Adequately protect finished flooring from damage. Take special measures when moving heavy loads or equipment on them.

e. Keep floors free of oils, grease or other materials likely to discolour them or affect bond of applied surfaces.

f. Protect work of other Subcontractors from damage while doing subsequent work. Damaged work shall be made good by appropriate Subcontractors but at expense of those causing damage.

g. Protect existing buildings, curbs, roads and lanes. If, during the Work, any buildings, curbs, roads or lanes are damaged, bear costs for repairs.

h. Protecting parts of the existing finishes in the building that are not part of the scope of work. If, during the Work, any finishes in the existing building are damaged, bear costs for repairs.

.8 Existing utilities:

a. When connecting to existing services or utilities, execute the Work at times approved by Owner, with a minimum of disturbance to Owner’s ongoing operations, the Work, and traffic.

b. Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in a manner approved by authority having jurisdiction and stake or otherwise record location of capped service.

.9 Protection of mechanical and electrical Products or materials:

a. Wrap in protective plastic and seal mechanical and electrical items of mechanical and electrical equipment prior to and during for shipment, storage at the Place of the Work and after installation.
b. Remove protective coverings only to the extent required for installation of the items. Re-install protection immediately following installation.
c. Remove protective coverings in stages, as work areas are completed, or when directed by Consultant.

.10 Operational requirements:

a. Operable Products shall be Provided fully operational and ready for intended use.
b. Adjust operating hardware and accessories for a tight fit at contact points and weather stripping for smooth operation and weather tight closure. Lubricate hardware and moving parts for smooth squeak-free function, in accordance with manufacturer's instructions.

.11 Alterations:

a. Restore new or existing work which is altered by new work and make good. Materials and workmanship shall be match existing materials and workmanship. Exposed materials shall match and blend in with the appearance of the existing undamaged surfaces in all respects, including, colours, textures, layout, jointing, and material types so as to not vary in appearance when compared to adjacent materials from a distance of 150 mm (6").

END OF SECTION

PART 1 GENERAL

1.1 CUTTING, PATCHING AND REMEDIAL WORK

.1 Submittal Items:

a. Comply with administrative requirements of Section 01 33 00.

b. Submit written request in advance of cutting, coring, and alteration that affects:

1. Structural integrity of any element of Work.
2. Integrity of weather-exposed or moisture-resistant elements.
3. Efficiency, maintenance, or safety of any operational element.
4. Visual qualities of sight-exposed elements.
5. Owner or work of other contractors.

c. Include in request:

1. Identification of Project.
2. Location and description of affected work.
3. Statement on necessity for cutting or alteration.
4. Description of proposed work, and Products to be used.
5. Alternatives to cutting and patching.
6. Effect on Owner or work of other contractors.
7. Written permission of affected separate contractor.
8. Date and time work will be performed.
9. Non-destructive structural survey: Location of reinforcement in concrete structure confirmed by non-destructive, positive method other than X-ray.

d. Do not commence cutting, patching, or remedial work until request has been reviewed by Consultant & Owner.

e. Submit engineered shop drawings for cutting, coring, patching, and alterations affecting existing structure or structural integrity of any element of Work.

.2 Preparation:

a. Inspect existing conditions, including elements subject to damage or movement during cutting and patching.

b. After uncovering, inspect conditions affecting performance of the Work.

c. Beginning of cutting or patching means acceptance of existing conditions.

d. Provide supports to assure structural integrity of surroundings; devices and methods to protect other portions of the Work from damage.

e. Provide protection from elements for areas which may be exposed by uncovering work.

f. Where uncovering of area exposes local deterioration, cracking, evidence of water infiltration, structural settlement, previous modifications, or other unexpected conditions, advise Consultant immediately in writing, share photographs. Leave conditions exposed until receipt of Consultant's written instructions.

.3 Execution:

a. Execute cutting, fitting, and patching to complete the Work. Under no circumstances will overcutting of corners of opening be accepted. Ensure corners of openings to be cut are predrilled or sawed.

b. Patch and repair existing conditions of concrete to match existing.

c. Remove and replace defective and non-conforming work.

d. Remove samples of installed work for testing if directed by Consultant.

e. Shop drawings identifying precise locations and size of openings to be cored and cut are to be submitted for review by Consultant. Provide non-destructive structural survey of structural concrete to be cored or cut, for Consultant review. Coring and cutting work locations shall be reviewed by Consultant for acceptance before proceeding.

f. Provide openings in non-structural elements of the Work for penetrations of mechanical and electrical work.

g. Perform work by methods to avoid damage to other work, and which will provide proper surfaces to receive patching and finishing.

h. Employ qualified installer with at least 3 years of relevant experience to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.

i. Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed to be used anywhere within existing buildings unless approved by Consultant.

j. Restore work with new Products in accordance with requirements of Contract Documents.

k. Fit work to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and with suitable allowance for deflection, expansion, contraction, and firestopping.

l. Enclose pipes, ducts, conduit and wires passing through floors at areas where faucets occur (for example, washrooms, kitchens, mechanical rooms on suspended floors, janitor rooms) in a 100 mm (4") high metal sleeve and make air and watertight with water resistant firestopping.

m. Completely seal voids of penetrations of fire rated wall, ceiling, and floor constructions to match existing adjacent material and thickness, provide firestopping and smoke seals.

n. Abandoned holes & penetrations must be filled with material to match existing adjacent and thickness. Minimize disruptions below by infilling from above. Basis of design Hole Mole by H&H Resources Inc. or equivalent.

o. Refinish surfaces to match adjacent finishes. Refinish continuous surfaces to nearest intersection. Refinish entire assembly units.

END OF SECTION

PART 1 GENERAL

1.1 ENVIRONMENTAL CONTROLS

.1 Conduct cleaning and disposal operations to comply with local ordinances and anti-pollution laws.

.2 Store volatile wastes in covered metal containers, and remove from Place of the Work daily.

.3 Prevent accumulation of wastes which create hazardous conditions.

.4 Provide adequate ventilation during use of volatile or noxious substances.

1.2 MATERIALS

.1 Use only cleaning materials recommended by manufacturer of surface to be cleaned and as recommended by cleaning material manufacturer.

1.3 CLEANING DURING CONSTRUCTION

.1 Clean-up the Place of the Work daily. Maintain clean and clear egress routes at all times.

.2 Maintain Place of the Work, grounds and public properties free from accumulations of waste materials and rubbish.

.3 Provide containers at the Place of the Work for collection of waste materials and rubbish. Remove waste materials and rubbish from the Place of the Work when containers become full.

.4 Vacuum and clean interior building areas when ready to receive finish painting, and continue vacuum cleaning on an as-needed basis until Substantial Performance.

.5 Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly painted surfaces.

.6 Promptly as the Work proceeds, on a daily basis and upon completion, clean up and remove rubbish, surplus materials and equipment.

.7 Remove as the work of this section progresses, corrosive and foreign materials which may set or become difficult to remove at time of final cleaning or which may damage members.

.8 Wash exposed surfaces with a cleaning solution approved by Product manufacturers.

1.4 FINAL CLEANING

.1 Perform final cleaning in accordance with requirements of Section 01 77 00.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL INSTRUCTIONS

.1 The procedures for completing Contract and acceptance by the Owner shall be in accordance with the methods described in OAA/OGCA Document 100 (latest edition) and any additional requirements described below.

.2 Stages will be reviewed at the Contract start-up meeting to ensure that parties understand their responsibilities.

.3 Within 4 weeks of commencement of the Work, submit to the Consultant a list of closeout submittals by way of table of contents required by the Contract Documents.

1.2 CLEANING

.1 Construction clean to be coordinated and paid for by the Contractor; area of work to be turned over in a clean state (walls, floors, windows, and surfaces wiped down and clear of any debris).

.2 Except as otherwise noted, terminal clean to be completed by Owner outside the Contract. Provide hospital-grade terminal clean in all areas of work.

.3 Environmental controls:

a. Conduct cleaning and disposal operations to comply with local ordinances and anti-pollution laws.

b. Store volatile wastes in covered metal containers, and remove from Place of the Work daily.

c. Prevent accumulation of wastes which create hazardous conditions.

d. Provide adequate ventilation during use of volatile or noxious substances.

.4 Materials:

a. Use only cleaning materials recommended by manufacturer of surface to be cleaned and as recommended by cleaning material manufacturer.

.5 Final cleaning:

a. Immediately prior to Consultant's review to determine if Substantial Performance of the Work has been achieved, remove surplus Products and construction machinery and equipment not required for the performance of the remaining Work.

b. Remove waste Products and debris other than that caused by the Owner, and leave the Work clean and suitable for occupancy by Owner.

c. When the Contract is completed, remove surplus Products, tools, construction machinery and equipment.
d. Clean glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, prefinished surfaces, and fixtures.
e. Remove stains, spots, marks and dirt from decorative parts of the Work, electrical and mechanical fixtures, furniture fittings, walls, and floors.
f. Vacuum clean and remove dust from building interiors, behind grilles, louvres, and screens. Vacuum clean interior of electrical equipment.
g. Clean floor finishes to recommendations of manufacturer.
h. Remove non-permanent labels.
i. Remove dirt and residue from surfaces.
j. Inspect finishes, fittings and equipment and ensure specified workmanship and operation.
k. At completion of the Work, remove protective coatings, clean surfaces and remove excess compounds and sealant materials. Make good defective, scratched or damaged work.
l. Clean equipment and fixtures to a sanitary condition, clean or replace filters of mechanical equipment.
m. Remove seal wrap on mechanical and electrical Products and materials and clean as required.
n. Clean and/or replace lamps, light fixtures, lenses and grilles.
o. Remove protective covering and labels from lamps, hardware, and specialty items.
p. Under the direction of the Consultant, aim adjustable luminaires.
q. Clean architectural metal surfaces to remove surface discoloration and rust staining.

1.3 CLOSEOUT SUBMITTALS

.1 Collect reviewed submittals, and assemble required closeout submittals executed by Subcontractors, Suppliers, and manufacturers. Prior to submitting closeout submittals to the Consultant, undertake the following:

a. Review maintenance manual contents (operating, maintenance instructions, as-built drawings, materials) for completeness.
b. Review supply and completeness of spare parts required by Contract Documents and manufacturers.

c. Review in relation to Contract Price, Change Orders, Change Directives, holdbacks and other adjustments to the Contract Price.

d. Review inspection and testing reports to verify conformance to intent of Contract Documents and that changes, repairs or replacements have been completed.

e. Execute transition of performance bond and labour and materials payment bond to warranty period requirements.

f. Submit a final statement of accounting giving total adjusted Contract Price, previous payments, and monies remaining at time of application for completion of the Contract. Consultant will issue a final change order reflecting approved adjustments to Contract Price not previously made.

.2 No later than 10 Working Days prior to submitting request for Consultant's review to determine if Substantial Performance of the Work has been achieved, submit to the Consultant the closeout submittals specified in this section, including, but not limited to, reviewed shop drawings, Product data sheets, samples, operating instructions, as-built records, fully executed warranties and guarantees, reports recording demonstration and instruction provided to Owner for operation and maintenance of building systems, software required for operation and maintenance of building systems, maintenance materials, and keys.

.3 For equipment put into use with Owner's permission during the Work, submit required closeout submittals within 10 Working Days after start-up.

.4 For items of the Work delayed materially beyond date of Substantial Performance of the Work, provide updated closeout submittals within 10 Working Days after acceptance, listing date of acceptance as start of warranty period.

.5 Neither the Consultant's review to determine if Substantial Performance of the Work has been achieved, nor acceptance of the Work, will take place until receipt, by the Consultant, of acceptable copies of the closeout submittals required herein and by the Contract Documents.

.6 As-built documents:

a. Accurately record as-built conditions and deviations from Contract Documents as the Work progresses.

b. Mark changes in red ink. Or red-lined digitally onto PDF document.

c. Record, without being limited to, the following:

1. Field changes of dimensions/details.

2. Changes by Change Orders, Change Directives, and Supplemental Instructions. Changes may not be provided in CAD format, if hand sketches

are provided it will be the responsibility of the Contractor to update the CAD files to reflect the change.

3. Locations of interior mechanical and electrical equipment and distribution.
4. Confirmed tie-ins with existing services; including plumbing, electrical circuitry, emergency power, med gas etc.

d. Submit completed as-built documents to Owner.

.7 Record documents:

a. Provide on digital file share folder of the marked-up information from the as-built documents to a master set of drawing files provided by the Consultant, as follows:

1. Drawings: AutoCAD.
   - AutoCAD base files may be made available by the Consultant: refer to Section 01 10 00.

b. Mark revised documents as "RECORD DOCUMENTS". Include all revisions, with special emphasis on mechanical and electrical.

c. Employ a competent computer draftsperson to indicate changes on the electronic set of record drawings. Provide updated record specifications in PDF format.

d. Submit completed record documents to Consultant. Provide, on a digital file share folder both AutoCAD and pdf files.

e. It is the Contractor's responsibility to ensure the completeness and accuracy of the submitted "RECORD DOCUMENTS". Any discrepancies noted or discovered during the final closeout period and warranty period that require revisions to the "RECORD DOCUMENTS" will be completed by the Contractor at no cost to the Owner. Additional costs incurred by the Consultant related to review and verification of discrepancies will be paid by the Contractor.

.8 Operation and maintenance manuals:

a. Submit 2 hard copies binder and a digital pdf version of operation and maintenance manuals, consisting of the following general components organized by master specification number sequence:

1. Operation and maintenance book.
2. Shop drawing book.
3. Warranty book.
4. Project data book.

b. Operation and maintenance books shall contain operating and maintenance data and information specified below for supplied Products, in English, and shall be made up as follows:

1. Charts, diagrams and reports identified in mechanical and electrical specifications.
2. Description, operation and maintenance instructions for equipment and parts list. Indicate nameplate information such as make, size, capacity, serial number.
3. Enclose title sheet, labelled as applicable, with project name, date and list of contents.
4. Organize contents into applicable sections of work to parallel project specifications break-down.
5. Neatly type lists and notes. Use clear drawings, diagrams of manufacturers' literature.

c. Shop drawing book:
   1. Submit one copy of each final accepted shop drawing issued for the Work on which have been recorded changes made during fabrication and installation caused by unforeseen conditions.
   2. Engineered shop drawings shall include copies of the certificate of insurance, the engineer's field review reports, and the engineer's letters of general conformity that were provided as part of the engineered submittal in accordance with Section 01 33 00 appended to the pertinent engineered shop drawing in the shop drawing manual.

d. Warranty book:
   1. Submit copies of bonds, guarantees, warranties and extended warranties together in one report binder, complete with an indexed summary list of warranties and expiration dates. Warranties to be in accordance with Section 01 78 36.
   2. Include Document noting warranty procedure.

e. Project data book: shall include the following information supplemented by additional required data specified elsewhere in the Contract Documents:
   1. Maintenance instructions for finished surfaces and materials.
   2. Copy of hardware and paint schedules.
   3. Names, addresses and phone numbers of Subcontractors and Suppliers, as applicable.
   4. Additional material used in the Work listed under various sections showing name of manufacturer and source of supply.

5. Report recording demonstration and instruction provided to Owner for operation and maintenance of building systems as described below in this section.
6. Key construction photos.
7. Permits and forms:
   - Workplace Safety & Insurance Board certificate of clearance.
   - Certificates of approval of the Work by local building department (if available).
   - Electrical authority certificate of inspection.

.9 Posted operating instructions:

a. Prepare operating instructions in English for posting near equipment and systems. Posted instructions to be glass covered, framed and mounted.

b. Posted instructions to consist of simplified, consolidated equipment, control and power diagrams graphically representing the entire system, including concise instructions on how to start and stop systems, what settings and conditions are to be observed by the operators, and what control adjustments are to be made or maintained by the operator.

c. Posted instructions shall include control diagrams with added specific operating instructions, controls, interlocks, and the like.

d. Posted instructions shall include:
   1. HVAC controls for each system.
   2. One line schematic diagrams of water supply.
   3. One line isometric diagrams of sanitary drainage.
   4. One line diagrams of steam distribution, hot and cold water systems, including risers, valves, control devices, etc.

.10 Maintenance materials:

a. Provide overage, extra stock, and maintenance materials. For required materials, see individual sections of specifications. Deliver to a location and at a time specified by the Owner, and as follows:
   1. Use unbroken cartons, or if not supplied in cartons, material shall be strongly packaged.
   2. Clearly mark cartons or packaging as to contents, project name, and Supplier.

3. If applicable give colour and finish, room number or area where material is used.

b. Replace incorrect or damaged maintenance materials delivered to Owner, including damage through shipment.

c. Provide a typed inventory list of maintenance materials prior to Substantial Performance of the Work application. List all items, complete with quantities, and storage locations.

d. Establish a master list identifying maintenance materials and maintain a log of when materials are turned over to Owner and signing authority for acceptance of materials on behalf of Owner.

1.4 SYSTEM DEMONSTRATION AND PROJECT COMMISSIONING

.1 Refer also to requirements of Divisions mechanical and electrical specifications with respect to commissioning for control systems, mechanical/electrical systems.

.2 Perform system demonstration and commissioning work no later than 10 Working Days prior to submitting request for Consultant's review to determine if Substantial Performance of the Work has been achieved.

.3 Submit required certificates of approval or acceptance from authorities having jurisdiction.

.4 Meet with other consultants; mechanical, electrical, to coordinate demonstration, instruction, commissioning and completion.

.5 Review condition of equipment such as lighting, elevators and heating system, which has been used in the course of the Work to ensure turning over at completion in "as new condition" with warranties dated and certified from time specified.

.6 When partial occupancy of uncompleted project is required by Owner, coordinate Owner's uses, requirements, access, and the like, with Contractor's requirements to complete the Work.

.7 Demonstration and instruction:

a. Demonstrate operation of each system and product to Owner via 2 in-person on-site training sessions. Contractor to keep an attendance list for each training session and include it as part of the close-out package.

b. Instruct Owner's personnel in operation, adjustment and maintenance of equipment and systems, using operation and maintenance data provided as the basis for instructions. Arrange and coordinate instruction of Owner's staff in care, maintenance and operation of building systems and finishes.

c. Contractor, manufacturer's representatives, and responsible personnel from Subcontractors whose work is being demonstrated shall be present at these demonstrations.

d. Instruct Owner's representative on use of software required for operation and maintenance of building systems and provide a toll-free telephone number or website address for further assistance to the Owner.

e. Prepare and insert additional data in the operation and maintenance data manuals when the need for additional data becomes apparent during demonstration or instruction.

f. Demonstration and instruction report: Submit a written report of such demonstration, instruction, and commissioning to the Consultant as part of the contract closeout submittals described earlier in this section. Report shall include time and date of each demonstration, instruction, and commissioning activity, complete with a list of persons present.

.8 Correct deficiencies and defects identified during demonstration, instruction, or commissioning.

.9 Attend 'end-of-work' testing and break-in or start-up demonstration.

1.5 SUBSTANTIAL PERFORMANCE OF THE WORK

.1 Deficiency review:

a. Neither Owner nor Consultant will be responsible for preparation or issuance of extensive lists of deficiencies. Contractor assumes prime responsibility for ensuring that items shown and described in the Contract Documents are complete. Any reviews to approve the certificate of Substantial Performance of the Work will be immediately cancelled if it becomes obvious to the Consultant that extensive deficiencies are outstanding.

b. The Contractor shall conduct an inspection of the Work to identify deficiencies and defects, which shall be repaired. When the Contractor considers that the Work is substantially performed, the Contractor shall prepare and submit to the Consultant a comprehensive list of items to be completed or corrected and apply for a review of the Work by the Consultant to determine if Substantial Performance of the Work has been achieved.

c. The Contractor's request described above shall include a statement by Contractor that the Work to be reviewed by Consultant and Owner for deficiencies is, to the best of the Contractor's knowledge, in compliance with Contract Documents,

reviewed shop drawings, and samples, and that deficiencies and defects previously noted by Consultant have been repaired.

d. No later than 10 Working Days after the receipt of the Contractor's request described above, but contingent upon the prior receipt, by the Consultant, of the closeout submittals in the manner and form specified in this section, the Consultant and the Contractor and Owner will review the Work to identify any defects or deficiencies. If necessary, the Contractor shall tabulate a list of deficiencies to be corrected prior to Substantial Performance of the Work being certified by the Consultant. During review, the Owner, Consultant and the Contractor will decide which deficiencies or defects must be rectified before Substantial Performance of the Work can be certified, and which defects are to be treated as warranty items.

e. Provide a schedule of planned deficiency review having regard to the foregoing.

.2 Certification of Substantial Performance of the Work:

a. When the Consultant considers that the deficiencies and defects have been completed and that it appears that the requirements of the Contract Documents have been substantially performed, the Consultant shall issue a certificate of Substantial Performance of the Work to the Contractor, stating the date of Substantial Performance of the Work.

b. The certificate of Substantial Performance of the Work shall be prepared in form required by Construction Lien Act.

.3 Final Inspection for completion of the Contract:

a. Deficiencies and defects shall be made good before the Contractor submits a written request for final review of the Work and before the Contract is considered complete.

b. When Contractor is satisfied that the Work is complete, and after the Contractor has reviewed the Work to verify its completion in accordance with the requirements of the Contract Documents, the Contractor shall submit a written request for a final review by the Consultant, who in turn will notify the Owner.

c. If there are any deficiencies identified as a result of this review, they shall be listed by the Consultant and submitted to the Contractor. This list shall be recognized as the final deficiency list for purposes of acceptance of the Work under the Contract.

d. Such deficiencies shall be corrected by a date mutually agreed upon between Consultant and the Contractor, unless a specific date is required by Contract, and a further review by the Consultant shall be called for by the Contractor following his own review to take place within 7 days from date of request.

e. Contractor shall thereafter submit invoice for final payment.

f. Money shall be withheld for deficiency work and will be released only when all deficiencies have been completed. No partial payment to be recognized until all work is completed.

1.6 WARRANTY PERIOD

.1 Provide on-going review and attendance to building call-back, maintenance and repair problems during the warranty periods.

.2 At the beginning of the 12th month after Substantial Performance of the Work, the Owner, Contractor and Consultant, along with key Subcontractors as designated, shall carry out a complete review of building and its systems to determine which deficiencies are to be rectified under the warranty. Contractor shall be responsible for timely written notification of Owner, and Consultant prior to such end of warranty period inspection and any delay in such notification shall extend such warranty period until proper notification is received by Owner, and Consultant.

END OF SECTION

PART 1 GENERAL

1.1 EXTENDED WARRANTIES

.1 Warranties shall be in accordance with General Condition GC 12.3, as amended, and as follows:

a. Written warranty shall be furnished by individual manufacturer for particular product/system/assembly or by Subcontractor for a particular product/system/assembly/section of Specifications and specifically endorsed by warrantor to Owner.

b. Warranty shall include for proper performance of the portion of the Work as defined by the scope of the applicable specification section to the extent that the design and Contract Documents permit such performance.

c. Warranty shall be provided by Subcontractor unless warranty is specified to be provided by product manufacturer.

d. The Owner shall promptly give the warrantor notice in writing of observed defects and deficiencies which occur during the warranty period.

e. Warranty shall commence at date of Substantial Performance of the Work.

f. Warranty specified shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranty do not relieve Contractor of obligations under requirements of the Contract Documents.

g. Submit warranty on warrantor’s standard form endorsed to Owner which includes the following information:

1. Name and address of Project.
2. Warranty commencement date (date of Substantial Performance of the Work).
3. Warranty period.
4. Specific warranty terms as required in applicable portion of Contract Documents.
5. Name and title of authorized signing officer and seal of warrantor.
6. Name and contact information for warranty related work.

END OF SECTION

PART 1 GENERAL

1.1 APPLICABILITY

.1 The work in this section lays out the responsibilities and the work required of the:

a. General contractor or Construction Manager.

b. Mechanical / Plumbing Contractor.

c. Electrical Contractor.

d. Controls contractor.

e. Testing, Adjusting, and Balancing Contractor.

f. Other contractors providing equipment and/or services under the requirements of this contract as may be noted in this or other related parts of the specifications.

1.2 DESCRIPTION

.1 Commissioning is a systematic process of ensuring that all building systems installed and starts up in accordance with the drawings and specifications, manufacturer's requirements and good industry practice. Commissioning also ensures that equipment operates and performs, in and of itself as well as in the system, as was intended by the designers in response to the owner's requirements. Finally commissioning ensures the owner has the documentation and training required to operate the equipment and systems in a safe, efficient and long lasting manner.

.2 During the construction phase, commissioning will include the following specific activities:

a. Review of submittals for commissionable mechanical and electrical equipment and systems at the same time as the designers. Comments from the Commissioning Agent (CxA) will be given to the design engineers to incorporate into their review as appropriate. Contractors will respond to the comments from the designer.

b. Verify equipment is installed in accordance with the manufacturer's recommendations and industry accepted good practice including review of completed manufacturers' start-up sheets, supplemented where required with commissioning installation verification checklists provided by the CxA. Contractor shall complete check sheets as required by the CxA.

c. Verify equipment is set-up, adjusted and balanced to perform as specified. This will include review of Testing, Adjusting, and Balancing (TAB) procedures, review of TAB reports and spot checking measurements on site. The TAB contractor shall cooperate with the CxA providing information requested and tools and manpower for spot checking measurements as required by the Cx.

d. Functional Performance Testing (FPT) of mechanical, plumbing, and electrical equipment and systems to ensure proper, complete and efficient operation under the range of conditions they are expected to encounter. Contractors shall provide manpower, tools and other services as required to adequately and properly perform all FPTs.

e. CxA will review O&M documentation provided to the owner to ensure it is complete and acceptable for ongoing operation and maintenance of the equipment. The review shall be sent to the designer for incorporation with his comments. The Contractors shall provide changes as required by the designer.

f. The CxA will witness the Owner's operating personnel training to verify it was adequate and complete to ensure they fully understand the requirements of operating and maintaining the equipment. Contractors shall ensure training meets the approval of the CxA and provide additional training if requested.

.3 Post occupancy contractors shall return to participate in any deferred testing as requested by the CxA.

.4 Approximately 10 months post start of warranty contractors shall return to review and address system operational issues, owner concerns, unresolved deficiencies, warranty issues.

.5 Commissioning does not take away from, reduce responsibility of or in any way diminish the requirement for manufacturers, suppliers, system designers, and/or installing contractors to provide a complete, finished and fully functioning product.

1.3 COORDINATION

.1 Commissioning Team: The following contractors will be required to participate in commissioning and to assist the commissioning team with verification, testing and documentation preparation as outlined below:

a. General contractor or Construction Manager.

b. Mechanical / Plumbing Contractor.

c. Electrical Contractor.

d. Controls contractor.

e. Testing, Adjusting, and Balancing Contractor.

f. Other contractors providing equipment and/or services under the requirements of this contract as may be noted in this or other related parts of the specifications.

.2 Other members of the commissioning team include:

a. Commissioning Agent (CxA).

b. Owner's Project Manager (PM).

c. Designated representatives of the owner's Operations and Maintenance personnel (O&M).

d. Architect and Design Engineers - particularly the mechanical and electrical engineers (A/M/E).

.3 Management: Contractors shall cooperate fully with the CxA, who is an Owner's Representative during all commissioning activities. Contractors shall work cooperatively with other members of the commissioning team as required to fulfil their responsibilities and meet commissioning objectives.

.4 Scheduling: The GC/CM, in cooperation with the CxA, will schedule commissioning meetings and activities required of contractors and subcontractors. All parties will address scheduling conflicts in a timely manner providing notifications and making adjustments to expedite the commissioning process.

.5 The GC/CM shall work to ensure contractors and subs cooperate and work to successfully commission the building.

1.4 RELATED SECTIONS

.1 Plumbing - Commissioning: Section 22 08 00

.2 HVAC - Commissioning: Section 23 08 00

.3 Integrated Automation - Commissioning: Section 25 08 00

.4 Electrical - Commissioning: Section 26 08 00

.5 Power Generation; Commission of Communication Systems: Section 26 32 00; Section 07 08 00

1.5 RESPONSIBILITIES

.1 Commissioning Agent:

a. Plan, organize and implement the commissioning process as specified herein.

b. Prepare the commissioning plan, ensure its distribution for review and revise the commissioning plan as required during construction.

c. Chair commissioning meetings, and prepare and distribute minutes to all commissioning team members, whether or not they attended the meeting.

d. In conjunction with the General Contractor, coordinate commissioning activities among all contractors, sub-trades and suppliers.

e. Review submittals for systems to be commissioned in conjunction with the designers. Submit comments to designers for their incorporation into reviews for return to the contractors and suppliers.

f. Monitor controls point-to-point checks done by the controls contractor and verify the results are accurately documented and any deficiencies are identified and corrected.

g. Observe start-ups and initial system operations tests and checks and ensure the results are accurately documented and deficiencies are identified and corrected.

h. Direct the contractors to operate equipment and systems as required to ensure that all required functional performance tests are carried out, document the results, and verify any deficiencies are identified and corrected.

i. Review O&M manuals for completeness and accuracy.

j. Witness owner training, verifying completeness and adequate understanding by staff.

k. Prepare and submit a final commissioning report which documents deficiencies resolutions and systems performance test results and evaluation. Reports for checks and tests done throughout the commissioning process, including results obtained to be included as appendices.

.2 Architect, Mechanical Designer, Electrical Designer:

a. Attend initial commissioning coordination meeting and subsequent commissioning meeting throughout construction as required.

b. Incorporate CxA submittal comments as appropriate into submittal returns.

c. Provide CxA access to site review logs and construction meeting minutes.

d. Commissioning does not relieve the design professionals of their duty to provide ongoing site administration to ensure the construction meets the intent of the drawings and Specifications.

.3 Owner:

a. The Owner will ensure the availability of operating staff for all scheduled instructions and demonstration sessions. This staff will possess sufficient skills and knowledge to operate and maintain the installation following attendance at these sessions.

b. The owner will also ensure the appropriate involvement of the mechanical designer, plumbing designer, electrical designer, architect, and any other consultants as required, in the commissioning process.

.4 Mechanical / Plumbing Contractor(s):

a. Attend initial commissioning coordination meeting and subsequent commissioning meeting throughout construction.
b. Provide a complete set of all submittals for mechanical / plumbing equipment to the CxA for review in parallel with the mechanical designer.
c. Perform installation verification, start-up and complete required documentation as directed by CxA.
d. Correct all deficiencies found during installation verification, startup, TAB and functional performance testing to ensure that all equipment and systems are fully functional and ready for occupancy.
e. Work with GC/CM to prepare schedule for pipe and duct system flushing, cleaning and testing, equipment start-up, TAB, O&M manuals submission, owner training including all commissioning activities. Update schedule throughout the construction period.
f. Schedule vendors and contractors required to participate in the installation verification and owner training sessions as required for all equipment and systems.
g. Provide a complete set of accurate as-built record drawings and schematics, include a copy to the CxA for review.
h. Return to site with the GC/CM, O&M and CxA approximately 10 months after the start of the warranty period to review system operation and to address operational issues.

.5 TAB Contractor:

a. Attend initial commissioning coordination meeting and subsequent commissioning meetings as requested.
b. Submit TAB procedures and report forms to CxA and designer for review and acceptance.
c. Provide a preliminary TAB report to CxA for review identifying alterations, if any, required for system to be complete and capable of being balanced to achieve design performance.
d. Attend TAB review meeting scheduled by the CxA. Be prepared to discuss procedures that shall be followed in TAB and findings of preliminary TAB.
e. Submittal of final TAB report in searchable PDF format showing all flows, pressures, motor speeds, voltages and amperages etc., as required for a full and complete balancing report on all systems. Provide a copy of the final TAB report including as-built distribution systems schematics to CxA for review.

f. Participate in verification of the TAB report, which includes of repeating selected measurement contained in the TAB report where required by the CxA for verification or diagnostic purposes.

.6 Building Controls and Automation System Contractor(s):

a. Attend initial commissioning coordination meeting and subsequent commissioning meeting throughout construction.

b. Attend Sequence of Operation and Graphics review meeting scheduled by the CxA during submittal review. Be prepared to discuss sequences, monitoring points, sensors, and schematics for each proposed graphic. Recognize there may be changes suggested.

c. Provide support and coordination with TAB contractor on all interfaces between their scopes of work. Provide all devices, such as portable operators' terminals, for TAB use in completing TAB procedures.

d. Provide control system technician to operate systems as required by and under the direction of the CxA during system verification and functional performance testing.

e. Provide the following to the CxA at time of FPT:

1. Point-to-point and sensor calibration verification checklists.
2. Mark-ups of submittals showing any changes made to control points, sensor locations, point names, actuators, etc. Also provide mark-ups of floor plans with controllers, transformers, remote sensor readouts, and other physical components not locatable on schematics.
3. Printout of panel layouts including all analog input, analog output, digital input, and digital output connections. Provide a separate list for each control unit.

f. Demonstrate system performance including all modes of system operation (e.g. normal, abnormal, emergency) as requested by the CxA.

g. Provide any trend logs as may be required by the CxA.

h. Provide the following:

1. Owners operation and maintenance manuals.
2. Printout of final control programming algorithms, include current values of all parameters for each system point.

i. Provide complete training to operating personnel on hardware, operation and programming, and the application program for the system.

j. Return to site with the GC/CM, O&M and CxA approximately 10 months after the start of the warrantee period to review system operation and to address operational issues.

.7 Electrical Contractor and Alternative Energy Contractor:

a. Attend initial commissioning coordination meeting and subsequent commissioning meeting throughout construction.

b. Provide a complete set of all submittals for electrical equipment alternative energy equipment to the CxA for review in parallel with the electrical designer.

c. Provide a copy of the electrical Coordination Study.

d. Provide verification of all protective device settings for all equipment and including verification all protection devices have been checked and reset to conform to the Coordination Study settings.

e. Correct all deficiencies found during Installation Verification, startup, TAB and FPT to ensure all equipment and systems are fully functional and in complete and proper working order for occupancy.

f. Prepare O&M manuals and supplementary information on all equipment. Supplementary information may include, but is not limited to, such items as power and control field wiring diagrams, equipment maintenance schedule, vendor and maintenance contact lists. Submit to CxA for review.

g. Provide electrical system technicians to assist during installation verification and functional performance testing as required by the CxA.

h. Provide a complete set of accurate as-built record drawings and schematics with a copy to the CxA.

i. Return to site with the GC and CxA approximately 10 months after the start of the warranty period to review system operation and to address operational issues as requested by the CxA.

1.6 EQUIPMENT / SYSTEMS TO BE COMMISSIONED

.1 Systems to be commissioned under this part are primarily associated with HVAC, plumbing, lighting, and controls for the building systems and central plant.

.2 Not within commissioning scope are process or special purpose equipment including:

a. Life safety systems such as fire alarm, sprinkler, fire pumps.

b. Security systems such as card readers, automatic door locks, CC cameras.

c. Communication systems such as data, paging and telephone systems.

d. Specialty equipment such as medical gas, elevators, laboratory equipment, etc.

e. Plumbing piping systems such as drainage and storm water management but scope does include booster pumps, hot water generation, cistern pumping and control systems for these.

.3 All major mechanical equipment and their controls will be commissioned using a series of installation verification and functional checks. Equipment to be commissioned during the course of this project includes but is not limited to:

a. Building Automation System (Controls System).
b. Agricultural Natural Ventilation System.
c. Gas Detection Systems.
d. Heat Tracing Systems.
e. Boilers.
f. Domestic Water Heater.
g. Split Type Air Conditioners.
h. Air Handling Units.
i. Humidifier.
j. Heat/Energy Recovery Ventilators.
k. Pumps.
l. Exhaust Fans.
m. Unit Heaters, Cabinet Unit Heaters, Terminal Heating Equipment.
n. Valves.
o. Fan Coil Units.
p. Lighting Control.
q. Heat Exchangers.
r. Piping Systems.
s. Ducting Systems.
t. VFD's.
u. Include other major energy consuming equipment not noted on this list.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

.1 All standard testing equipment required to perform start-up and installation verification and required functional performance testing shall be provided by the division contractor for the equipment being tested.

.2 All testing equipment shall have had a certified calibration, traceable to a national standard, performed within the past year. If not otherwise noted, temperature sensors and digital thermometers shall have an accuracy of ± 0.1°C, pressure sensors shall have an accuracy of ± 2.0% for each range.

.3 Special test equipment, tools or instruments required by the contract documents shall be provided for commissioning and shall be left on site with other Owner owned equipment.

PART 3 EXECUTION

3.1 MEETINGS

.1 Commissioning Meetings: Soon after construction commences, the CxA will conduct an initial commissioning scoping meeting with the entire commissioning team in attendance. Commissioning requirements, procedures, responsibilities and schedule will be reviewed.

.2 Other commissioning meetings will be conducted as required throughout construction. These meetings will cover coordination, deficiency resolution and planning issues with Contractors and Subs.

3.2 SUBMITTALS

.1 GC or CM shall distribute a copy of all submittals for equipment to be commissioned to the CxA for review at the same time they are provided to the designers.

.2 If requested, in addition to the submittal the following shall be provided:

a. Manufacturer's printed installation and start-up procedures.

b. Power and control field wiring schematics.

c. Internal controls drawings and specs.

d. Sequences of operation.

e. Optional components included.

.3 TAB contractor shall provide report forms and outline procedures indicating adjusting, balancing, and equipment data required. Submit prior to commencing work.

3.3 INSTALLATION AND VERIFICATION AND START-UP

.1 The installing Contractor or Sub-contractor shall be responsible for performing and documenting installation verification and start-up based on manufacturer's requirements

and/or good industry practice. They shall perform all required procedures and checks and document the results. Manufacturers installation verification and start-up documents as modified by the CxA shall be used.

.2 Controls actuator and sensor point-to-point and calibration checks for all actuators and sensors shall be provided by the controls contractor. The results shall be documented and provided to CxA.

.3 Execution of Installation Verification and Start-Up:

a. IV & SU checklists shall be provided by CxA. As appropriate manufacturers IV & SU checklists and procedures shall be modified by the CxA for final use.

b. The contractor, sub-contractor, manufacturer's rep or supplier shall perform IV & SU. They shall complete the checklist on each piece of equipment. IV shall be successfully completed prior to start-up. Start-up shall be successfully completed prior to Functional Performance Testing.

c. At their discretion the CxA shall observe, recheck or verify the IV &/or SU documentation of any or all equipment. The contractor shall cooperate with and provide support to the CxA as requested.

d. Only individuals with direct knowledge of and who personally witnessed any IV &/or shall sign off on the checklists.

e. It will be the responsibility of the contractor to remedy all deficiencies and issues identified. Retesting by the contractor may be required to demonstrate corrections have been made.

f. The CxA will work with all parties as required to affect proper corrective measures, correct and retest deficiencies or uncompleted items.

g. Items left incomplete or not properly corrected, causing delays or multiple call-backs for retest may result in back-charges to the party(parties) involved.

3.4 TESTING ADJUSTING AND BALANCING (TAB)

.1 A preliminary TAB field inspection report indicating deficiencies in systems such as missing or improperly located balancing ports or other system components that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance shall be provided prior to commencing balancing. Requiring correction prior to final TAB shall be documented and corrected prior to commencing balancing.

.2 All system deficiencies shall be corrected by the contractor prior to commencing balancing.

.3 TAB contractor shall participate in repeating selected measurement as required by the CxA for verification or diagnostic purposes.

3.5 FUNCTIONAL PERFORMANCE TESTING (FPT)

.1 Functional performance testing shall be conducted after installation verification and start-up have been satisfactorily completed, the control system is fully operational, and TAB is complete.

.2 The installing Contractor or Sub-contractor, under the direction of the CxA, shall execute all FPT and shall maintain responsibility for all equipment tested.

.3 Each system shall be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part-load, full-load). Proper responses to such modes and emergency conditions (e.g., power failure, freeze condition, no flow, equipment failure, etc.) shall be verified.

.4 FPT verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. The CxA will determine which method is most appropriate.

.5 The GC/CM in conjunction with the CxA will schedule FPTs with the affected Contractors and Subs.

.6 Corrections of minor deficiencies identified during FPT may be made by the Contractor or Sub during the tests.

.7 Where a deficiency cannot be corrected immediately, the Contractor or Sub shall provide a reasonable timeline for correction. The CxA shall document the deficiency and reschedule the FPT.

.8 Where there is a dispute regarding whether a problem is a deficiency or who is responsible, the deficiency shall be documented and resolution attempted by parties in attendance. Final acceptance of proposed resolution lies with the Owner or designated representative.

.9 The burden of responsibility to solve and correct deficiencies lies with the A/M/E designers, manufacturers, vendors, GC/CM, Contractors, and Subs. The CxA may participate in recommending solutions to problems in consultation with these parties.

.10 Cost of Retesting:

a. If the Contractor or Sub is responsible for a deficiency then they shall carry out the rework the deficiency and complete the FPT at no cost to the owner.

b. The CxA will direct the first retesting of the equipment at no charge.

c. If corrections of deficiencies have been reported to be successfully completed but are determined during testing to be faulty or otherwise incomplete, the time for the CxA to direct second or subsequent retests may be charged back.

3.6 TRAINING OF OWNER PERSONNEL

.1 The contractor supplying each piece of equipment shall be responsible for providing complete and satisfactory training on that piece of equipment. Training may be performed by the contractor, supplier, manufacturer or others as the contractor may decide best able to provide that training.

.2 Owner personnel shall be provided with completed O&M Manuals prior to training. In addition, up to five (5) copies of the related maintenance booklet and wiring as-builts shall be provided to owner personnel for the purpose of training.

.3 Final completion of the O&M manuals including all required submittals is the responsibility of the Contractor. The CxA will review and forward comments to the designer for follow-up.

.4 The GC shall be responsible for training coordination and scheduling and ultimately for ensuring that training is completed. The CxA shall be responsible for overseeing and approving the content and adequacy of training for all commissioned equipment.

.5 Basic training for each piece of equipment shall include the following items at a minimum:

a. General description of the system and its operation (Design Intent).
b. Detailed itemization and identification of major components and access to same.
c. Detailed itemization and identification of operating controls and safeties including normal and abnormal sensor readings.
d. Review of the O&M manuals for identification of service requirements, procedures, wiring diagrams, parts identification, safety procedures, etc.
e. Review of system drawings and schematics.
f. Review of control drawings and schematics.
g. Operational Review for Start-up:
    1. Normal operation.
    2. Shut down.
    3. Unoccupied operation.
    4. Seasonal changeover.
    5. Manual operation.
    6. Controls set-up and programming.
    7. Troubleshooting and alarms.
h. Interactions with other systems.
i. Adjustments and optimizing methods for energy conservation.
j. Health and safety issues.

k. Regular maintenance requirements including frequency, parts and equipment, and tools needed, replacement parts sources.

l. Special maintenance needs.

m. Tenant interaction issues.

n. Discussion of environmentally responsible system features.

o. Identification of contacts for service support and maintenance parts.

3.7 DEFERRED TESTING

.1 If any check or test cannot be completed due to weather conditions, the building structure, required occupancy condition or other deficiency, execution of FPT may be delayed upon approval of the Owner.

3.8 POST-OCCUPANCY REVIEW

.1 The CxA, GC/CM, mechanical, electrical, and controls sub-contractors shall return to the building approximately 10 months after the start of the warranty period to review system operation, owner concerns, unresolved deficiencies or warranty issues and to address any outstanding operational issues.

.2 The exact date and time of this meeting is to be coordinated by CG/CM in conjunction with the CxA and the contractor or sub involved.

.3 CxA will provide site report to the consultants and owner for review, acceptance and formal issue to the appropriate parties.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included:

a. Demolition and removal of existing building components not required in final Work.

b. Salvage of existing building components and equipment.

c. Temporary shoring and bracing.

1.3 REGULATORY REQUIREMENTS

.1 Conform to applicable codes and regulations for demolition or partial demolition of structures, safety of adjacent structures, dust control, runoff control and disposal.

.2 Obtain required permits from Authorities Having Jurisdiction.

.3 Notify affected utility companies before starting Work and comply with their requirements.

.4 Do not close or obstruct roadways, sidewalks, or utilities without permits.

1.4 SUBMITTALS

.1 Submit shop drawings indicating required shoring and bracing bearing the stamp and seal of a Professional Engineer licensed in the Province of Ontario.

PART 2 PRODUCTS

2.1 GENERAL

.1 Unless otherwise indicated, remove all materials, requiring demolition and not forming a permanent part of Work, from site.

.2 Remove surplus excavated material and dispose of in conformity with all applicable provincial legislation, with Ontario Provincial Standard Specification (OPSS) 180.

.3 Leave Site in a condition equivalent to the existing conditions prior to Work.

PART 3 EXECUTION

3.1 PREPARATION

.1 Follow procedures for the safe removal and disposal of designated hazardous substances present within the existing structure.

.2 Identify items noted on drawings for salvage.

.3 Remove all contaminates, handle and dispose of from the site, according to Ontario Regulations.

.4 Provide, erect, and maintain temporary barriers and security devices as required.

3.2 DEMOLITION REQUIREMENTS

.1 Conduct demolition to minimize interference with adjacent lands.

.2 Conduct operations with minimum interference to public or private accesses. Maintain egress and access at all times.

.3 Sprinkle exterior Work with water to minimize dust.

.4 Arrange with hydro, telephone, gas, water utilities to have all abandoned services disconnected, capped off and removed and made safe as applicable to Authorities.

.5 When contaminated or dangerous material is encountered, remove from Site and dispose of by safe means so that no danger is involved at job Site or in disposing operations.

.6 Selling from Site is not permitted.

3.3 DEMOLITION

.1 Disconnect, cap off and remove exposed utilities not required in final work. Mark on as-built drawing exact location and size of abandoned lines.

.2 Remove demolished materials from site.

.3 Leave site in clean condition.

3.4 SALVAGE

.1 Prior to commencement of demolition work, carefully remove items identified for salvage, and store in safe area away from general demolition activities.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included:

a. Removal of hazardous substances prior to demolition.

b. Unless otherwise indicated, all materials requiring demolition and not forming permanent part of building shall become property of Contractor. The Contractor to provide demolition, service termination, and pay all associated fees and costs. Include all costs in the Tender Price.

c. The designated substances Report identifies the locations of all known and suspect asbestos-containing materials (ACM) within the building. However, where new friable material is discovered during work and the friable material was not referenced, the contractor shall immediately report the discovery orally and in writing to the asbestos abatement consultant. Refer to Appendix E.

d. Identify the locations of buried utilities and services prior to beginning any excavation or demolition.

.2 Related Work Specified Elsewhere:

a. Designated Substance Report: Appendix E

b. General Demolition: Section 02070

c. Mechanical and Electrical Demolition: Div 15 and 16

1.3 QUALITY ASSURANCE

.1 Requirements of Regulatory Agencies:

a. Conform to the requirements of all pertinent codes, by-laws and regulations.

b. Conform to the requirements of NFPA 51B Fire Prevention in use of cutting and welding processes.

.2 Carry out demolition in strict accordance with provincial and municipal regulations as applicable, and Part 4 of Ontario Building Code.

.3 Ministry of Labour Occupational Health and Safety Act Regulations for Construction Projects including Revised Statutes of Ontario 1980, Chapter 321 as amended by Ontario

Regulation 213/91 and R.R.O. 1990, Reg. 838 as amended by O. Reg. 510/92 (formerly Ontario Regulation 654/85).

.4 The Ontario Building Code, especially Part 2, General Requirements (as applicable), The Occupational Health and Safety Act, 1980, and Regulations for Construction Projects and Fire Code, a Regulation under the Fire Marshals Act, especially Section 8.1.

.5 Ministry of Transportation Regulations for the transport of waste, including the Transportation of Dangerous Goods Act.

.6 Ministry of Environment Regulations for the disposal of waste, including R.R.O. 1990, Reg. 347 (formerly Ontario Regulation 309/82).

.7 CSA S350-M1980 - Code of practice of Safety in Demolition in Structures.

.8 Asbestos on Construction Projects & In Buildings Repair Operations (Ontario Regulation 278.05).

.9 Ministry of Environment and Energy 3R Regulations for the reducing, reusing and recycling of generated waste material, this includes Ontario Regulations 101/94, 102/94, 103/94, 104/94 and 105/94 made under the Environmental Protection Act.

1.4 SUBMITTALS

.1 Submit completed Waste Manifest forms on a weekly basis and upon completion of the work.

PART 2 GENERAL

2.1 DEFINITIONS

.1 Friable Material: Asbestos-containing material that when dry can be crumbled, pulverized or powdered by hand pressure and includes material that is crumbled, pulverized or powdered.

2.2 WORKER PROTECTION

.1 Provide instruction and training to workers in respirators, work boots, eye protection, hearing protection, and other items of personal protection. Workers must wear respirators with filters appropriate to the work being performed. Instruction must be provided by a competent person as defined by the Occupational Health and Safety Act.

2.3 TEMPORARY PROTECTION

.1 Take all necessary precautions to prevent access by unauthorized persons.

.2 Take all necessary precautions to prevent damage to existing properties and services scheduled to remain.

PART 3 EXECUTION

3.1 GENERAL

.1 When contaminated or dangerous material is encountered, remove from Site and dispose of by safe means so that no danger is involved at job Site or in disposing operations. Selling from Site is not permitted. Ensure the demolition, removal, and handling of materials and operation of equipment is performed by persons experienced in the methods, procedures and industry practices for demolition work.

.2 During demolition operations, keep Work wetted down thoroughly to prevent dust and dirt rising. Provide multiple 25 mm spray tipped hoses and fulltime staff to ensure dust is kept to an absolute minimum.

.3 Arrange with appropriate trades to have all services within and leading from areas being demolished to be disconnected and temporarily sealed as applicable.

.4 Remove resultant debris from Site.

.5 Remove elements that are continuous with or connected to that which is to remain in a manner to preserve the integrity, and leave good that which is to remain and allow for efficient completion of the Work.

.6 At end of day's work, leave work in safe condition so that no part is in danger of toppling or falling.

.7 Ensure work proceeds to schedule, meeting all requirements of this specification.

3.2 HAZARDOUS MATERIALS ABATEMENT

.1 Asbestos:

a. Ensure the removal and handling of ACM or other Designated Substances or hazardous materials is performed by persons licensed and experienced in the methods, procedures and industry practices applicable to the Work.

b. Demolition of spray or trowel-applied asbestos can be hazardous to health. Should material resembling spray or trowel-applied asbestos or pipe covering containing asbestos be encountered in the course of demolition work, stop work immediately. Proceed with approved abatement measures of ACM removal. Notify Consultant of findings and method for removal. All work requiring asbestos abatement shall be carried out in compliance with Regulation Respecting Asbestos on Construction

Projects and in Buildings and Repair Operations made under the Occupational Health and Safety Act, Ontario Regulation 654-85.

.2 Mercury:

a. Mercury switches in the form of room thermostat's or pressure switches may be present. Collect glass bulbs from units and hand over to metal processor for recycling. Do not break glass container, package and handle with care during transportation. Provide proof of recycling.

.3 Chloroflourocarbons:

a. Air conditioners freezers, fridge's and other equipment containing Freon or other chloroflourocarbons left behind by previous owners shall be purged and disposed of at appropriate disposal site. Provide proof of disposal.

3.3 SERVICES

.1 Before commencing Work, establish location and extent of existing services and utilities, above and below ground, affected by the Work.

.2 Whenever it is necessary to cut, interfere with, or connect to existing services or facility, do so at hours and times recommended by governing authorities and approved by Consultant and with minimum disturbance to occupants, pedestrian and vehicular traffic and public and private property. Obtain permission and permits from applicable utility.

.3 Schedule and obtain approval from Consultant for each proposed shut-down of active service or facility. Adhere to approved schedule and provide notice to affected parties.

.4 If unknown services are encountered, immediately notify Consultant and confirm findings in writing and/or on drawings. Obtain Consultant's written direction if such services require cutting, capping or relocation to do the work.

3.4 DISPOSAL OF WASTE MATERIALS

.1 Obtain approval and use the following off-site disposal, depending upon materials involved, recycling, burying, composting, Municipal collection or local dump or sanitary landfill site:

a. Coal tar roofing membrane shall be transferred to a licensed waste disposal site by an approved waste management system.

b. Recycle concrete, masonry, wood and steel.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included: Supply and install, unless specifically designated to be supplied only, all miscellaneous metal Work not included in the Work of other Sections. Where items are required to be built into masonry, concrete or other Work, supply such items to respective Sections with all anchors and accessories for building in.

.2 Related Work Specified Elsewhere:

a. Structural Metal Stud Framing: Section 05 41 00

b. Structural Steel Framing: Section 05 12 00

c. Structural Roof Decking: Section 05 31 23

d. Rough Carpentry: Section 06 10 10

e. Finish Carpentry: Section 06 20 00

f. Finish painting: Section 09 90 00

1.3 QUALITY ASSURANCE

.1 Requirements of Regulatory Agencies: Conform to applicable requirements of the latest editions of the following:

a. The 2012 Building Code Compendium, Part 4, Structural Design.

b. CSA S16, Steel Structures for Buildings (Limit State Design).

c. CSA W55.3, Resistance Welding Qualification Code for Fabricators of Structural Members Used in Buildings.

d. CSA W47.1-M, Certification of Companies for Fusion Welding of Steel Structures.

e. CSA W117.2-M, Code for Safety in Welding and Cutting (Requirements for Welding Operators).

f. American Hot Dip Galvanizers Association: The Design of Products to be Hot Dip Galvanized After Fabrication.

1.4 SUBMITTALS

.1 Shop Drawings: Submit Shop Drawings, showing all elements of adjacent walls, floors and roof framing systems and calculations for systems showing design loads and deflections, bearing the stamp and seal of a Professional Engineer licensed in the Province of Ontario.

PART 2 PRODUCTS

2.1 MATERIALS

.1 Structural Steel Sections and Steel Plates: CSA-G40.21-M, Grade 300W, except HSS: Grade 350W, Class H.

.2 Sheet Steel: Structural Quality ASTM A570. Commercial quality ASTM A366.

.3 Sheet Aluminum: Clear Anodized finish ASTM B209.

.4 Galvanized Sheet Steel (Structural Quality): Galvanizing as specified ASTM A446, structural quality sheets.

.5 Galvanized Sheet Steel (Commercial Quality): Galvanizing as specified ASTM A526, plain commercial galvanized stretcher levelled to temper rolled.

.6 Galvanizing (Other): All steel specified to be galvanized except galvanized sheet steel, CSA G164-M, Hot Dip Galvanizing of Irregularly Shaped Articles.

.7 Welding Materials: CSA W59-M.

.8 Metal Filler: Polyester based, one of the following:

a. M12555 Red Flexibond by Kleen-Flo Tumbler Industries, Scarborough.

b. Red Lightnin' by Marson Division, Swingline of Canada Ltd., Toronto.

c. M45 by Dura Chemicals Ltd., Hamilton.

.9 Structural Steel Pipe: ASTM A53, Grade B.

.10 Square Steel Tube: ASTM A500 or ASTM A501, seamless.

.11 Stainless Steel: Type 304, No. 4 finish.

.12 Bolts, Nuts and Washers: ASTM A325.

.13 Anchors, Bolts, Nuts, Washers for Dissimilar Metals: Of stainless steel alloy with min 12% chromium.

.14 Expanded Metal Sheet: 20 mm x 2.278 mm thickness carbon steel standard diamond pattern mesh, SWD and LWD size to fit designs: Z600 galvanized after fabrication when for exterior use.

.15 Grout: non-shrink, non-metallic, epoxy flowable, 12 hr., MPa 15, pull-out strength 7.9 MPa.

.16 Galvanized Surfaces for Paint: Do not passivate galvanized surfaces to be finish painted.

.17 Primer and Touch-Up for Ungalvanized Surfaces: CGSB 1-GP-40M, Primer, Structural Steel, Oil Alkyd Type.

.18 Touch-Up Paint for Field Welds on Galvanized Surfaces: CGSB 1-GP-181M, Coating, Zinc-Rich, Organic, Ready-Mixed.

.19 Bituminous Paint: CAN/CGSB 1.108-M.

.20 Neoprene Sheet: Dense, solid neoprene.

2.2 DESIGN

.1 Design each item to be structurally sound.

.2 Design steel and iron articles to be galvanized after fabrication in conformance with the referenced standards.

2.3 FABRICATION AND MANUFACTURE

.1 General:

a. Exchange and coordinate Shop Drawings with related Sections to ensure accurate fit of components with the Work of other Sections.

b. Fit and assemble Work in shop where possible. Execute Work according to details and reviewed Shop Drawings. Where shop fabrication is not possible, make trial assembly in shop.

c. Do all welding in accordance with requirements of CSA W59-M. File or grind welds smooth and flush were exposed to view and where specifically indicated on Drawings.

d. Complete all assembly and welding before galvanizing.

e. Site assemble by bolting all galvanized items to be left exposed (not finish painted). Perform all welding on such items before galvanizing.

f. Fit joints and intersecting members accurately. Make Work in true planes with adequate fastening, mitre corners unless specified or shown otherwise.

g. Supply all fastenings, anchors accessories required for fabrication and erection of Work of this Section. Such items occurring on or in an exterior wall or slab shall be hot dip galvanized.

h. Make exposed metal fastenings and accessories of same material, texture, colour and finish as base metal on which they occur unless otherwise shown or specified. Keep exposed fastenings to an absolute minimum evenly spaced and neatly laid out. Make fastenings of permanent type unless otherwise indicated.

i. Fabricate gratings and other items with multiple parts so that a regular pattern is presented in the finished Work with all members lined up or evenly spaced and pattern is unbroken.

.2 Finish:

a. Shop Prime Paint all interior metals unless otherwise indicated on Drawings.

b. Thoroughly clean all metals and apply one coat of primer. Brush on thoroughly and Work well into all crevices and interstices.

c. Galvanize all exterior metals (including lintels) unless otherwise indicated on Drawings. Prime paint galvanized items that are to receive final Site painting.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Take measurements at the Place of the Work to ensure that metal fabrications are fabricated to fit surrounding construction, around obstructions and projections in place, or as indicated, and to suit service locations.

3.2 INSTALLATION

.1 Install metal fabrications plumb, true, square, straight, level, and accurately and tightly fitted together and to surrounding work.

.2 Include in work of this section anchor bolts, high tensile bolts, washers and nuts, expansion bolts, toggles, straps, sleeves, brackets, clips, and other items necessary for secure installation as required by loading and jurisdictional authorities. Weld to CAN/CSA-S16-01 CONSOLIDATION.

.3 Attach metal fabrications to interior concrete and masonry with corrosion resistant expansion bolts to support load with a safety factor of 3.

.4 Insulate between dissimilar metals or between metal, and masonry or concrete with bituminous paint to prevent electrolytic action.

.5 Hand items over for casting into concrete or building into masonry to appropriate trades together with setting templates.

3.3 ADJUSTMENT AND CLEANING

.1 After erection, touch up primed surfaces that are burned, scratched or otherwise damaged with prime paint to match shop paint.

.2 Remove damaged, dented, defaced, defectively finished, or tool marked components and replace with new.

3.4 PROTECTION

.1 Maintain protection of work of this section from time of installation until final finishes are applied or to final cleanup.

.2 Protect finished surfaces from damage.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION OF SYSTEM

.1 Lightweight Structural Steel Framing includes Wind Bearing Studs and Joists. Wind Bearing Studs includes:

- .1 Wall studs subjected to lateral loads and as indicated on drawings.
- .2 Steel bridging.
- .3 Top and bottom track.
- .4 Head and sill members and jamb studs for wall openings.
- .5 Stud, bridging and track connections.
- .6 Top and bottom track connections to main structure including detailing to accommodate floor deflections.

1.3 RELATED SECTIONS

.1 Section 04 27 13 – Masonry: Accessories (e.g. brick ties, furring channels).

.2 Section 07 21 16 – Batt Insulation.

.3 Section 09 21 16 – Gypsum Board Assemblies: Sheathing materials.

1.4 REFERENCED STANDARDS

.1 Referenced standards refer to the latest edition except where specified otherwise.

.2 Where referenced standards conflict with this specification, this specification governs.

.3 The following standards are referenced in this specification:

- .1 Ontario Building Code.
- .2 National Building Code of Canada.
- .3 Canadian Standards Association (CSA):
  - .1 CAN/CSA-S136, Cold Formed Steel Structural Members.
  - .2 CAN/CSA-W47.1, Certification of Companies for Fusion Welding of Steel Structures.
  - .3 CAN/CSA-W59, Welded Steel Construction (Metal Arc Welding).
- .4 American Society for Testing and Materials (ASTM):

.1 ASTM A525M, General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process.

.2 ASTM A591, Steel Sheet, Cold-Rolled, Electrolytic Zinc-Coated.

.3 ASTM A792M, General Requirements for Steel Sheet, Aluminum-Zinc Alloy Coated by the Hot-Dip Process.

.5 American National Standards Institute / American Welding Society (ANSI/AWS):

.1 ANSI/AWS D1.3, Structural Welding Code – Sheet Steel.

.6 Canadian General Standards Board (CGSB):

.1 CGSB 1-GP-181M, Standard for Coating, Zinc Rich, Organic Ready Mix.

1.5 DESIGN CRITERIA

.1 Design is based on Limit States Design principles using factored loads and resistances in accordance with the National Building Code of Canada and CAN/CSA-S136.

.2 Provide bridging to prevent member rotation and member translation perpendicular to the minor axis. Provide for secondary stress effects due to torsion between lines of bridging. Collateral sheathing may be used to help restrain member rotation and translation perpendicular to the minor axis.

.3 Maximum deflections under specified loads shall conform to the following:

.1 Wall studs: L/240.

.2 Joists: L/360.

.4 The spacing of members shall not exceed the following:

.1 Wall studs – 600 mm o/c.

.2 Joists – 600 mm o/c. or as shown on the drawings.

.5 Allow for movement of the structure. Design wind bearing stud end connections to accommodate floor/roof deflections such that the studs are not loaded axially. Allow for 10 mm maximum deflection at all locations.

.6 Connections between lightweight steel framing members shall be by bolts, welding or sheet metal screws.

.7 Resistances to sheet metal screws shall be based on the manufacturer's lower bound test values multiplied by the appropriate resistance factor, øc, given in CAN/CSA-S136.

1.6 SUBMITTALS

.1 Submit 3 certified copies of mill reports covering chemical and mechanical properties, and coating designation of steel used in this work.

.2 Submit 2 representative pieces of all framing component parts including mechanical fasteners if used. The length of pieces submitted need not exceed 300 mm. Tag pieces with the name of the part, the metal thickness exclusive of coating and the manufacturer.

.3 Submit 6 copies of shop drawings, stamped by a Professional Engineer licensed in the Province of Ontario.

.4 Include all necessary shop details and erection diagrams. Indicate member sizes, locations, thicknesses, exclusive of coating, coatings and materials. Include connection details for attaching framing to itself and for attachment to the structure. Show splice details where permitted. Indicate dimensions, openings, requirements of related work and critical installation procedures. Show temporary bracing required for erection purposes.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

.1 Bailey Metal Products Ltd., CSM Canadian Steel Manufacturing Inc., or approved equal.

2.2 MATERIALS

.1 Steel shall have metallic coatings that conform to one of the following ASTM Standards:

.1 ASTM A525M – General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process.

.2 ASTM A591 – Steel Sheet, Cold-Rolled, Electrolytic Zinc-Coated.

.3 ASTM A792M – General Requirements for Steel Sheet, Aluminum-Zinc Alloy Coated by the Hot-Dip Process.

.2 Steel shall conform to the requirements of CAN/CSA-S136 and shall be identified as to specification, type, grade and mechanical properties.

.3 Roof and wall members forming part of the exterior building envelope shall have a minimum coating of Z180 galvanizing in accordance with ASTM A525M. Other coatings (e.g. aluminum-zinc alloy) providing equal or better corrosion protection may be used.

.4 Interior members not forming part of the exterior building envelope shall have a minimum coating of Class C electro-galvanizing in accordance with ASTM A591. Other coatings (e.g. electro-deposited zinc, chromate treated; zinc-iron alloy; aluminum-zinc alloy) providing equal or better corrosion protection may be used.

.5 Sheet metal screws shall have a minimum coating thickness of 0.008 mm of zinc or cadmium. Other coatings providing equal or better corrosion protection may be used.

.6 Welding electrodes shall be of the 480 MPa minimum tensile strength series (e.g. E48XXX, E480S-X).

.7 Zinc rich paint for touching up welds and damaged metallic coatings shall conform to CGSB 1-GP-181M.

.8 The minimum steel thickness, exclusive of coating, shall be as follows:

.1 Exterior wall studs – 1.52 mm (16 ga.).

PART 3 EXECUTION

3.1 GENERAL

.1 Fabrication and erection shall conform to the approved shop drawings. Modifications required to accommodate as-built conditions (other than minor dimensional changes) shall be submitted for approval.

3.2 WELDING

.1 Companies engaged in welding shall be certified by the Canadian Welding Bureau to CSA Standard W47.1. Companies shall have welding procedures approved and welders qualified for the base material types and thicknesses that are to be welded.

.2 Welds shall conform to CSA W59 and/or ANSI/AWS D1.3, whichever is applicable.

.3 For material less than 3 mm thick, shop drawings may show nominal weld leg sizes. For such material, the effective throats of welds shall not be less than the thickness of the thinnest connected part.

.4 Touch-up welds with zinc rich paint.

3.3 SCREWS

.1 Steel screws shall equal or exceed the minimum diameter indicated on the shop drawings.

.2 Penetration beyond joined materials shall be not less than 3 exposed threads.

.3 Thread types and drilling capability shall conform to the manufacturer's recommendations.

.4 Screws covered by sheathing materials shall have low profile heads.

3.4 FABRICATION

.1 Provide cut-outs centered in the webs of wall members to accommodate services. Unreinforced cut-outs shall be manufacturer's standard openings only.

.2 The steel thickness, exclusive of coating, shall be marked on each member by embossing, stamping with indelible ink or by colour coding.

3.5 ERECTION

.1 Methods of construction may be either piece by piece (stick-built) or by fabrication into panels either on or off site.

.2 Lightweight steel framing shall be erected true and plumb within the specified tolerances. Temporary bracing shall be employed wherever necessary to withstand all loads to which the structure may be subject during erection and subsequent construction. Temporary bracing shall be left in place as long as required for the safety and integrity of the structure. The Erector shall ensure that during erection a margin of safety consistent with the requirements of the National Building Code and CAN/CSA-S136 exists in the uncompleted structure.

.3 Erection tolerances:

.1 For the purposes of this section, camber is defined as the deviation from straightness of a member or any portion of a member with respect to its major axis, and sweep is defined as the deviation from straightness of a member or any portion of a member with respect to its minor axis.

.2 For wind bearing studs, out-of-plumbness shall not exceed 1/500th of the member length. Out-of-straightness (camber and sweep) shall not exceed 1/1000th of the member length.

.3 For rafters and joists, out-of-straightness (camber and sweep) shall not exceed 1/1000th of the member length.

.4 For track, camber shall not exceed 1/1000th of the member length.

.5 Studs shall seat into top and bottom tracks. The gap between the end of the stud and the web of the track shall not exceed 1.5 mm for axial load bearing studs or 4 mm for wind bearing studs.

.6 Align adjacent prefabricated panels to provide surface continuity at the interface.

.7 Spacing of studs shall not be more than 3 mm from the design spacing. The cumulative error in spacing shall not exceed the requirements of the finishing materials.

.4 Make all field measurements necessary to ensure the proper fit of all members.

.5 Cutting of members may be by saw or shear. Torch cutting is not permitted.

.6 Insulation equal to that specified shall be placed in all jamb and header assemblies that will be inaccessible after their installation into the wall. Ensure that insulation is kept dry and not compressed.

.7 Handling and lifting of prefabricated panels shall not cause permanent distortion to any member or collateral material.

3.6 WASTE MANAGEMENT

.1 Separate and recycle waste materials in accordance with the Waste Management Plan.

.2 Fold up metal banding, flatten and place in designated areas for recycling.

.3 Collect wood packing shims and pallets, place in designated area.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included:

a. Provide framing, sheathing, interior plywood and back-blocking for the Work.

.2 Related Work Specified Elsewhere:

a. Finish Carpentry: Section 06 20 00

b. Gypsum Board Assemblies: Section 09 20 15

1.3 QUALITY ASSURANCE

.1 Requirements of Regulatory Agencies: Conform to the requirements of:

a. The Code, Part 9 for wood framing and sheathing.

b. CAN3-086.1-M, Engineering Design in Wood (Limit States Design).

c. Conform to HLGA 1970, Standard Grading Rules for Canadian Lumber.

d. Pressure treated wood must bear stamp of processing plant indicating treatment.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

.1 Protect all wood products from wetting and moisture. Protect wood products from moisture gain, by covering with well secured tarpaulins during rain or snow or storing indoors during prolonged inclement weather.

PART 2 PRODUCTS

2.1 MATERIALS

.1 Conform to:

a. The National Lumber Grades Authority Standard Grading Rules for Canadian Lumber, 1977.

b. CSA 0141, Softwood Lumber.

c. Kiln dried.

d. FSC certified wood.

.2 Moisture Content: All wood products shall be S-dry at time of delivery and installation.

.3 Framing Lumber: NLGA, Spruce-Pine-Fir, Stress Grades: “Studs” and “Structural Joists and Planks – No. 1”.

.4 Plywood: to CSA 0121-M, Standard Grade.

.5 Moisture Resistant Plywood – Exterior Grade: Douglas Fir, G1S, Marine board, 19 mm thick unless noted.

.6 Other Lumber: CSA 0141, Spruce-Pine-Fir, dressed structural.

.7 Sheathing:

a. Gypsum to ASTM C1177, 16 mm DensGlass Gold Exterior Guard and 16 mm DensGlass Gold Fireguard, Type X to ASTM E136 by Georgia-Pacific Corporation or UGC or American Gypsum.

1. Joint Tape: 50 mm wide 10 x 10 glass mesh.
2. Joint Compound: G-P Gypsum setting-type joint compound, compatible with exterior stucco system by Georgia-Pacific Corporation or UGC or American Gypsum.

.8 Adhesive: CSA 0112.7-M, Resorcinal and Pheno-Resorcinal Resin Adhesives, Type 1 (room-temperature curing).

.9 Bolts, Nuts and Washers: CSA-S16.1-M and ASTM A325, standard structural grade, hexagonal nuts.

.10 Nails: CSA BIII:

a. Structural Framing: Common Spiral.

b. Sheathing: Plywood Subfloor Attachment Nails, Ring Thread.

.11 Back-blocking: 19 mm plywood or solid framing lumber.

PART 3 EXECUTION

3.1 INSTALLATION

.1 Nailing of framing and sheathing shall conform to or exceed requirements of Tables 9.23.3.4 and 9.23.3.5 – A, B and C of the Code.

.2 Attach eye-hook suspension system to existing concrete structure using drilled anchors. Power-activated devices are not allowed. Locate fasteners at sufficient frequency to carry anticipated loads. Review location of fasteners and receive approval to commence from Structural Consultant.

.3 Provide Equipment back panels as called for in other Divisions of the Specifications.

.4 Provide back-blocking as indicated on drawings and at all wall mounted items weighing more than 10 kg, including but not limited to:

a. Upper millwork cabinets.
b. Television brackets.
c. Roller shades.
d. Mop racks and/or hooks for janitorial equipment.
e. Where recommended by equipment/furnishing supplier.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included But Not Limited To:

a. Provide finish wood items, trim and grommets for the Work.

b. Provide nailing strips for Architectural Woodwork and Specialties.

c. Receive and install: Architectural woodwork, metal fabrications as specified, doors, door frames, finish hardware unless specified otherwise, access doors for concealed mechanical equipment, door grilles, built-in equipment.

.2 Related Work Specified Elsewhere:

a. Rough framing: Section 06 10 00

b. Millwork: Section 06 40 00

c. Items installed by this Section include but are not limited to those supplied by the following Sections:

- Wood Doors and Frames: Section 08 21 00
- Finish Hardware: Section 08 70 00
- Mechanical General Requirements: Division 22, 23, 24
- Electrical General Requirements: Division 26

1.3 QUALITY ASSURANCE

.1 Perform work of this Section by carpenters familiar with the work they are installing.

.2 Conform to the requirements of the latest edition of the following:

a. The Code.

b. CAN3-086.1-M84, Engineering Design in Wood (Limit States Design).

c. The National Lumber Grades Authority Standard Grading Rules.

d. Quality Standards For Premium Architectural Woodwork, by the Architectural Woodwork Manufacturers Association of Canada (AWMAC), latest edition.

e. CSA O112 - Series M, Standards for Wood Adhesives.

f. CSA O115-M, Hardwood and Decorative Plywood.

g. CSA O121-M, Douglas Fir Plywood.

h. CSA O141, Softwood Lumber.
i. CSA O151-M, Canadian Softwood Plywood.
j. CSA O153-M, Poplar Plywood.

1.4 SUBMITTALS

.1 Submit installation details and instructions for all work to be installed by this Section. Where products are fabricated by other Sections, instructions and details shall be as provided by the fabricator through this Section.

.2 Submit samples as requested by Architect.

PART 2 PRODUCTS

2.1 MATERIALS

.1 General: Conform to:

a. The National Lumber Grades Authority Standard Grading Rules.
b. The Architectural Woodwork Manufacturers Association of Canada Millwork Standards (AWMAC), Premium Grade unless noted otherwise.

.2 Moisture Content: All wood products shall be within the following prescribed range at time of delivery and installation:

a. Interior Wood: 7%, with range permitted in individual pieces of 5% to 9%.

.3 Unfinished Lumber: NLGA Spruce-Pine-Fir, “Construction” Light Framing Grade.

.4 Unfinished Plywood: Douglas Fir, G1S, sanded, waterproof, 19 mm thick unless noted.

.5 Moisture Resistant Plywood: Douglas Fir, G1S, Marine board, 19 mm thick unless noted.

.6 Interior Exposed Wood for Paint: AWMAC Paint Grade, White birch or Poplar.

.7 Interior Exposed Wood for Clear Finish and Concealed Hardwood: AWMAC Premium Grade (Standard Grade at concealed hardwood), quarter cut Birch.

.8 Interior Exposed Plywood for Paint: AWMAC Paint Grade, White birch face or faces (each exposed face).

.9 Interior Exposed Plywood for Clear Finish: AWMAC Architectural Grade on exposed faces and AWMAC Good Grade on exposed faces as indicated on drawings, White birch face or faces (each exposed face).

.10 Nails: “Common spiral nails”, for unfinished work, and “spiral finishing nails” for finished work, conforming to CSA B111. Galvanized nails for exposed exterior use.

.11 Wood Screws: CSA B35.4, Wood Screws, non-ferrous, corrosion-resistant alloy finished. Stainless steel for exterior use.

.12 Adhesives: Waterproof, suited to work for which they are used, conforming to CSA 0112 Series-M.

.13 Grommets: Provide the following quantity and sizes of grommets (for placement in millwork) by Hafele or approved equal. Location to be determined on site:

a. 50 mm dia.

2.2 FABRICATION

.1 Fabricate work of this Section to AWMAC Premium Grade.

.2 Prep doors and frames for (but not limited to) heavyweight hinges, continuous hinges, concealed vertical rod and mortise lock case exit devices, cylindrical locksets, surface door closures and concealed overhead stops.

PART 3 EXECUTION

3.1 INSTALLATION, INCLUDING BUT NOT LIMITED TO

.1 Finished Woodwork: Conform to AWMAC Millwork Standards for Premium Grade work.

.2 Woodwork: Cut and fit accurately, neatly and true to line. Cope inside corners of wood base, screw fasten at 400 mm o.c. min., countersink and fill.

.3 Securement: Secure woodwork and other products in accordance with manufacturer's recommendations for best results, in accordance with AWMAC standards, the Drawings and reviewed shop drawings and to best practice to ensure all work in place for long life under hard use.

.4 Installation of Products from Other Sections: Collect and review shop and installation drawings of all such work. Install all such work in accordance with reviewed installation drawings and manufacturers printed instructions and directions.

a. Doors and frames are prepped for (but not limited to) heavyweight oversize butt hinges, continuous hinges, cylindrical locks, rim exit devices, concealed vertical rod at panic sets, surface door closers and concealed overhead stops.

.5 Doors and Screens: Hang wood and steel doors and screens plumb and accurately within openings, free of hinge bound condition.

.6 Special Doors: Install locking ceiling access doors to manufacturer's instructions. Install access doors for concealed mechanical and electrical equipment in accordance with those Divisions, reviewed shop drawings and reviewed instructions.

.7 Hardware: Install all hardware except cabinet hardware, unless specified otherwise. Install in strict accordance with manufacturer's instructions and as dictated by hardware schedule.

.8 Equipment Supplied by Owner: Install in accordance with supplier's written instructions.

.9 Grommets: Install in locations directed by Consultant.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included:

a. Provide all architectural woodwork requiring shop fabrication c/w hardware.

b. Provide Solid Surfaces for installation by Others.

.2 Related Work Specified Elsewhere:

a. Installation of this work: Section 06 20 00

1.3 QUALITY ASSURANCE

.1 Quality Standards for Architectural Woodwork by the Architectural Woodwork Manufacturers Association of Canada (AWMAC), Premium Grade.

.2 Manufacture and install Architectural Woodwork to the specified AWMAC Architectural Woodwork Standards manual, Latest Edition.

1.4 SUBMITTALS

.1 Shop Drawings: Submit shop drawings for review.

.2 Samples:

a. Submit samples of range of clear finishes available for selection by Architect.

b. Submit samples 1 bd. ft. in size of each type of finish on each type of wood to be used.

c. Submit samples of all joinery, if requested.

d. Submit triplicate samples of plastic laminate and solid surface.

e. Submit triplicate samples of wood species and stains.

f. Submit samples of hardware.

.3 Reference Data: Provide finish materials catalogue cuts and maintenance instructions including warnings on wrong maintenance practices for insertion in Operating Manuals and Reference Data specified in Section 01 33 00, Submittals.

1.5 WARRANTY

.1 Provide a warranty against defects attributable to labour, material and workmanship for a period of three (3) years from date of Substantial Performance, or a three (3) year maintenance bond for the full value of the Work.

PART 2 PRODUCTS

2.1 MATERIALS

.1 Materials:

a. Medium Density Fibreboard: Industrial Grade Medium Density Fibreboard (MDF) with a formaldehyde free binder to ANSI A201.2-1994 density 740 Kg/m^3, product class MD: paint grade, good/solid grade. 19 mm thickness unless noted otherwise on drawings.

b. Plywood: Douglas Fir, G1S, sanded, waterproof, 19 mm thick unless noted – FSC Certified Wood.

c. Veneer Plywood: Walnut and Oak faced, A grade flat cut, thickness as noted and/or required for curving – FSC Certified Wood.

d. Solid Wood: Walnut and Oak – FSC Certified Wood.

e. Plastic Laminate: Conforming to CAN3-A172-M, Standard Grade, 2 mm thick except 1.25 mm thick post forming grade where required, 0.50 mm thick backing sheet, sanded one side by same manufacturer, colour and finish choice by Architect from Arborite, Formica, Nevamar or Wilsonart complete range. Premium finish (speckled, crystal or quarry etc.) at countertops.

1. See Drawings for colour selection.

f. Thermofused Melamine: Certified EPP (Environmentally Preferred Product) by CPP (Composite Panel Association) and to NEMA LD-3-95 Grade VGL consists of a decorative paper impregnated and saturated with melamine resin, thermally fused under heat and pressure to MDF substrate. Overlay bonded to both faces to prevent warping.

g. Solid Surface: Corian. See Drawings 4/A3.3 and colour selection.

h. Door and Drawer Edges: 3 mm vinyl, to match adjacent laminate or melamine colour/pattern, 3 mm solid hardwood for wood doors and drawers.

i. Nails, screws and fasteners: To CSA B111, galvanized for exterior work, plain finish elsewhere.

.2 Cabinet Hardware:

a. Heavy Duty Hinges: Self closing, concealed European style 170° open, all metal plated parts with six-way adjustability by Blum, Hettic or Grass.

b. Pulls: Brushed Aluminum, 100 mm D-style pull.

c. Drawer Slides: Heavy duty ball bearing carrier, fully extendable, heavy duty.

d. Pilaster Strips and Shelf Brackets: Brushed metal, recessed.

e. Locks: Cam style, keyed same for all Work.

.3 Adhesives: Waterproof resin type except for plastic laminate which shall be recommended by plastic laminate manufacturer, all conforming to CSA 0112 Series – M and in conformance with The South Coast Rule #1168 VOC limits for adhesives (www.aqmd.gov).

2.2 FABRICATION

.1 Provide backing sheet on all plastic laminate work. Plastic laminate surfaces shall be free of core ghosting. Adjacent sheets of plastic laminate on finished work shall be matched in colour with seam inconspicuous. Do not use more than one sheet when a sheet size is available that will cover required area. Precision camber outside corners between finished surfaces.

.2 Make all joints tight, flush, level and plumb.

.3 No exposed fasteners on exterior surfaces of melamine panels in finished (installed) condition. Assemble melamine millwork using doweled/wafered-and-glued construction unless otherwise specified.

.4 Make provisions for electrical, gas and water services and outlets and provide concealment of service lines in the work except where service connections must be exposed.

.5 Seal edges of cut-outs in countertops with two coats of varnish.

.6 Install hardware. Install all pulls horizontally or as shown otherwise on Drawings.

.7 Ship all work fully assembled as far as practicable. Otherwise fabricate for site assembly and provide Section 06 20 00 with instructions to assemble on Site.

.8 Protect all work with wrappings of cardboard or heavy kraft paper as is necessary to protect shipped work.

.9 Replace, rework and/or refinish Work that does not meet specified AWMAC AWS Standards Latest Edition, at no additional cost to the Owner, and to the approval of AWMAC's independent Inspector.

PART 3 EXECUTION

3.1 INSTALLATION

.1 Install Work to AWMAC Standards.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Instructions.

1.2 DESCRIPTION

.1 Work Included: Provide air and vapour barrier membranes for the Work.

.2 Related Work Specified Elsewhere:

a. Sheathing: Section 06 10 00

b. Insulation: Section 07 20 00

1.3 REFERENCE STANDARDS

.1 ASTM International:

a. ASTM D1204-[2008], Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.

b. ASTM D3330-[2010], Standard Test Method for Peel Adhesion of Pressure-Sensitive Tape.

c. ASTM D5034-09, Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).

d. ASTM E84-[2010b], Standard Test Method for Surface Burning Characteristics of Building Materials.

e. ASTM E96/96M-[2010], Standard Test Methods for Water Vapor Transmission of Materials.

f. ASTM E154-[2008a], Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.

g. ASTM E2178-[2003], Standard Test Method for Air Permeance of Building Materials.

1.4 QUALITY ASSURANCE

.1 Mock-up: Construct full size 3 m x 3 m mock-up of wall showing barriers using proposed procedures, materials and quality of work where directed by Consultant:

a. Include examples of window frame, door frame, interior corner, exterior corner and common protrusions or penetrations of barrier membrane.

b. Provide Consultant 24 hours notice for inspection of mock-up.

c. Do not proceed with subsequent work without written receipt of acceptance of mock-up by Consultant.

d. Approved mock-up may remain part of finished work.

Apply membrane system at ambient temperatures satisfactory to the manufacturer and under dry conditions. Obtain Architect's approval before installing membrane at temperature below 4°C or under cool and windy conditions.

.2 Protection of Finished Work: Co-ordinate manufacturer's recommended limit for exposure of completed membrane system with Work of other Sections.

1.5 SUBMITTALS

.1 Samples: Submit 300 mm x 300 mm samples of membrane upon request.

PART 2 PRODUCTS

2.1 MATERIALS

.1 Air Barrier: Blueskin SA vapour impermeable by Bakor Henry Inc. or equal by Dorken Systems Inc., Grace, WR Meadows, all to CGSB 71-GP-24M.

.2 Vapour Retarder:

a. At walls, decks: Translucent Polyethylene film conforming to CAN/CGSB-51.34-M86, 10 mil thickness.

b. Under slabs on grade: Conform to ASTM E 1745, Classes A, B and C, Perminator, 15 mil by W.R. Meadows Inc., or equal WVT rating of 0.011 grains/sq.ft./hr with perm rating of 0.027 Perms. Provide manufacturer's approved tape at joints.

.3 Related Materials: Provide the membrane manufacturer's following:

a. Primers, Substrate Cleaners and Surface Conditioners.

b. Adhesives and Lap Cements.

c. Tapes.

d. Flashing and Transition membranes.

e. Mastic and Sealants.

PART 3 EXECUTION

3.1 SUBSTRATE PREPARATION

.1 Prior to the installation, inspect areas to receive membrane system to ensure they are clean, dry, sound, smooth, continuous and suitable for installation to manufacturer's recommendations.

3.2 PRIMING, SURFACE CONDITIONING

.1 Prime all surfaces according to manufacturer's recommendations.

.2 Reprime surfaces not covered in the same working day.

3.3 AIR AND VAPOUR BARRIER APPLICATION

.1 Apply components of air and vapour barrier systems according to manufacturer's recommendations.

.2 Apply a continuous and unbroken air barrier to outside face of exterior walls as indicated on the Drawings. Ensure continuity of air barrier at all control joints and penetrations.

.3 Provide a continuous air barrier from damp course at top of foundation wall to roof membrane at flat roof. Provide continuous buffer between membrane roofing and air barrier to ensure no contact, as indicated on Drawings.

.4 Carry air and vapour barriers into window and door openings and terminate in a neat straight line.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

.1 Section Includes: Cold-applied, Styrene-butadiene-styrene (SBS) modified bituminous membrane roofing system on metal deck, including but not limited to:

a. Self-adhered air vapour control membrane.

b. Polyisocyanurate roof insulation, fully adhered in Low Rise Foam. Thickness to be confirmed by Roofing Contractor.

c. 0.5 inch (12.7 mm) asphalt impregnated fiberboard fully adhered in Low Rise Foam.

d. 2 ply modified bitumen membrane and flashings adhered in Cold Adhesive.

e. Walkway material.

.2 Tested Roofing Assembly Compliance:

a. Fire Classification as tested to CAN/ULC-S107 Fire Test of Roof Coverings:

1. Exterior Fire: Class A.

b. Daily manufacturer’s inspection is required unless otherwise approved by owner.

1.2 PREINSTALLATION MEETINGS

.1 Preinstallation Roofing Conference: Conduct conference at Project site.

a. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.

b. Review drawings and specifications.

c. Review methods and procedures related to roofing installation, including manufacturer's written instructions.

d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

e. Examine substrate conditions and finishes for compliance with requirements, including flatness and fastening.

f. Review structural loading limitations of roof deck during and after roofing.

g. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.

h. Review governing regulations and requirements for insurance and certificates if applicable.

i. Review temporary protection requirements for roofing system during and after installation.

j. Review roof observation and repair procedures after roofing installation.

1.3 ACTION SUBMITTALS

.1 Product Data: For each type of product indicated.

.2 Product Data Test Reports: For membrane, adhesives and sealants, indicating compliance with requirements for low-VOC/low-emitting materials.

.3 Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work. Provide roof plan showing orientation and types of roof deck, orientation of membrane roofing, and fastening spacings and patterns for mechanically fastened components.

a. Base flashings and built-up terminations.

b. Indicate details meet requirements of this Section.

c. Crickets, saddles, and tapered edge strips, including slopes.

d. Membrane adhesion requirements.

.4 Samples for Verification: For the following products:

a. Sheet roofing materials, of colour specified for exposed material.

b. Metal termination bars.

c. Walkway materials.

1.4 INFORMATIONAL SUBMITTALS

.1 Contractor's Product Certificate: Submit notarized certificate, indicating products intended for Work of this Section, including product names and numbers and manufacturers' names, with statement indicating that products to be provided meet the requirements of the Contract Documents.

.2 Qualification Data: For Installer, Manufacturer, and Roofing Inspector.

a. Include letter from Manufacturer written for this Project indicating approval of Installer.

.3 Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

.4 Product Compatibility: Indicate manufacturer has verified compatibility of roofing system components, including but not limited to: Roofing membrane, flashing sheets, adhesives and sealants.

.5 Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of built-up roofing.

.6 Warranties: Unexecuted sample copies of special warranties.

.7 Field Quality Control Reports: Reports of Roofing Inspector. Include weather conditions, description of work performed, tests performed, defective work observed, and corrective actions required and carried out.

a. Submit reports within 48 hours after inspection.

1.5 CLOSEOUT SUBMITTALS

.1 Maintenance Data: To include in maintenance manuals.

.2 Warranties: Executed copies of warranties.

1.6 QUALITY ASSURANCE

.1 Installer Qualifications: An employer of workers trained and certified by manufacturer, including a full-time on-site supervisor with a minimum of five years' experience installing products comparable to those specified, able to communicate verbally with Contractor, Architect, and employees, and qualified by the manufacturer to install manufacturer's product and furnish warranty of type specified.

.2 Manufacturer Qualifications: Approved manufacturer with CAN/ULC-S107 listed and UL listed roofing systems comparable to those specified for this Project, with minimum five years' experience in manufacture of comparable products in successful use in similar applications, and able to furnish warranty with provisions matching specified requirements.

.3 Roofing Inspector Qualifications: A technical representative of manufacturer not engaged in the sale of products and experienced in the installation and maintenance of the specified roofing system, qualified to perform roofing observation and inspection specified in Field Quality Control Article, to determine Installer's compliance with the requirements of this Project, and approved by the manufacturer to issue warranty certification. The Roofing Inspector shall be one of the following:

a. An authorized full-time technical employee of the manufacturer.

.4 Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

.2 Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

.3 Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

.4 Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

.5 Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.8 PROJECT / FIELD CONDITIONS

.1 Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

.2 Daily Protection: Coordinate installation of roofing so insulation and other components of roofing system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

a. Provide tie-ins at end of each day's work to cover exposed roofing and insulation with a course of roofing sheet securely in place with joints and edges sealed.

b. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing.

c. Remove temporary plugs from roof drains at end of each day.

d. Remove and discard temporary seals before beginning work on adjoining roofing.

1.9 WARRANTY

.1 Installer Warranty: Installer's warranty signed by Installer, as follows.

a. Form of Warranty: Form acceptable to Roofing Manufacturer and Owner.

b. Scope of Warranty: Work of this Section.

c. Warranty Period: 2 years from date of completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

.1 Basis of Design: The roof system specified in this Section is based upon products of Tremco, Inc., Toronto, ON, (800) 562-2728, www.tremcoroofing.com that are named in other Part 2 articles. Provide specified products.

a. Contact your local Manufacturer's Design Professional Rep or Sales Rep to confirm availability and Installation Procedures.

.2 Source Limitations: Obtain components for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer.

2.2 PERFORMANCE REQUIREMENTS

.1 General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.

.2 Ontario Building Code Compliance: Roofing system shall comply with local codes and bylaw requirements and shall be certified by a third-party testing agency. Provide documentation from Manufacturer confirming Fire and Wind Test results.

a. Fire Classification as tested to CAN/ULC-S107 Fire Test of Roof Coverings:

1. Exterior Fire: Class A.

.3 Flashings and Fastening: Provide base flashings, perimeter flashings, detail flashings and component materials and installation techniques that comply with requirements and recommendations of the following:

a. NRCA Roofing Manual (Sixth Edition) for construction details and recommendations.

b. SMACNA Architectural Sheet Metal Manual (Seventh Edition) for construction details.

c. Comply with requirements of Division 07 Section “Sheet Metal Flashing and Trim”.

2.3 MATERIALS, GENERAL

.1 Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

2.4 ROOFING MEMBRANE MATERIALS

.1 SBS Modified Bituminous Membrane Smooth-Surfaced Sheets:

a. Nonperforated, asphalt coated, fiberglass/polyester reinforced sheet dusted with fine mineral surfacing on both sides, ASTM D4601 Type II.

b. Basis of design product: Tremco, Burmastic Composite Ply HT.

c. Tensile Strength, minimum, ASTM D5147: Machine direction, 28.9 kN/m (165 lbf/in): cross machine direction 26.3 kN/m (150 lbf/in).

d. Tear Strength, minimum, ASTM D145: machine direction, 0.9 kN (210 lbf); cross machine direction, 0.8 kN (185 lbf).

e. Elongation at 25 deg. C (77 deg. F), minimum, ASTM D5147: Machine direction 6 percent; Cross machine direction 6 percent.

f. Thickness, minimum, ASTM D5147: 1.4 mm (0.055 inch).

.2 SBS Modified Bituminous Membrane Granular-Surfaced Cap Sheet:

a. SBS/RET/Urethane-modified asphalt-coated polyester-reinforced sheet, white granular surfaced, fire-resistant, ASTM D6164 Type II Grade G.

b. Basis of design product: Tremco, POWERply Endure 200 FR.

c. Tensile Strength at 25 deg. C (77 deg. F), minimum, ASTM D5147: Machine direction 22 kN/m (130 lbf/in); Cross machine direction 19 kN/m (110 lbf/in).

d. Tear Strength at 25 deg. C (77 deg. F), minimum, ASTM D5147: Machine direction, 710 N (160 lbf); Cross machine direction 620 N (140 lbf).

e. Elongation at 25 deg. C (77 deg. F), minimum, ASTM D5147: Machine direction 55 percent; Cross machine direction 60 percent.

f. Low Temperature Flex, maximum, ASTM D5147: -40 deg. C (-40 deg. F).

g. Thickness, minimum, ASTM D5147: 3.8 mm (0.150 inch).

.3 Flashing Sheet:

a. Flashing Sheet: Same as base sheet and cap sheet.

b. Basis of design product: Flashing Sheet: Same as base sheet and cap sheet.

2.5 COLD-APPLIED ADHESIVE MATERIALS

.1 General: Adhesive and sealant materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.

.2 Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

.3 Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Other Adhesives: 250 g/L.
d. Nonmembrane Roof Sealants: 300 g/L.
e. Sealant Primers for Nonporous Substrates: 250 g/L.
f. Sealant Primers for Porous Substrates: 775 g/L.

.4 Roofing Membrane Adhesive:

a. Cold-applied bio-based low odor urethane roofing adhesive, two-part, formulated for compatibility and use with specified roofing membranes and flashings.
b. Basis of design product: Tremco, POWERply Endure BIO Adhesive TF.
c. Volatile Organic Compounds (VOC), maximum, ASTM D3690: 0 g/L.
d. Low Temperature Flexibility, ASTM D2240: Pass at -34 deg C (-30 deg F).
e. Solids, by Volume, ASTM D2697: 100 percent.
f. Biobase Content, Minimum, ASTM D6866: 70 percent.

.5 Cap Flashing Sheet and Flashing Backer Adhesive:

a. Bonding and Flashing Adhesive, SEBS/SIS modified asphalt, for elastomeric flashing membranes.
b. Basis of design product: Tremco, Sheeting Bond.
c. VOC, maximum, ASTM D3960: 250 g/L.
d. Adhesion in peel, minimum, ASTM D1876: 0.5 N/mm (3 lbf/in).
e. Lap shear adhesion, minimum, ASTM D816: 124 kPa (18 psi).
f. Color: White.

.6 Asphalt Primer:

a. Asphalt primer, water-based, polymer modified.
b. Basis of design product: Tremco, TREMprime WB.
c. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 2 g/L.
d. Colour: Brown/black.

2.6 AUXILIARY ROOFING MATERIALS

.1 General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.

.2 Joint Sealant: Elastomeric joint sealant compatible with roofing materials, with movement capability appropriate for application.

.3 Joint Sealant, Polyurethane: ASTM C920, Type S, Grade NS, Class 50 single-component moisture curing sealant, formulated for compatibility and use in dynamic and static joints; paintable.

a. Basis of design product: Tremco, TremSEAL Pro.
b. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 40 g/L.
c. Hardness, Shore A, ASTM C661: 40.
d. Adhesion to Concrete, ASTM C794: 35 pli.
e. Tensile Strength, ASTM D412: 2410 kPa (350 psi).
f. Colour: Closest match to substrate.

.4 Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roofing components to substrate, tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.

.5 Metal Flashing Sheet: Metal flashing sheet is specified in Division 07 Section “Sheet Metal Flashing and Trim.”

.6 Miscellaneous Accessories: Provide miscellaneous accessories recommended by roofing system manufacturer.

2.7 VAPOUR RETARDER

.1 Vapour Retarder Membrane:

a. Self-Adhering Sheet: 40 mil- (1.0 mm-) thick polyethylene film laminated to layer of SBS rubberized asphalt adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); with slip-resisting surface and release-paper backing. Provide primer when recommended by vapour-retarder manufacturer.
b. Basis of design product: Tremco, AVC Membrane.
c. Permeance, maximum, ASTM E 96: 0.05 perms.
d. Tensile Strength, minimum, ASTM D2523: 4.3 kN/m (25 lbf/in).
e. Elongation, minimum, ASTM D412: 250 percent.
f. Low Temperature Flexibility, ASTM D1970: Unaffected, -32 deg. C.
g. Adhesion to Plywood, ASTM D903: 1.05 kN/m (6 lbf/in).

.2 Vapour Retarder Primer:

a. Asphalt primer, water-based, polymer modified.

b. Basis of design product: Tremco, AVC Primer WB.

2.8 ROOF INSULATION MATERIALS

.1 Roof Insulation, General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated.

a. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated, not less than two times the roof slope.

.2 Roof Insulation:

a. Board Insulation, Polyisocyanurate: CFC- and HCFC- free, with recycled content fiber reinforced mat facer on both major surfaces, ASTM C1289 Type II Class.

b. Compressive Strength, ASTM D1621: Grade 2: 138 kPa (20 psi).

c. Conditioned Thermal Resistance at 24 deg. C (75 deg. F): 50.8 mm (14.4 at 2.5 inches) thick.

d. Thickness: To match existing. Contractor to confirm thickness.

2.9 ROOF INSULATION ACCESSORIES

.1 Insulation Cover Board:

a. Board Insulation, Cellulosic-fiber: With water-resistant binders, non-asphaltic primer coated on four sides and chemically treated for deterioration, ASTM C208, Type II, Grades 1 and 2.

b. Compressive strength, ASTM C165: 15 lbf/sq. in.

c. Thermal resistance at 75 deg. F (24 deg C.) ASTM C518: R 1.3.

d. Recycled content, pre-consumer: 20 percent.

e. Rapidly renewable content: 6 percent.

f. Thickness: 1/2 inch (13 mm).

.2 Insulation and Cover Board Adhesive:

a. Urethane adhesive, bead-applied, low-rise two-component solvent-free low odour, formulated to adhere roof insulation to substrate.

b. Basis of design product: Tremco, Low Rise Foam Insulation Adhesive.

c. Flame Spread Index, ASTM E84: 10.

d. Smoke Developed Index, ASTM E84: 30.
e. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 0 g/L.
f. Tensile Strength, minimum, ASTM D412: 1720 kPa (250 psi).
g. Peel Adhesion, minimum, ASTM D903: 2.50 kN/m (17 lbf/in).
h. Flexibility, 39 deg. C (70 deg. F), ASTM D816: Pass.

.3 Insulation Cant Strips: ASTM C208, Type II, Grade 1, cellulosic-fiber insulation board.

.4 Substrate Joint Tape: 150- or 200-mm- (6- or 8-inch-) wide, coated, glass fiber.

2.10 WALKWAYS

.1 Walkway Material:
a. Roof Pavers: Refer to Division 07 Section “Roof Pavers.”

PART 3 EXECUTION

3.1 EXAMINATION

.1 Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
a. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
b. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
c. Existing Prepared Roof Substrate: Verify that existing insulation and substrate is sound and dry. Refer to requirements of Division 07 Section “Preparation for Re-Roofing.”
d. Steel Roof Deck:
1. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1.6 mm (1/16 inch) out of plane relative to adjoining deck.
2. Verify that substrate is sound and dry.

.2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

.1 Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

.2 Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.3 INSTALLATION, GENERAL

.1 Install roofing system in accordance with manufacturer's written instructions, approved shop drawings, and Contract Documents.

.2 Install wood cants, blocking, curbs, and nailers in accordance with requirements of Division 06 Section "Miscellaneous Rough Carpentry."

.3 Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.4 VAPOUR RETARDER INSTALLATION

.1 Vapour Retarder Installation, General: Completely seal vapour retarder/air barrier at terminations, obstructions, and penetrations to prevent air movement into roofing system. Seal vapour retarder/air barrier to air barrier in adjacent construction at perimeter of roofing system.

.2 Self-Adhering Sheet Vapour Retarder: Install self-adhering sheet vapour retarder over area to receive vapour retarder, side and end lapping each sheet a minimum of 90 mm and 150 mm (3-1/2 inches and 6 inches), respectively. Seal laps by rolling.

3.5 INSULATION INSTALLATION

.1 Comply with roofing manufacturer's written instructions for installing roof insulation.

.2 Coordinate installing membrane roofing system components, so insulation is not exposed to precipitation or left exposed at the end of the workday.

.3 Cant Strips: Install and secure preformed 45-degree cant strips at junctures of built-up roofing with vertical surfaces or angle changes greater than 45 degrees.

.4 Tapered Insulation and Crickets: Install tapered insulation under area of roofing to conform to slopes indicated.

a. Where crickets are indicated or required to provide positive slope to drain, make slope of crickets minimum of two times the roof slope, not less than 1:48 (1/4 inch in 12 inches).

.5 Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 6 mm (1/4 inch) with insulation.

.6 Cut and fit insulation within 6 mm (1/4 inch) of nailers, projections, and penetrations.

.7 Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

.8 Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.

.9 Fully Adhered Insulation Application Method: Install each layer of insulation and secure to deck using low rise foam specifically designed for adhering specified board-type roof insulation to deck type.

a. Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining cover in place. 6 inch o.c.

.10 Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 150 mm (6 inches) in each direction. Loosely butt cover boards together. Tape joints if required by roofing manufacturer.

.11 Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining cover in place. 6 inch o.c.

3.6 COLD-APPLIED ROOFING MEMBRANE INSTALLATION, GENERAL

.1 Install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in NRCA's “Quality Control and Quality-Assurance Guidelines for the Application of Membrane Roofing” and as follows:

a. Number of Trilaminate Mineral Surfaced Sheets: One.

b. Adhering Method: Cold-adhesive applied.

c. Granular-Surfaced SBS-Modified Asphalt Cap Sheet:

1. Adhering Method: Cold-adhesive applied.

.2 Start installation of roofing membrane in presence of roofing system manufacturer's technical personnel.

.3 Cooperate with testing agencies engaged or required to perform services for installing roofing system.

.4 Coordinate installation of roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

.5 Provide tie-offs at end of each day's work configured as recommended by NRCA Roofing Manual Appendix: Quality Control Guidelines - Insulation to protect new roofing.

.6 Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing.

.7 Remove temporary plugs from roof drains at end of each day.

.8 Remove and discard temporary seals before beginning work on adjoining roofing.

.9 Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.7 SBS-MODIFIED BITUMINOUS MEMBRANE INSTALLATION

.1 Install modified bituminous roofing membrane base-ply sheet and cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants, installing as follows:

a. Unroll roofing membrane sheets and allow them to relax for minimum time period required by manufacturer.

b. Embed each sheet in cold-applied membrane adhesive applied at rate required by roofing manufacturer.

c. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Install roofing membrane sheets so side and end laps shed water. Completely bond and seal laps, leaving no voids.

d. Repair tears and voids in laps and lapped seams not completely sealed.

e. Granular Cap Sheet Laps: Apply roofing granules to cover exuded bead at laps.

3.8 HEAT-WELDING CAP SHEET SEAMS

.1 Cap Sheet Seam Heat-Welding: Prepare and weld seams according to roofing manufacturer's written instructions.

a. Clean minimum 102 mm (4 inch) wide seam area on both surfaces to be joined. Remove debris and contaminants. Allow seam to thoroughly dry prior to performing welding.

b. Continuously weld 102 mm (4 inch) wide seam using roofing manufacturer's recommended automatic heat welding machine or hand-held heat gun. Roll seam with minimum 34 kg (75 lb.) steel roller.

3.9 FLASHING AND STRIPPING INSTALLATION

.1 Base Flashing Installation, General: Install base flashing over cant strips and other sloped and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates according to roofing system manufacturer's written instructions, and as follows:

a. Extend base flashing up walls or parapets a minimum of 300 mm (12 inches) above modified bituminous roofing and 150 mm (6 inches) onto field of built-up roofing.

b. Prime substrates with primer if required by roofing system manufacturer.

.2 Backer Sheet Installation: Apply backer sheet to substrate as follows:

a. Mechanically fasten backer sheet to vertical surfaces. Adhere backer sheet over modified bituminous roofing at cants in cold-applied flashing sheet adhesive.

b. Adhere backer sheet to substrate in cold-applied flashing sheet adhesive.

.3 Cap Flashing Sheet Installation: Adhere flashing sheet to backer sheet in cold-applied adhesive. Apply cold-applied flashing sheet adhesive to back of flashing sheet if recommended by roofing manufacturer.

.4 Flashing Sheet Top Termination: Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.

a. Seal top termination of base flashing with a metal termination bar and a continuous bead of joint sealant.

.5 Flashing Sheet Bottom Termination: Adhere flashing sheet to roofing membrane in continuous bed of cold-applied adhesive.

a. Bituminous Flashing: Seal bottom termination of base flashing by adhering to roofing membrane and stripping flashing to membrane joint.

b. Cap Sheet Flashing: Heat weld vertical flashing joints. Seal bottom termination of base flashing by adhering to roofing membrane with cold-applied adhesive and sealing flashing-to-membrane joint with joint sealant.

.6 Install roofing membrane cap-sheet stripping where metal flanges and edgings are set on membrane roofing according to roofing system manufacturer's written instructions.

.7 Install stripping, according to roofing manufacturer's written instructions, where metal flanges and edgings are set on modified bituminous membrane roofing.

.8 Flashing-Sheet Stripping: Install flashing-sheet stripping in a continuous coating of compatible mastic/adhesive sealer, as recommended by roofing manufacturer, and extend onto roofing membrane. Apply number of courses recommended by manufacturer.

3.10 WALKWAY INSTALLATION

.1 Walkways, General: Install walkways according to roofing manufacturer's written instructions.

.2 Install walkways at following locations:

a. Where indicated on Drawings.

b. Perimeter of each rooftop unit.

c. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.

d. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.

e. Top and bottom of each roof access ladder.

f. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.

.3 Roof-Paver Walkways: Refer to Division 07 Section “Roof Pavers.”

3.11 FIELD QUALITY CONTROL

.1 Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation at commencement and upon completion.

a. Notify Architect and Owner 48 hours in advance of date and time of inspection.

.2 Repair or remove and replace components of built-up roofing where test results or inspections indicate that they do not comply with specified requirements.

.3 Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.12 PROTECTING AND CLEANING

.1 Protect roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

.2 Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

.3 Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL INSTRUCTIONS

.1 Conform to Division 01, General Requirements.

1.2 SECTION INCLUDES

.1 Work Included: Provide firestopping and smoke seals for the Work.

1.3 REFERENCES

.1 NFPA 101-00 – Life Safety Code.

.2 CAN/ULC S101-M89 – Standard Methods of Fire Endurance Tests of Building Construction and Materials.

.3 CAN/ULC S102-M88 – Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.4 ULC-S115-95 – Standard Method of Fire Tests of Firestop Systems.

.5 ULC Guide No. 40U19 – Firestop Systems.

.6 ULC Guide No. 40U19.13 – Firestop Systems Components.

.7 UL – Underwriters Laboratories of Northbrook, IL (UL tests conforming to ULC-S115 given cUL listing published by UL in their Products Certified for Canada (cUL) Directory).

1.4 SUBMITTALS

.1 Submit manufacturer’s specifications and technical data for each material including compositions, limitations, documentation conforming ULC and/or UL firestop system and manufacturers’ installation instructions.

.2 Submit fireproofing manufacturer's written verification that manufacturers have identified where firestopping is required, have selected correct firestop system and applicators have been trained by system manufacturers. Products, systems and assemblies have been installed in accordance with manufacturer's requirements.

.3 Submit manufacturer's verification that installed firestopping and smoke seal materials comply with specified requirements.

.4 Submit copies of ULC, Warnock Hersey and/or cUL Listing cards for review.

1.5 WARRANTY

.1 Warrant work of this Section against defects and deficiencies for period of five (5) years in accordance with General Conditions of the Contract. Promptly correct any defects or deficiencies which become apparent within warranty period, to satisfaction of Consultant and at no additional expense to Owner. Defects include but are not limited to cracking, breakdown of bond, failure to stay in place or bleeding.

PART 2 PRODUCTS

2.1 MANUFACTURERS

.1 Products of following manufacturers are acceptable subject to conformance to requirements of Drawings, Schedules and specifications:

a. A/D Fire Protection Systems Inc.; www.adfire.com
b. Canadian General Electric Company Limited; www.gesilicones.com
c. Electrical Products Division/3M; www.3m.com
d. Grace Construction Products; www.graceconstruction.com
e. Instant Firestop Inc.
f. Hilti (Canada) Limited; www.ca.hilti.com
g. Johns Manville, Fire Protection Systems; www.jm.com
h. M.W. McGill and Associates Ltd.
i. Nelson Firestop Products.
j. ThermoFire Systems Inc.
k. Thomas & Betts Ltd.
l. Tremco (Canada) Limited; www.tremcosealants.com

2.2 MATERIALS

.1 Firestopping System 1 (JF Systems):

a. This Firestopping System is primarily an expansion, control and perimeter seal without smoke resistance, and shall be non-combustible, semi-rigid, felt fire protection, 65 kg/m3 minimum density, depth, length and required width. Certified assembly of 1 of listed manufacturers and acceptable to Consultant. Provide sealant of spray firestopping over mineral wool.
b. Blanket type firestopping shall be listed and labelled in accordance with ULC Guide No. 40-U19 or 40-U19.13, with reference to 'JF System Listings'.

c. Where required by listing, impaling clips shall be heavy gauge galvanized wire or 25 mm wide x 0.607 mm (24 ga) galvanized steel, Z formed with horizontal bottom and dimensions conforming to location of firestopping and width of void to be filled. Ensure compression of joint do not damage clips.

.2 Firestopping System 2: Same materials as in System 1, but without use of impaling clips and with smoke and fluid seal with hose stream resistance. Certified assembly of 1 of listed manufacturers and acceptable to Consultant.

.3 Firestopping System 3: Fire, gas, fluid and hose stream resistant elastomeric sealant with movement capabilities, ULC labeled assembly of 1 of listed manufacturers and acceptable to Consultant. Materials shall have elastic characteristics where used at openings subject to movement. Intumescent pads may form part of this system, at Contractor's option.

.4 Firestopping System 4: Firestopping, gas, fluid and hose stream resistant seals at openings intended for ease of re-entry such as cables shall be an elastomeric seal or proprietary assembly of following types; a cementitious or rigid seal at such locations is not permitted. Certified assembly of 1 of listed manufacturers and acceptable to Consultant.

.5 Firestopping System 4-A: Where openings are considered large such as at cable trays and bus ducts. Certified assembly of 1 of listed manufacturers and acceptable to Consultant.

.6 Firestopping System 5 (Cavity Wall Compartment Closer and Firestopping): Strips of "RXL Safe" semi-rigid mineral fibre insulation by Roxul Inc. 75 mm wide by depth of cavity plus 13 mm with galvanized skewers for securement at 300 mm o.c., or compressed 25% to fill depth of cavity.

.7 Firestopping System 6 (Electrical Outlet Boxes): Premolded red putty CP 617 by Hilti or equal.

.8 Primers: To manufacturer's recommendations for specific material, substrate and end use.

.9 Damming and Backup Materials, Supports and Anchoring Devices: Non-combustible, to manufacturer's recommendations in accordance with tested assembly being installed and as acceptable to authorities having jurisdiction. Sheet steel covers over temporarily unused sleeves in tenant and similar spaces shall be minimum 0.912 mm (20 ga) thick galvanized sheet steel formed to a tight fit over opening with specified firestopping materials installed beneath. Combustible materials are acceptable only if they are approved under ULC or UL systems, otherwise they should be removed after permanent firestop materials have cured.

.10 Pipe and Duct Insulation and Wrappings Compatible with Firestopping Systems: "Nelson WRP" by Nelson Electric Ltd. for use with Nelson Electric Ltd. firestops and "Instant Type PI" by Instant Firestop Inc. for use with Instant Firestop Inc. firestops; or "TREMstop WS" by Tremco Canada Limited.

.11 Intumescent Pads: “AFSP 1077” by Grace Construction Products or “FSP Pads” by Nelson Electric, or “Instant Putty 200” by Instant Firestop Inc., or “Type PLW Firestop Pillow” by Electrovert Ltd.

.12 Re-Entry Pillows: Permanently pliable, “AFSPIL Pillows” by Grace Construction Products or “Type PLW Firestop Pillow” by Electrovert; or “PLW” by Nelson Electric; or “TREMstop PS” by Tremco Canada Limited.

PART 3 EXECUTION

3.1 PREPARATION

.1 Fully protect walls, windows, floors and other surfaces around areas to be firestopped from marring or damage. Mask where necessary to avoid spillage on to adjoining surfaces. Mask areas adjacent to openings, where necessary to prevent contamination or marring of adjacent surface materials. Remove masking after seal has been completed and an initial set has been achieved. Remove stains on adjacent surfaces as required.

.2 Provide primer or surface conditioner if required by Product manufacturer. Prime surfaces in accordance with manufacturer's directions.

.3 Verify openings, dimensions and surfaces conform to fire and smoke seal assembly.

.4 Comply with manufacturer's recommended requirements for temperature, relative humidity, moisture content and presence of any sealer or release agents on substrate during application and curing of materials. Ensure surfaces are dry and frost free.

.5 Remove combustible material and loose material detrimental to bond from edges of penetration. Clean, prime or otherwise prepare substrate material to manufacturer's recommendation.

.6 Remove insulation from insulated pipe and duct where such pipes or ducts penetrate a fire separation unless ULC certified assembly permits such insulation to remain within assembly, or where mechanical trades have installed special fire rated insulated sleeves. Ensure continuity of thermal and vapour barriers where such are removed, altered or replaced, to satisfaction of Division 21, 22, 23 and Consultant.

.7 Alternatively, ensure pipe and duct insulation and wrappings occurring within openings to receive firestopping and smoke seals under this Section are installed prior to work of this Section and insulation and wrappings within fire seals are ULC listed components of system to be installed under this Section, unless ULC certified assembly permits such other insulation and wrappings to remain within assembly. Coordinate work of this Section with Division 21, 22 and 23.

.8 Do not apply firestop material to surfaces previously painted or treated with sealer, curing compound, water repellent to other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.

.9 Provide temporary forming, packing and bracing materials necessary to contain firestopping. Upon completion, remove forming and damming materials not required to remain as part of system.

.10 Install damming and firestopping materials as per manufacturer's instructions.

.11 Examine sizes of penetrating service and sleeve or opening sizes with exact annular space calculations, anticipated movement and all conditions necessary to establish correct type, thickness and installation of back-up materials and seals.

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

3.2 INSTALLATION

.1 Mix and apply firestopping and smoke seals in accordance with manufacturer's instructions and tested designs to provide required fire (temperature and flame) rated seal, to prevent passage of smoke and where specifically designated, passage of fluids.

.2 Provide temporary forming and packing as required. Apply materials with sufficient pressure to properly fill and consolidate mass to seal openings.

.3 Tool or trowel exposed surfaces. Allow materials to cure by not covering up materials until full curing has taken place.

.4 Where a designated system described hereinafter does not meet Code requirements for particular service condition, substitute with next higher system meeting required rating.

.5 Notify Consultant when completed installations are ready for inspection and prior to concealing or enclosing firestopping and smoke seals.

.6 System 1:

a. Install fire rated joint firestopping by compressing material minimum of 25% to ensure complete sealing and to follow irregularities of concrete slabs at perimeter of building where junction occurs with back of cladding system. Apply firestopping sealant of spray over compressed mineral wool.

b. Butt succeeding sections of firestopping material tightly up against preceding. Leave no voids.

c. Provide firestopping between exterior wall cladding and concrete floor slab. Secure and support to suit design requirements.

d. Use this System for joint seals through fire-resistance rated floor slabs, ceilings and roofs unless otherwise stipulated.

.7 System 2:

a. At fire-rated masonry walls and gypsum board partitions which extend nominally to within 19 mm (3/4") of underside of deck above, insert fire rated joint assembly firestopping material in 25% compression in accordance with ULC test requirements and manufacturer's instructions. Provide adequate depth of material to fill gap flush with face of wall, except as otherwise specified. Apply firestopping sealant of spray over compressed mineral wool.

b. Insert at intersection of fire-resistance rated masonry and gypsum board partitions.

c. Insert at both sides of control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.

d. Where wall/slab junction is exposed in finished work, keep fibre back 9 mm (3/8") from face of block and apply fire-resistant sealant to gap, tooling to a concave joint.

e. At perimeter slab locations where this system would otherwise be exposed in finished work and where smoke seal is required, provide cover spray material of thickness as recommended by manufacturer of System 3 material set flush with top of slab and tooled smooth. Minimum cover spray thickness 3 mm (1/8"). Where anticipated movement in joint width is inevitable, select sealant with elastic capabilities.

.8 System 3:

a. This System establishes fire rated firestopping for service penetrations throughout the Project. Seal gaps and holes in fire-rated walls and slabs and composite construction through which conduit, wire, cables, ductwork, piping and all other protrusions pass as a result of work using fire-resistant penetration sealant. Include openings which have been formed, sleeved and cored.

b. Apply at unpenetrated openings and sleeves installed for future use through fire-resistance rated assemblies.

c. Apply this System between spaces having different air pressures. (See Mechanical Drawings for pressurized areas and locations of moving penetrants.)

d. Apply at “wet” rooms supported by suspended slabs at locations over Electrical and Equipment Rooms or similar areas containing power devices in which future re-entry is not required.

e. Apply at Mechanical Rooms and similar rooms having systems containing liquids, including piping runs, unless such rooms are located over slab-on-grade.

f. Install System 3 materials at elevator shafts, duct shafts and other similar locations over occupied spaces.

g. Install 6 mm to 9 mm (1/4" to 3/8") bead of firestop caulking at interface of retaining angles around fire dampers, where angles meet fire-rated assembly and between retaining angles and fire damper, both sides of penetration. At floor locations, sealant bead at top of assembly is adequate.

h. Where necessary, remove insulation from insulated pipe and duct where such services penetrate a fire separation unless certified assembly permits such insulation to remain within assembly. Apply wrapping materials as listed herein.

i. Install System 3 materials at open wall joints, including expansion joints between fire rated enclosures and assemblies.

.9 Systems 4 and 4A: Install at following locations:

a. At Electrical, Electrical Switchgear, Electrical Transformer Rooms and at Telephone Equipment Rooms requiring re-entry for additional services.

b. Install at communications and computer cable penetration points throughout.

c. Accessories: At hollow fire-rated walls, apply intumescent pads to back surfaces and cable entry points of electrical boxes, panels and other service penetration points, ensuring close coordination with electrical, mechanical and drywall trades. Where greater dimension of panel exceeds 500 mm (20"), gypsum board trades construct fire-rated enclosure around recessed panels.

.10 System 5: Maintain maximum cavity wall compartments to lesser of following 2 criteria by bridging gap between cavity back-up material and back face of brick with full-depth strips of compartment closer and firestopping material, securing in position with mechanical fasteners and sealing against firm, primary cavity materials:

a. 10 m2 (100 sq ft).

b. Paragraph 3.1.11 of OBC.

.11 System 6: Ensure box is cleaned of loose debris, dirt, oil, moisture, frost and wax. Remove label from one side of pad and place against box. Wrap pad around box and adhere to all exposed exterior sides of box.

3.3 INSPECTION AND TESTING

.1 Perform a series of 5 fog tests to random locations as designated by Consultant. Should any penetration, joint or void, under jurisdiction of this Section, emit visible fog, make repairs and replace deficiencies and re-perform fog test at no additional cost to Owner.

.2 Fog units (machines) shall have a formulation output range of (1.5 gal/hr). Formulation particle size 0.5 - 25 µm. Fogging agent shall be non-toxic, non-staining and shall provide a heavy fog at 30 ppm with a permissible airborne level concentration of 50 ppm.

.3 Fog at a rate of 4 s/100 cu ft. Maintain fog density until inspection is complete.

.4 Where work or materials fail to meet requirements as indicated by test results, pay costs of additional inspection and testing required for new replacement work or materials.

3.4 CLEANING

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

.2 Remove temporary dams after initial set of firestopping and smoke seal materials where such materials are left exposed in finished areas and flame spread rating of such materials exceed a value of 25, in accordance with CAN/ULC-S102-M.

3.5 CABLE TRAY PENETRATIONS

.1 Seal cable tray penetrations with re-enterable matrices having a minimum compressive strength of 250 psi having a minimum FTH Rating of 1/2 hr for 500 MCM cables and 2 hr for 300 MCM cables.

.2 Listings shall be for cable tray tests carried out having minimum 30% actual and/or 100% visual cable density.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included: Provide sealants and joint fillers for the Work.

.2 Related Work Specified Elsewhere: Provide the following work in conformance with this Section:

a. Fire stopping and smoke seals: Section 07 84 00

b. Sealing of gypsum board partitions: Section 09 20 15

c. Mechanical Sealing: Mech Divisions

d. Electrical Sealing: Elec Divisions

1.3 QUALITY ASSURANCE

.1 Qualifications of Products: All products shall be packaged in conformance with the specified standards with every package bearing a label stating the standard to which the product conforms.

.2 Qualifications of Subcontractor: Possess a copy of and be familiar with all standards specified. Have a minimum of 5 years' experience in the work specified.

1.4 SUBMITTALS

.1 Samples: Submit samples of full colour range of all exposed products for colour choice by Architect.

.2 Maintenance and Reference Data: Submit to Section 01 33 00 as specified therein.

1.5 JOB CONDITIONS

.1 Other Sections providing joints between elements to be sealed by or in conformance with this Section shall conform to the limits of movement of the specified sealant by the careful determination of acceptable lengths of element to be joined (spacing of joints) and establishment of sufficiently wide joints to accommodate anticipated movement in the finished Work.

.2 Install sealants at temperatures above 4.4°C.

.3 Inspection: Inspect work of other Sections upon which work of this Section depends and verify that conditions are suitable for this work to proceed.

1.6 WARRANTY

.1 Warrant sealant work for a total of Two Years.

PART 2 PRODUCTS

2.1 MATERIALS

.1 Primer: As recommended by sealant manufacturer for type of surface being primed and conditions of service.

.2 Joint Filler and Back-up: Circular cross-section unless shown as slab or sheet, min. 25% wider than joint, semi-rigid: closed cell polyethylene or polyurethane product, Ethafoam by Dow Chemical of Canada Limited, or product of Herecules Inc., Delaware, U.S.A., rubber tubing or non-migrating plasticized vinyl having a shore 'A' hardness of 20 and tensile strength of 130 - 200 kPA, compatible with sealant and as recommended by sealant manufacturer.

.3 Bond Breaker: As recommended for use by sealant manufacturer.

.4 Vent Tubes: Rigid clear extruded plastic, min. 6 mm ID and 9 mm OD.

.5 Sealant Colours: Colours of exposed sealants as chosen by the Architect from manufacturer's complete range.

.6 Sealant Types:

a. Type 1: Sealing Compound, One Component, Acrylic Base, Solvent Curing conforming to CGSB 19-GP-5M.

b. Type 2: Air barrier and sealant quality conforming to Thermal Insulation, Urethane, Spray in Place, CGSB 51-GP-23M.

c. Type 3: Latex Sealing Compound, One Component, acrylic latex conforming to Can/CSGB 19-GP-17M and ASTM C834, Type OP Grade -18 deg C.

d. Type 4: Sealing Compound, One Component, Acrylic Emulsion Base conforming to CAN/CGSB 19.17-M.

e. Type 5: Sealing Compound, One Component, Silicone Base, Solvent Curing conforming to CGSB-19.18-M87; Dow Corning 795 (790 at concrete) or G.E. Silicones Silpruf.

f. Type 6: Non-curing, non-skinning, non-oxidizing, non-bleeding Sealing and Bedding Compound for Acoustical Purposes and/or metal building sealant for concealed joints conforming to CGSB 19-GP-21M.

g. Type 7: Sealing Compound, Mildew Resistant, for Tubs and Tile conforming to CGSB 19-GP-22M; Dow Corning 786 or G.E. Silicones Sanitary 1700.

h. Type 8: Sealing Compound, Multicomponent, Chemical Curing conforming to CAN2-19.24-M80.

i. Type 9: Tacky preformed tape of 100% solids butyl polyisobutylene base, cross sectional size as required or as specified.

j. Type 10: Tacky preformed tape of 100% solids vulcanized-rubber base or macro polyisobutylene base with solid rubber bead centered in tape, cross-sectional size as required or as specified.

k. Type 11: Preformed wedge or gasket in shape designed for specific installation condition of appropriate shore 'A' hardness of dense neoprene, EPDM or Santoprene PVC by Monsanto Canada Inc.

l. Type 12: Expanding preformed foam sealer fabricated of open cell, high density polyurethane foam impregnated throughout with polymer modified asphalt, performance temperature range -40˚C to 85˚C (95˚C short term), excellent resistance to UV, mildew, and aging, non-bleeding, 144 to 160 kg/m3 density, acceptable product: Emseal by Emseal Joint Systems Ltd.

PART 3 EXECUTION

3.1 PREPARATION

.1 Check compatibility of proposed sealants with materials to be in contact with sealant and ensure durable seal is provided.

.2 Clean joints and surfaces and ensure that they are dry and free of dust, loose mortar, oil, grease and other foreign material. Clean ferrous metals of rust, mill scale and foreign materials by wire brushing, grinding or sanding.

.3 Provide bond breaker between sealant and other materials spanning joint where backup rod cannot be provided because of depth.

.4 Where surfaces adjacent to joints are likely to become coated with sealant during applications, mask them prior to priming and caulking.

.5 Seal joints in surfaces to be painted before surfaces are painted. Where surfaces to be caulked are prime-painted in shop before caulking, check to make sure prime paint is

compatible with primer and sealant. If they are incompatible, inform Architect and change primer and sealant to compatible types approved by Architect.

3.2 APPLICATION

.1 Apply sealant using hand-operated guns fitted with suitable nozzles and equipment approved by sealant manufacturer. Apply in strict accordance with manufacturer's directions and recommendations.

.2 Apply sealant under pressure in such a manner as to assure good adhesion to sides of joints and to completely fill all voids in the joint.

.3 Form surface of sealant smooth, concave, free from ridges, wrinkles, sags, air pockets and embedded foreign matter.

.4 Upon completion, remove masking and sealant smears and droppings from adjacent and other surfaces.

.5 Install preformed expanding foam sealants in compressed state of width to provide final compression in service necessary to provide required acoustic-, air-, moisture-, or water-proof seal as per manufacturer's recommendations and as specified in List following.

3.3 LIST OF TYPES AND USES OF SEALANTS

.1 Interior Joints:

a. Not for glazing, not on exterior walls, not on interior of exterior window, door or screen frames, not in shower or washroom areas, not specifically for acoustic isolation: Type 3 or 8; paintable.

b. Perimeter of mirrors, washroom accessories to wall and other dissimilar materials: Type 4.

.2 Building Envelope Joints:

a. Joints in Sheet Metal Air/Vapour Barrier: Sealant Type 6.

b. Lap Joints in Plastic Sheet Vapour Barrier: Sealant Type 6.

c. Securement Joints in Plastic Sheet Air/Vapour Barrier: Sealant Type 3.

d. Joints in Air Barrier Sheathing Insulation and Joints Between Air/Vapour Barrier or Insulation Wythe and Frames of Windows, Doors or Equipment: Sealant Type 2.

e. Control Joints in Masonry: Type 4.

f. Interior and Exterior Window, Door and Screen Frames: Sealant Type 4.

g. Thresholds in Exterior and Vestibule Doors: Type 8, or 13 (watertight).

h. Roof: As supplied by roofing membrane manufacturer. Check compatibility of all sealants in contact with roof membrane or roof sealants.

i. Joints in Exterior and Interior Pavements: Sealant Type 8, with a toughness when cured which resists damage due to mischief and traffic. Sealant Type 8 pourable in floor slab and floor finish expansion and crack control joints.

.3 Joints in Shower Rooms and Washrooms: Sealant Type 7.

.4 Sealing Partitions for Acoustical Isolation: Sealant Type 6.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 1, General Requirements.

1.2 DESCRIPTION

.1 Work Included: Supply steel doors, frames and screens to Sections installing them.

.2 Related Sections:

a. Installation of steel doors, frames and hardware: Section 06 20 00

b. Supply of hardware: Section 08 70 00

c. Glazing of steel doors an frames: Section 08 80 00

1.3 QUALITY ASSURANCE

.1 Requirements of Regulatory Agencies: Perform Work of this Section in accordance with requirements of latest edition of Canadian Manufacturing Specifications for Steel Doors and Frames, of Canadian Steel Door and Frame Manufacturers' Association (CSDFMA), except as otherwise specified herein or shown.

.2 Coordination: Give full cooperation to finish hardware distributor's representative during preparation of Shop Drawings and execution of shop fabrication.

1.4 SUBMITTALS

.1 Shop Drawings:

a. Indicate each type of door, transom panel, door frame and window frame, materials being supplied, sufficient detail to show door construction and anchorage, type of primer, cutouts and reinforcements for hardware, mortar boxes, anchors, fire and sound ratings and location of fastenings.

b. Submit on sheets conforming to format of Canadian Steel Door and Frame Manufacturers' Association Guide. Manufacturer's numbering system shall correspond to Architect's numbering system.

c. Draw frame profile details at scale not less than 1:5.

PART 2 PRODUCTS

2.1 EXAMPLE MANUFACTURERS

.1 S.W. Fleming, Steldor, Daley, Ambico, Macotta or Daybar Industries Ltd.

.2 Minimum Specification for Products: Canadian Steel Door and Frame Manufacturers' Association.

2.2 MATERIALS

.1 Sheet Steel:

a. Doors and frames: Wipe coated galvanized steel to requirements of ASTM A526-80 with zinc coating designation ZF075 to ASTM A525.

b. Metal jamb anchors occurring in exterior walls: hot dipped galvanized sheet steel.

c. Minimum core thickness to CSDFMA Specifications Table 1 and as follows:

1. Doors, frames and screens: 16 ga.
2. Anchors: 14 ga.
3. Stiffeners: 14 ga.

.2 Core:

a. Interior doors (non rated): 25 mm resin impregnated rot resistant kraft honeycomb.

b. Exterior doors (and fire-rated and STC40 interior doors): steel stiffened, all voids insulated with fiberglass or foam.

.3 Glass: See Door and Frame Schedule.

.4 Miscellaneous:

a. Door Bumpers/Silencers: Single stud rubber/neoprene type; acceptable type, Glynn-Johnson #64 of colour selected or Johnsonite Inc., or S.W. Fleming.

b. Panel Fasteners: Concealed fasteners of hot dip galvanized steel, type to provide accurate, secure installation.

c. Glazing Stops: Formed channel, minimum 16 mm height.

2.3 FABRICATION

.1 General: Prep doors and frames for (but not limited to) heavyweight hinges (minimum 4 per leaf greater than 915 mm wide and/or 2300 mm high), continuous hinges, concealed vertical rod and mortise lock case exit devices, cylindrical locksets, surface door closures and concealed overhead stops.

.2 Frames and Glazed Screens:

a. Fabricate frames to profiles indicated.

b. Mitre corners of frames. Cut accurately and weld continuously on inside of frame profile.

c. Fabricate vertical members to open into heads to allow for mortar fill.

d. Reinforce all frames greater than 900 mm in width with steel angles or channels to provide continuous unwavering support under all conditions.

e. Mortise, reinforce, box, drill, and tap frames to receive hardware. Reinforce all frames for application of surface mounted closers and for automatic door operators, where scheduled. Protect strike and hinge reinforcements with guard boxes welded to frame. Obtain templates from Finish Hardware Supplier.

f. Provide two welded-in channel or angle spreaders per frame to ensure proper alignment.

g. Provide three rubber bumpers for each door frame.

h. Where frames terminate at finished floor, provide floor plates for anchorage to floor.

i. Provide adjustable jamb anchors of appropriate type. For frames occurring in masonry walls, provide minimum three anchors for each jamb up to 2260 mm in height. Provide additional anchors for higher frames in accordance with referenced standard.

j. For glazing, provide accurately fitted removable steel channel glazing stops with butted corners, and fastened with countersunk Phillips oval head sheet metal screws. Place stops on inner non-secure side of frame.

.3 Doors:

a. Fabricate each face of door from a single sheet of steel.

b. Continuously weld longitudinal edges and grind smooth.

c. Stiffen exterior doors vertically with stiffeners spot welded to face sheets at maximum 150 mm on centre.

d. Close top and bottom of door with recessed projection welded channel end closures. Provide steel top cap on exterior doors to protect against weather.

e. Provide 1 mm clearance at hinge jamb, 1.5 mm clearance at latchside and head, and 6 mm clearance between bottom of door and finished floor line, except where undercutting specified in Door Schedule. Bevel opening edge of single leaf doors 3 mm and of double doors 1.5 mm each.

f. Where door lights are indicated, provide accurately fitted removable steel channel glazing stops with butted corners, fastened with countersunk Phillips oval head sheet metal screws. Place stops on inner non-secure side of door.

g. Fill internal spaces in exterior doors fully with specified insulation core material.

h. Mortise, reinforce, drill, and tap doors to receive hardware. Note that doors will be fitted with mortise lever locksets. Obtain templates from Finish Hardware supplier.

i. Reinforce stiles and rails of fully glazed doors with continuous channels.

.4 Fire-Rated Assemblies:

a. Fabricate assemblies required to have a fire-resistance rating to requirements of testing and labeling agency.

b. Supply assemblies required to have a fire-resistance rating complete with appropriate label of testing and labelling agency affixed in a visible but unobtrusive location.

.5 Welding:

a. Grind exposed welds smooth and flush.

b. Fill open joints, seams and depressions with filler or by continuous brazing or welding. Grind smooth to true arises and profiles, and sand down to smooth, true uniform finish.

.6 Adjust and Clean: Promptly make good any disfigurement or damage caused by shipping and handling.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included:

a. Provide lead lined hollow metal doors and frames.

.2 Related Sections:

a. Radiation Protection – General: Section 13 49 00

1.3 SUBMITTALS

.1 Shop Drawings: Submit shop drawings as per Section 01 30 00, Submittals.

.2 Certificate of Compliance: Provide manufacturer's certificate of compliance indicating that hollow metal doors and frames for this project has been produced in accordance with requirements specified herein and the radiation physicist shielding report.

1.4 REFERENCE STANDARDS

.1 Comply with requirements of National Council on Radiation Protection and Measurement (NCRP) Report No. 49 "Structural Shielding Design and Evaluation for Medical Use of X-Rays and Gamma Rays of Energies up to 10 MeV", and NCRP Report No. 147 "Structural Shielding Design for Medical X-Ray Imaging Facilities".

.2 Visionlites: Lead-lined and require X-Ray Safety Glass labeled as impact resistant meeting the requirements of ANSI Z97.1 and CPSC 16 CFR 1201 Category 2. (If fire-rated, additional clear ceramic fire-rated glazing is required).

PART 2 PRODUCTS

2.1 MANUFACTURERS

.1 Acceptable manufacturers:

a. MarShield - Division of Mars Metal Company.

b. Mayco Industries, Inc.

c. Nelco.

d. Pitts Little Corporation.

e. Ray-Bar Engineering Corporation.

2.2 MATERIALS

.1 Faces: 18 gauge thick Hot Dipped Galvanized Steel (HDGS). Prime quality, conforming to ASTM A527. Wilsonart Plastic Laminate may be factory added to faces only, if specified.

.2 Edges: 16-gauge thick Hot Dipped Galvanized Steel (HDGS) channel. Prime quality conforming to ASTM A527.

.3 Core: 99.9% Pure lead sheet per Federal Specification QQ-L-201f, Grade C. Reference radiation shielding report for thickness of lead.

.4 Finish: Galvanized pre-treatment and manufacturer's standard rust inhibitive primer.

.5 Lead Sheet: Rolled lead sheet: 99.9% pure unpierced virgin lead, free from dross, oxide inclusions, scale, laminations, blisters, and cracks, to ASTM B749-03. Thickness: 3 mm Pb. Variation in thickness not to exceed 3%.

2.3 FABRICATION

.1 Reinforce top and bottom edges with 16 gauge channels spot welded to the face sheets.

a. Hinge Reinforcement: 7 gauge
b. Lock Reinforcement: 12 gauge
c. Closer Reinforcement: 14 gauge
d. Other Surface Mounted Hardware: 16 gauge
e. Lock Support: 20 gauge

.2 Internal construction for the door consists of 12 mm cell honeycomb core with single layer unpierced sheet lead bonded to the door skins. Apply lead sheet continuously from top to bottom and edge to edge. Label door lead thickness value clearly on door edge.

.3 Mortised and reinforced to allow field application of hinges and lock sets in accordance with an appropriate hardware schedule and templates supplied by the hardware contractor.

PART 3 EXECUTION

3.1 INSTALLATION

.1 Secure lead lining to door frames with steel stud anchors.

.2 Provide minimum 3 anchors per jamb, located adjacent to hinge on hinge jamb, and at corresponding heights on strike jamb.

.3 Lap lead lining of frames over lining in walls at least 25 mm.

.4 Line inside of door frames with lead of thickness not less than that required in doors and walls in which frames are used. Form lead to match frame contour, continuous in each jamb and across head, lapping stops. Form lead shields around areas prepared to receive hardware. Lap lead lining over lining in walls by minimum 25 mm.

.5 Hardware: Line covers, escutcheons, and plates to provide effective shielding at cutouts and penetrations of frames and doors.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included: Supply plastic laminate faced wood doors.

.2 Related Work Specified Elsewhere:

a. Installation of wood doors and hardware: Section 06 20 00

b. Supply of hardware: Section 08 70 00

c. Glazing of wood doors: Section 08 80 00

d. Supply of door grilles: Division 24

1.3 QUALITY ASSURANCE

.1 Requirements of Regulatory Agencies: Conform to the latest editions of the following:

a. CSA 0132.2-Series 90, General Requirements for Wood Flush Doors.

b. Architectural Woodwork Manufacturers Association of Canada “Quality Standards for Architectural Woodwork” (AWMAC).

1.4 SUBMITTALS

.1 Shop Drawings: Submit Shop Drawings.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

.1 Do not deliver doors to Site until Work of wet trades is complete and moisture readings of surfaces in proposed storage area are less than 18%.

.2 Store doors flat on level surface in dry, well ventilated area inside building.

.3 Cover top of pile with waterproof covering, but allow air circulation at sides.

1.6 WARRANTY

.1 Warrant the Work of this Section against defect for a total of Three Years.

.2 Make good defects during warranty period by replacing defective doors in finish to match adjacent similar doors or of original door finish. Defects shall include, but not be limited to bubbling, delamination of faces or edges, warp, twist bow exceeding 6 mm, and

telegraphing of core. “Replace” as used herein includes installing hardware, finishing, hanging and fitting.

PART 2 PRODUCTS

2.1 MATERIALS

.1 Conform to CSA 0132.2 for materials, except as specified otherwise herein.

.2 Core Materials for Solid Core Doors: Solid Eastern White Pine or Western Red Cedar conforming to CAN3-0188.1-M, Grade R.

.3 Adhesive: CSA 0112 Series M, Type III.

.4 Finish:

a. Plastic Laminate faced doors: Conforming to CAN3-A172-M, Standard Grade, 2 mm thick, 0.50 mm thick backing sheet, sanded one side by same manufacturer, colour and finish choice by Architect from Arborite, Formica, Nevamar or Wilsonart complete range.

.5 Fire-rated Assemblies:

a. Fabricate assemblies required to have a fire-resistance rating to requirements of testing and labelling agency.

b. Supply assemblies required to have a fire-resistance rating complete with appropriate label of testing and labelling agency affixed in a visible but unobtrusive location.

.6 Glass: See Door and Frame Schedule.

2.2 FABRICATION AND MANUFACTURE

.1 General:

a. Conform to CSA 0132.2 for solid core flush doors, except as specified otherwise herein.

b. Size doors for 2 mm clearance of heads and jambs and 10 mm at sills.

c. Prep rated doors for (but not limited to) heavyweight hinges (minimum 4 per leaf greater than 915 mm wide and/or 2300 mm high), continuous hinges, concealed vertical rod and mortise lock case exit devices, cylindrical locksets, and concealed overhead stops.

.2 Flush Doors:

a. Core: Laminated wood framed or unframed core construction comprising narrow kiln dried wood strips not less than 40 mm wide, grain running vertically and joints well staggered, electronically glue bonded.
b. Edges: 19 mm minimum thickness one piece full length Maple with plastic laminate faced jambs and painted head and underside edge.
c. Sealing: Factory seal all door edges with one coat of stain sealer to closely match plastic laminate colour.
d. Cutouts: Prepare doors in factory for any openings required. Fit loose stops and tack in place.

PART 3 EXECUTION

3.1 INSTALLATION

.1 Supply wood doors to Section 06 20 00, Finish Carpentry, for installation.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 1, General Requirements.

1.2 DESCRIPTION

.1 Work Included:

a. Supply Hardware for the Work.

b. Supply finish hardware and templates to other Sections as required.

c. Contractor to retain Hardware Consultant directly.

.2 Related Work Specified Elsewhere:

a. Payment for Hardware: Section 01 21 00

b. Installation of Hardware: Section 06 20 00

c. Metal Doors: Section 08 11 00

d. Wood Doors: Section 08 21 00

e. Aluminum Doors: Section 08 41 50

1.3 QUALITY ASSURANCE

.1 Coordination: Give full cooperation to other Sections during preparation of Shop Drawings and execution of shop fabrication.

.2 Materials: Conform to the following as a minimum standard: CAN/CGSB-69: 18-M, 19-M, 20-M, 21-m, 22-M, 23-M, 24-M, 25-M, 27-M, 28-M, 29-M, 30-M, 31-M, 32-M, 33-M, 34-M.

1.4 SUBMITTALS

.1 Hardware List:

a. Provide an itemized hardware schedule which lists all doors by number indicated on Drawings, with complete details and catalogue numbers of the hardware to be supplied.

b. Hardware Supplier to examine Contract Documents to determine the final dimensions, size and quantity of the required hardware items.

.2 Samples: Submit samples to Consultant if requested.

.3 Templates: Submit templates and information to all Sections requiring same.

.4 Operating Manuals: Submit operating manuals to Section 01 30 00.

1.5 WARRANTIES

.1 Warrant all hardware for one year and door closers for five years from date of acceptance. State in the warranty that all moving parts will be replaced in part or in whole at no cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

.1 Doors and frames to be prepared for, but not limited to preparations for heavy weight oversized butt hinges, continuous hinges, cylindrical locksets, concealed vertical rod and mortise lock case exit devices, surface door closers and concealed overhead stops.

2.2 HARDWARE COMPONENTS

.1 Butt Hinges: Permit 175° swing.

.2 Continuous Hinges: Provide at all doors 1015 mm wide and larger. Permit 175° swing where required.

.3 Handles: Smooth curved lever style – not sharp bend.

.4 Locksets: ULC labeled if installed on labeled fire doors.

.5 Exit Devices: ULC labeled if installed on labeled fire doors. Low profile panic style at doors serving greater than 60 occupants.

.6 Door Closers:

a. Permit 175° swing and be complete with built-in check.

b. ULC labeled if installed on labeled fire doors.

.7 Overhead Door Stops:

a. Interior doors: solid steel and plated as specified.

b. Exterior doors: solid bronze and plated as specified.

.8 Fasteners:

a. Supply door pulls with oval head thru bolts and cup washers on doors where no push plate is specified. Where door pulls are specified on one side with push plates on the other, supply flathead thru bolts, countersunk flush with face of door so that push plates will cover the bolts.

b. Continuously weld longitudinal edges and grind smooth.

c. Stiffen exterior doors vertically with stiffeners spot welded to face sheets at maximum 150 in.

PART 3 EXECUTION

3.1 INSPECTIONS AND SUPPERVISION

.1 Attend site meetings when so requested.

.2 Make periodic inspections of the hardware installations and report improper or unsatisfactory conditions. Expedite the replacement or correction of faulty hardware.

HARDWARE SCHEDULE

HARDWARE SETS

SET: 1.0

DOORS: D108

DESCRIPTION: BIPARTING POCKET DOORS

QTY	ITEM	MODEL / DESCRIPTION	FINISH	MFR
2	GUIDE CHANNEL	C-914 GUIDE CHANNEL X DOOR WIDTH	CA	KN
1	TRACK	C-108 X TRACK LENGTH	CA	KN
1	FASCIA	C-110-FASCIA X TRACK LENGTH	CA	KN
1	END CAPS	C-111 PAIR	CA	KN
2	HARDWARE SET	C-810WX1DRHDWE		KN

SET: 2.0

DOORS: D121

DESCRIPTION: CARD READER ADO UNEVEN DOORS LEAD LINED

QTY	ITEM	MODEL / DESCRIPTION	FINISH	MFR
1	CONTINUOUS HINGE W/ POWER TRANSFER	FM300 HT EL12 X DOOR HEIGHT	630	MR
1	CONTINUOUS HINGE	FM300 HT X DOOR HEIGHT	630	MR
2	FLUSH BOLT SET	GSH401	C26D	GA
1	DUST PROOF STRIKE	GSH412	C26D	GA
1	FAIL SAFE LOCK MELR	LX RX 56 8270 LNL	US32D	SA
1	PERMANENT CORE	MEDECO LFIC BY OWNER		MC
1	DOOR OPERATOR	SW200I		BM
1	KICKPLATE	GSH80A 200MM X WIDTH 3M TAPE	C32D	GA

1	ASTRAGAL	357C LEADLINE X DOOR HEIGHT		PE
1	GASKETING	S773BL 1/HEADER X 2/JAMBS		PE
2	DOOR SWEEP	29326CNB X DOOR WIDTH		PE
1	ADVANCED LOGIC RELAY	CX-33		OT
1	ELECTROLYNX HARNESS (IN FRAME)	QC-CXXXX SIZE TO FIT		MK
1	ELECTROLYNX HARNESS (IN DOOR)	QC-CXXX SIZE TO FIT		MK
1	CARD READER	BY SECURITY CONTRACTOR		OT
2	WAVE/PUSH TO OPEN COLUMN SWITCH	CM-7436VR A2	CLR	CM
2	DOOR POSITION SWITCH	DPS-M-BK		SU
1	POWER SUPPLY	AQD1		SU
1	ELECTRIFIED HARDWARE ELEVATION	BY CONTRACTOR		OT

NOTES: AUTO DOOR OPERATOR(S) ARE ONLY SUPPLY & INSTALL. 120VAC IS REQUIRED AT THE HEAD OF THE DOOR OF ALL AUTO DOOR OPERATORS, 15A DEDICATED CIRCUIT. WALL/FRAME MUST BE REINFORCED FOR AUTOMATIC OPERATOR MOUNTING, ALL CONDUIT AND BACK BOXES WITH PULL CORDS ARE TO BE PROVIDED BY THE ELECTRICAL CONTRACTOR OR BY OTHERS.

1. DOORS ARE NORMALLY CLOSED AND LOCKED.
2. GAIN ACCESS BY PRESENTING AN AUTHORIZED CREDENTIAL ON THE CARD READER FOR PREDETERMINED TIME LIMIT.
3. LATCH CAN BE ELECTRICALLY HELD RETRACTED FOR OPEN ACCESS.
4. DOOR OPENS AUTOMATICALLY BY EXTERIOR “WAVE/PUSH TO OPEN” ACTUATOR ONLY ACTIVE ON A VALID CREDENTIAL. EMERGENCY ACCESS BY KEY OVERRIDE.
5. INTERIOR “WAVE TO OPEN” ACTUATOR ALWAYS ACTIVE. FREE EGRESS FOR IMMEDIATE EXIT.
6. REX SWITCH FROM THE LOCK ALLOWS AN AUTHORIZED EXIT WITHOUT ALARM CONDITION.
7. DOOR POSITION SWITCHES MONITORING THE DOOR STATUS (OPENED/CLOSED).
8. UPON THE FIRE ALARM ACTIVATION OR POWER FAILURE, THE DOOR WILL BE CLOSED AND LATCHED. FREE EGRESS AT ALL TIMES.

SET: 3.0

DOORS: D118, D119

DESCRIPTION: PASSAGE ADO UNEVEN DOORS LEAD LINED

QTY	ITEM	MODEL / DESCRIPTION	FINISH	MFR
1	CONTINUOUS HINGE W/ POWER TRANSFER	FM300 HT EL12 X DOOR HEIGHT	630	MR
1	CONTINUOUS HINGE	FM300 HT X DOOR HEIGHT	630	MR
2	FLUSH BOLT SET	GSH401	C26D	GA
1	DUST PROOF STRIKE	GSH412	C26D	GA
1	PASSAGE LATCH MELR	56 8215 LNL	US32D	SA
1	DOOR OPERATOR	SW200I		BM
1	KICKPLATE	GSH80A 200MM X WIDTH 3M TAPE	C32D	GA
1	ASTRAGAL	357C LEADLINE X DOOR HEIGHT		PE
1	GASKETING	S773BL 1/HEADER X 2/JAMBS		PE
2	DOOR SWEEP	29326CNB X DOOR WIDTH		PE
1	ADVANCED LOGIC RELAY	CX-33		OT
1	ELECTROLYNX HARNESS (IN FRAME)	QC-CXXXX SIZE TO FIT		MK
1	ELECTROLYNX HARNESS (IN DOOR)	QC-CXXX SIZE TO FIT		MK
2	WAVE/PUSH TO OPEN COLUMN SWITCH	CM-7436VR A2	CLR	CM
1	POWER SUPPLY	AQD1		SU
1	ELECTRIFIED HARDWARE ELEVATION	BY CONTRACTOR		OT

NOTES: AUTO DOOR OPERATOR(S) ARE ONLY SUPPLY & INSTALL. 120VAC IS REQUIRED AT THE HEAD OF THE DOOR OF ALL AUTO DOOR OPERATORS, 15A DEDICATED CIRCUIT. WALL/FRAME MUST BE REINFORCED FOR AUTOMATIC OPERATOR MOUNTING, ALL CONDUIT AND BACK BOXES WITH PULL CORDS ARE TO BE PROVIDED BY THE ELECTRICAL CONTRACTOR OR BY OTHERS.

1. DOORS ARE NORMALLY CLOSED AND LATCHED. PASSAGE FUNCTION.
2. DOOR OPENS AUTOMATICALLY BY “WAVE/PUSH TO OPEN” ACTUATORS ON BOTH SIDES.
3. UPON THE FIRE ALARM ACTIVATION OR POWER FAILURE, THE DOOR WILL BE CLOSED AND LATCHED.
4. FREE EGRESS AT ALL TIMES.

SET: 4.0

DOORS: D107B

DESCRIPTION: STOREROOM UNEVEN DOORS LEAD LINED

QTY	ITEM	MODEL / DESCRIPTION	FINISH	MFR
2	CONTINUOUS HINGE	FM300 HT X DOOR HEIGHT	630	MR
2	FLUSH BOLT SET	GSH401	C26D	GA
1	DUST PROOF STRIKE	GSH412	C26D	GA
1	STOREROOM LOCK	64 8204 LNL	US32D	SA
1	PERMANENT CORE	MEDECO LFIC BY OWNER		MC
1	SURFACE CLOSER	CPS7500	689	NO
1	KICKPLATE	GSH80A 200MM X WIDTH 3M TAPE	C32D	GA
1	ASTRAGAL	357C LEADLINE X DOOR HEIGHT		PE
1	GASKETING	S773BL 1/HEADER X 2/JAMBS		PE
2	DOOR SWEEP	29326CNB X DOOR WIDTH		PE

SET: 5.0

DOORS: D117

DESCRIPTION: CARD READER LEAD LINED

QTY	ITEM	MODEL / DESCRIPTION	FINISH	MFR
1	CONTINUOUS HINGE W/ POWER TRANSFER	FM300 HT EL12 X DOOR HEIGHT	630	MR
1	FAIL SECURE LOCK	LX RX 64 8271 LNL	US32D	SA
1	PERMANENT CORE	MEDECO LFIC BY OWNER		MC
1	SURFACE CLOSER	7500	689	NO
1	KICKPLATE	GSH80A 200MM X WIDTH 3M TAPE	C32D	GA
1	FLOOR STOP	GSH209	C26D	GA
1	GASKETING	S773BL 1/HEADER X 2/JAMBS		PE
1	ELECTROLYNX HARNESS (IN FRAME)	QC-CXXXX SIZE TO FIT		MK
1	ELECTROLYNX HARNESS (IN DOOR)	QC-CXXX SIZE TO FIT		MK
1	CARD READER	BY SECURITY CONTRACTOR		OT
1	DOOR POSITION SWITCH	DPS-M-BK		SU
1	POWER SUPPLY	AQD1		SU
1	DOOR VIEWER	GSH199B	C26D	GA
1	ELECTRIFIED HARDWARE ELEVATION	BY CONTRACTOR		OT

NOTES:

1. DOOR IS NORMALLY CLOSED AND SECURED.
2. GAIN ACCESS BY PRESENTING AN AUTHORIZED CREDENTIAL ON THE CARD READER. EMERGENCY ACCESS BY KEY OVERRIDE.
3. UPON THE FIRE ALARM ACTIVATION OR POWER FAILURE, THE DOOR WILL BE CLOSED AND LOCKED.
4. FREE EGRESS AT ALL TIMES.

SET: 6.0

DOORS: D113, D116, D120

DESCRIPTION: PASSAGE ADO LEAD LINED

QTY	ITEM	MODEL / DESCRIPTION	FINISH	MFR
1	CONTINUOUS HINGE W/ POWER TRANSFER	FM300 HT EL12 X DOOR HEIGHT	630	MR
1	PASSAGE LATCH MELR	56 8215 LNL	US32D	SA
1	DOOR OPERATOR	SW200I		BM
1	KICKPLATE	GSH80A 200MM X WIDTH 3M TAPE	C32D	GA
1	FLOOR STOP	GSH209	C26D	GA
1	GASKETING	S773BL 1/HEADER X 2/JAMBS		PE
1	DOOR SWEEP	29326CNB X DOOR WIDTH		PE
1	ADVANCED LOGIC RELAY	CX-33		OT
1	ELECTROLYNX HARNESS (IN FRAME)	QC-CXXXX SIZE TO FIT		MK
1	ELECTROLYNX HARNESS (IN DOOR)	QC-CXXX SIZE TO FIT		MK
2	WAVE/PUSH TO OPEN COLUMN SWITCH	CM-7436VR A2	CLR	CM
1	POWER SUPPLY	AQD1		SU
1	ELECTRIFIED HARDWARE ELEVATION	BY CONTRACTOR		OT

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1. DOOR IS NORMALLY CLOSED AND LATCHED. PASSAGE FUNCTION.
2. DOOR OPENS AUTOMATICALLY BY “WAVE/PUSH TO OPEN” ACTUATORS ON BOTH SIDES.

3. UPON THE FIRE ALARM ACTIVATION OR POWER FAILURE, THE DOOR WILL BE CLOSED AND LATCHED.
4. FREE EGRESS AT ALL TIMES.

SET: 7.0

DOORS: D114

DESCRIPTION: STOREROOM LEAD LINED

QTY	ITEM	MODEL / DESCRIPTION	FINISH	MFR
1	CONTINUOUS HINGE	FM300 HT X DOOR HEIGHT	630	MR
1	STOREROOM LOCK	64 8204 LNL	US32D	SA
1	PERMANENT CORE	MEDECO LFIC BY OWNER		MC
1	SURFACE CLOSER	7500	689	NO
1	KICKPLATE	GSH80A 200MM X WIDTH 3M TAPE	C32D	GA
1	FLOOR STOP	GSH209	C26D	GA
1	GASKETING	S773BL 1/HEADER X 2/JAMBS		PE
1	DOOR SWEEP	29326CNB X DOOR WIDTH		PE

SET: 8.0

DOORS: D112

DESCRIPTION: CARD READER OFFICE

QTY	ITEM	MODEL / DESCRIPTION	FINISH	MFR
2	HINGE, FULL MORTISE	H T4A3386 5" X 4-1/2"	US32D	MK
1	HINGE, FULL MORTISE	H T4A3386 QC12 5" X 4-1/2"	US32D	MK
1	FAIL SECURE LOCK	LX RX 64 8271 LNL	US32D	SA
1	PERMANENT CORE	MEDECO LFIC BY OWNER		MC
1	SURFACE CLOSER	7500	689	NO
1	KICKPLATE	GSH80A 200MM X WIDTH 3M TAPE	C32D	GA
1	GASKETING	S773BL 1/HEADER X 2/JAMBS		PE
1	ELECTROLYNX HARNESS (IN FRAME)	QC-CXXXX SIZE TO FIT		MK
1	ELECTROLYNX HARNESS (IN DOOR)	QC-CXXX SIZE TO FIT		MK
1	CARD READER	BY SECURITY CONTRACTOR		OT
1	DOOR POSITION SWITCH	DPS-M-BK		SU

1	POWER SUPPLY	AQD1		SU
1	DOOR VIEWER	GSH199B	C26D	GA
1	ELECTRIFIED HARDWARE ELEVATION	BY CONTRACTOR		OT

NOTES:

1. DOOR IS NORMALLY CLOSED AND SECURED.
2. GAIN ACCESS BY PRESENTING AN AUTHORIZED CREDENTIAL ON THE CARD READER. EMERGENCY ACCESS BY KEY OVERRIDE.
3. UPON THE FIRE ALARM ACTIVATION OR POWER FAILURE, THE DOOR WILL BE CLOSED AND LOCKED.
4. FREE EGRESS AT ALL TIMES.

SET: 9.0

DOORS: D115

DESCRIPTION: UNIVERSAL WASHROOM INSWING ADO RESCUE HARDWARE

QTY	ITEM	MODEL / DESCRIPTION	FINISH	MFR
1	CONT HINGE, DOUBLE SWING W/ POWER TRANSFER	DSH1000XXC SER12 X DOOR HEIGHT		PE
1	EMERGENCY RELEASE STOP	ERSBH__C-NBPXHT X DOOR HEIGHT		PE
1	FAIL SAFE LOCK MELR	56 64 8270 LNL	US32D	SA
1	PERMANENT CORE	MEDECO LFIC BY OWNER		MC
1	CUSTOM EXTENDED LIP STRIKE	CS-ASA1 SIZE TO FIT	US32D	RO
1	AUTO DOOR OPERATOR	SW-200I DAC DOUBLE ACTING ARM	689	BM
2	KICKPLATE	GSH80A 200MM X WIDTH 3M TAPE	C32D	GA
1	FLOOR STOP	GSH209	C26D	GA
1	DOOR SWEEP	29326CNB X DOOR WIDTH		PE
1	ADVANCED LOGIC RELAY	CX-33		OT
1	ELECTROLYNX HARNESS (IN FRAME)	QC-CXXXX SIZE TO FIT		MK
1	ELECTROLYNX HARNESS (IN DOOR)	QC-CXXX SIZE TO FIT		MK
1	EMERGENCY CALL SYSTEM	CX-WEC12-TS FE		CM

2	WAVE/PUSH TO OPEN COLUMN SWITCH	CM-7436VR A2	CLR	CM
1	WAVE/PUSH TO LOCK COLUMN SWITCH	CM-7436VR 8C	CLR	CM
1	DOOR POSITION SWITCH	DPS-M-BK		SU
1	POWER SUPPLY	AQD1		SU
1	ELECTRIFIED HARDWARE ELEVATION	BY CONTRACTOR		OT

NOTES: AUTO DOOR OPERATOR(S) ARE ONLY SUPPLY & INSTALL. 120VAC IS REQUIRED AT THE HEAD OF THE DOOR OF ALL AUTO DOOR OPERATORS, 15A DEDICATED CIRCUIT. WALL/FRAME MUST BE REINFORCED FOR AUTOMATIC OPERATOR MOUNTING, ALL CONDUIT AND BACK BOXES WITH PULL CORDS ARE TO BE PROVIDED BY THE ELECTRICAL CONTRACTOR OR BY OTHERS.

1. CASED OPENING DOOR FRAME. DOUBLE ACTING HINGE AND RELEASE STOP FOR EMERGENCY RESCUE ACCESS.
2. DOOR IS NORMALLY CLOSED AND UNLOCKED FOR WAVE/PUSH TO OPEN ACTUATORS USE.
3. DOOR OPENS AUTOMATICALLY BY EXTERIOR “WAVE/PUSH TO OPEN” ACTUATOR, ONLY ACTIVE WHEN THE ROOM IS VACANT.
4. INTERIOR “WAVE/PUSH TO OPEN” ACTUATOR, ALWAYS ACTIVE.
5. LOCK THE DOOR BY “WAVE/PUSH TO LOCK” ACTUATOR. ASK FOR ASSISTANCE BY THE “EMERGENCY CALL BUTTON” OR ENGAGE THE EMERGENCY SIGNAL STRIP.
6. EMERGENCY ACCESS BY KEY OVERRIDE AND EMERGENCY RESCUE STOP. FREE EGRESS AT ALL TIMES.
7. EMERGENCY CALL SYSTEM KIT INCLUDED: EMERGENCY SIGNAL STRIP, RESET, STROKE LIGHT/SOUNDER, SIGNAGE.
8. SIGNAL STRIP MUST TIE INTO EMERGENCY CONTROL KIT SYSTEM.

MANUFACTURER LIST

CODE	**NAME**
BM	BESAM
CM	CAMDEN DOOR CONTROLS
GA	GALLERY SPECIALTY HARDWARE
KN	K.N. CROWDER
MC	MEDECO

MK	MCKINNEY
MR	MARKAR
NO	NORTON RIXSON
OT	OTHER
PE	PEMKO
RO	ROCKWOOD
SA	SARGENT
SU	SECURITRON

OPENING LIST

NO.	OPENING	HDW SET	FIRE RATING
1	D107B	4.0	
2	D108	1.0	
3	D112	8.0	
4	D113	6.0	
5	D114	7.0	
6	D115	9.0	
7	D116	6.0	
8	D117	5.0	
9	D118	3.0	
10	D119	3.0	
11	D120	6.0	
12	D121	2.0	

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included:

a. Gypsum board wall, bulkhead and ceiling assemblies, supporting metal framing and furring, as required.

.2 Related Work Specified Elsewhere:

a. Structural Metal Studs: Section 05 41 00

b. Back blocking: Section 06 10 00

c. Suspended acoustic ceilings: Section 09 51 00

1.3 QUALITY ASSURANCE

.1 Requirements of Regulatory Agencies: Conform to the latest editions of:

a. CSSBI Light Weight Steel Framing Manual.

b. CSA A82.21-M, Gypsum and Terms Relating to Gypsum Products.

c. CSA A82.27-M, Gypsum Board Products.

d. CSA A82.31-M, Gypsum Board Application.

e. ASTM C645-88, Specification for Non-load Bearing Steel Studs, Runners, and Rigid Furring Channels for Screw Application of Gypsum Board.

f. ASTM E336, Method for Measurement of Airborne Sound Insulation In Buildings.

g. ASTM E413, Classification for Rating Sound Insulation.

.2 Qualifications of Designer: Be a Registered Professional Engineer licensed in the Province of Ontario.

.3 Allowable Tolerances:

a. Straight, vertical, flat and true to building lines to within 3 mm in 3 m.

b. Suspended gypsum board assemblies: level to within 8 mm in 3 m.

1.4 SUBMITTALS

.1 Shop Drawings: Submit Shop Drawings, showing all elements of adjacent walls, floors and roof framing systems and calculations for systems showing design loads and deflections, bearing the stamp and seal of a Professional Engineer licensed in the Province of Ontario.

1.5 JOB CONDITIONS

.1 Commence this work only after air temperature has been maintained at 13˚C to 21˚C for at least 24 hours before and can be maintained at same until joint cement and adhesives are fully cured, with proper ventilation to provide dry condition.

.2 Provide adequate ventilation to eliminate excessive moisture before commencing and during work to ensure proper drying of joint filler. Do not force dry joint treatment.

PART 2 PRODUCTS

2.1 MATERIALS

.1 Gypsum Board: Conforming to CSA A82.27-M, 1.2 m wide by longest lengths practicable.

a. Standard Board.

b. Fire-rated Board.

c. Moisture/Mold Resistant.

d. Abuse Resistant.

e. Thickness, unless shown or specified otherwise on Drawings:

1. Standard board: 15.6 mm at walls.
2. Standard board: 15.6 mm at ceilings.
3. Fire-rated board: 15.6 mm, Type X at fire rated assemblies.
4. Moisture Resistant board: 12.7 mm Denshield at tile and 15.6 mm Type X TileBacker at fire rated assemblies.
5. Moisture Resistant board: 12.7 mm Greenboard at washrooms.
6. Abuse resistant board: 12.7 mm Fiberock, 15.6 mm Type X at fire rated assemblies.

.2 Steel Studs: Min 0.53 mm core, Z275 galvanized, with min. 31.8 mm knurled faces and min 6 mm return, knock-outs in web for horizontal services and bracing. Increase core thickness and stud depth for heights over 2400 mm as indicated below:

a. 92 mm x 25 ga 3430 mm.

b. 92 mm x 20 ga 4270 mm.

c. 92 mm x 16 ga 5490 mm.

d. 152 mm x 25 ga 4880 mm.
e. 152 mm x 20 ga 6400 mm.
f. 152 mm x 16 ga 7600 mm.

.3 Structural Steel Studs: 16 gauge, Z275 galvanized, depth as indicated.

.4 Stud Runner Channels: As per studs with min. 25 mm flange, widths to suit.

.5 Furring Channels: 22.2 mm deep, 35 mm knurled face, min. 0.53 core, Z275 galvanized.

.6 Ceiling Carrying Channels: Cold rolled, 0.606 kg/m, 38 mm x 15 mm min., Z275 galvanized.

.7 Tie Wire: Min. 1.588 mm soft annealed galvanized steel.

.8 Corner and Casing Bead: Min 0.38 mm core, Z275 galvanized, perforated flanges.

.9 Screws: Self drilling, self-tapping, gypsum wallboard screws. Purpose made for penetrating studs.

.10 Reinforcing Tape: As recommended by board manufacturer.

.11 Joint Treatment Cement: Joint, topping and laminating compounds as recommended by board manufacturer.

.12 Control Joint: Of minimum 0.53 mm steel core, Z275 galvanized, perforated flanges.

.13 Acoustic Insulation: As per Section 07 20 00.

.14 Egg Crate: 12 mm x 12 mm plastic grid, 12 mm thick, white.

PART 3 EXECUTION

3.1 INSTALLATION

.1 General:

a. Conform to latest edition of CSA A82.31-M, except as otherwise specified herein.
b. Co-operate with mechanical, electrical and other trades to accommodate fixtures, fittings and other items in wallboard areas.

.2 Metal Stud Framing:

a. Install metal studs at 400 mm maximum spacing and at every 400 mm centre across any wall surface.
b. Install true, straight and square with wall plane.
c. Provide full stud framing around all openings.
d. Provide double studs each side of all openings and infill studs above and below openings as per Sentence “a.” above.
e. Provide double studs at head and sill of all openings under 1200 mm wide.
f. Provide reinforced box stud assemblies at all openings over 1200 mm wide.
g. Fabricate wall panels with screwed on top bottom runner channels.

h. Erect wall stud panels to provide for finished Work within specified tolerance.

i. Brace with secured cross-bridging at every 1200 mm vertically all walls that exceed 2700 mm.

j. Brace as above walls between 2400 mm high and 2700 mm high with one row of cross-bracing at mid-height.

k. At acoustical walls, bed both edges of perimeter studs and runners in bead of sealant Type 5 (Section 07 90 00).

.3 Ceiling Framing:

a. Carrying Channels: Where ducts are large or where combination of ducts, or combination of ducts and other items interfere so that hanger spacing exceeds 1200 mm, increase size of main runner channels accordingly to sustain increased loading and span. Space channels at maximum 1200 mm o.c. and not more than 150 mm from boundary walls, interruptions of continuity and changes in direction. Where splices are necessary, lap members at least 200 mm and wire each end with minimum double strand of tie wire. Avoid clustering or lining up splices. Attach channels to rod hangers by bending hanger sharply under bottom flange of runner and securely wire in place with a saddle tie.

b. Cross Furring: Erect wallboard furring channels at right angles to carrying channels. Space wallboard furring channels at 600 mm o.c. and not more than 150 mm from boundary walls, interruptions in ceiling continuity and changes in direction. Secure wallboard furring channels to each support with a double strand of tie wire or with clip approved by manufacturer of furring components. Splice joints by nesting and tying channels together.

.4 Moisture Resistant Board: Provide moisture resistant board at all washroom, changeroom and shower locations. Erect board with long dimension at right angles to supports. Locate end joints over supporting members.

.5 Gypsum Board; Application:

a. Ceilings and Bulkheads: Apply gypsum board with screws. Erect wallboard with long dimension at right angles to supports, stagger joints when applied over plywood protection board. Locate end joints over supporting members. Space screws at 200 mm o.c.

b. Walls: Apply gypsum board to studs and strapping with screws. Erect board with long dimension at right angles to supports. Locate end joints over supporting members. Locate vertical joints at least 300 mm from the jamb lines of openings. Space screws at 200 mm o.c. at board edges and 300 mm o.c. on board field. Leave minimum 10 mm gap between top of board and structure above to accommodate deflection of structure.

c. Fire Protection of Beams and Ducts: 2 layers of 15 mm fire rated board on studs or furring at 400 mm maximum spacing with board secured to framing with screws at maximum 150 mm centres and wire mesh between layers of board if required.

d. Ceiling and Partition Fasteners: Perimeter screws shall be not less than 9 mm nor more than 13 mm from edges and ends, and shall be opposite the screws on adjacent boards. Screws shall be driven with a power screw gun and set with countersunk head slightly below the surface of the board.

.6 Access Doors:

a. Build-in doors supplied by Mechanical Division, where required in wallboard installations, in accordance with manufacturer's recommendations, to match and blend with surrounding surfaces if exposed.

.7 Control Joints:

a. In the absence of Drawing notations, provide control joints in the following approved locations:

1. Where gypsum board is installed over masonry control joints.
2. Abutting structural elements.
3. Dissimilar walls and ceilings.
4. Changes in substrate construction.
5. Approximate 10 m spacing on long partition runs.
6. Approximate 15 m spacing on large ceilings.
7. Changes in superficial area.

b. Install in accordance with manufacturer's instructions.

c. Double furring members or studs at control joints, placing one furring member or stud on each side of control joint.

.8 Finishing:

a. Finish all joints.

b. Plaster Beads: Install casing beads where gypsum wallboard butts against a surface having no form concealing its juncture, and where shown. Erect casing beads plumb or level with minimum number of joints. Do not use scrap pieces.

c. Joint Treatment: Filling shall be done either manually, using the tools of the trade, or by a mechanical taping and filling machine of proven efficiency. Apply joint filler, tape and topping cement according to manufacturer's directions. The finish Work shall be smooth, seamless, plumb, true and flush, having square, neat corners.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL INSTRUCTIONS

.1 Read and be governed by conditions of the Contract and sections of Division 1.

1.2 SECTION INCLUDES

.1 Metal support systems for interior gypsum board partitions, interior ceilings, interior shaft walls and interior assemblies as indicated.

1.3 QUALITY ASSURANCE

.1 Retain a Professional Engineer registered in the Place of the Work to design the work of this section; to prepare, seal and sign shop drawings; and to perform field review. Shop drawings shall show both design and installation requirements.

.2 Qualifications: Provide work of this section, executed by a Subcontractor with minimum 5 years' experience in application of Products, systems and assemblies specified and with approval and training of Product manufacturers.

.3 Fire resistance rating: Where gypsum board systems with fire resistance ratings are indicated or required, provide materials and installations that are identical with those of applicable assemblies tested by fire testing laboratories acceptable to authorities having jurisdiction.

.4 Reference Standards:

a. Applicable requirements of ASTM C754-11 for installation of steel framing.

.5 Conduct quality control in accordance with Section 01 45 00. Inspection and testing company may perform random load tests for ceiling anchor installation.

1.4 SUBMITTALS

.1 Submit required submittals in accordance with Section 01 33 00.

.2 Product data sheets:

a. Submit manufacturer's Product data sheets for Products proposed for use in the work of this section, including additional data as may be required to demonstrate compliance with the Contract Documents.

.3 Test results:

a. Submit certified test results for each required fire resistance rated assembly for work of this section.

.4 Shop drawings; for engineered interior metal support systems:

a. Shop drawings shall be engineered, and stamped & signed by a P.Eng in good standing, licensed in the province of the Work.

b. Submit design for metal support systems at interior locations where noted as engineered or specified to be engineered.

1.5 DESIGN REQUIREMENTS FOR ENGINEERED INTERIOR METAL SUPPORT SYSTEMS

.1 Design system members to withstand own dead load, super-imposed dead loads, to maximum allowable deflection of L/240, without permanent deformation.

.2 Loads on walls acting as guards: Where the floor elevation on one side of a wall, including a shaftwall, is more than 600 mm (24") higher than the elevation of the floor or ground on the other side, the wall shall be designed to resist the lateral design loads prescribed in the building code or 0.5 kPa (0.07 PSI), whichever produces the greatest effect.

.3 Metal support systems shall be engineered where indicated in Contract Documents as “engineered” or “structural”. Horizontal framing of ceilings shall be engineered. Indicated framing depths are maximum permitted unless approved otherwise by Consultant.

1.6 FIRE RESISTANCE RATED ASSEMBLIES

.1 Materials for fire resistance rated construction shall conform to requirements of indicated fire resistance rated assembly.

PART 2 PRODUCTS

2.1 GENERAL

.1 For sheet metal Products: Sheet metal thickness indicated herein pertains to the “minimum base steel thickness exclusive of coating”.

2.2 PARTITION SUPPORT MATERIALS

.1 Interior non-loadbearing and engineered metal channel stud framing: to ASTM C645-11a; roll formed from 0.836 mm (0.0329") minimum thickness unless otherwise indicated, electro-galvanized steel sheet. Provide service holes starting at 450 mm (18") from bottom, then 914 mm (36") on centre to top of studs.

.2 Interior floor and ceiling tracks (runners): to ASTM C645-11a; in widths to suit stud sizes.

a. Metal thickness: to match studs.

b. For openings wider than 914 mm (36"), provide 0.752 mm (0.0296") minimum thickness for header.

.3 Runner fasteners:

a. To concrete and masonry: Use stub nails or power-driven fasteners.

b. To metal concrete inserts: Use 10 mm (3/8") Type S-12 Pan Head screws.

c. To suspended ceilings: Use prefinished clips to match ceiling grid, as manufactured by CGC.

.4 Bracing channels: Minimum 19 mm x 10 mm x 1.087 mm (3/4" x 3/8" x 0.0428") cold rolled galvanized steel.

2.3 CEILING SUPPORT MATERIALS AND SYSTEMS

.1 General: Size ceiling support components to comply with ASTM C754-11 unless otherwise indicated.

.2 Main runners: Steel channels, hot or cold rolled; G60 galvanized where used in shower rooms, other wet areas, and outdoors.

.3 Hanger wire: ASTM A641/A641M-09a, soft, Class 1 galvanized, minimum 3.77 mm (0.1484").

.4 Hanger rods and flats: Mild steel with zinc coating, galvanized for exterior applications.

a. General: Size devices for 5 times load imposed by completed system as determined in accordance with ASTM E488/E488M-10.

1. Power-actuated fasteners in concrete: Size devices for 10 times load imposed by completed system as determined in accordance with ASTM E1190-95(2007).

b. Screws, clips, bolts, concrete inserts or other devices for ceiling hangers whose suitability for use intended has been proven through standard construction practices or by certified test data.

c. Hangers: Comply with ASTM C754-11 for maximum ceiling area and loads to be supported.

d. Interior concrete ceiling anchors; acceptable products:

1. Dynabolt Sleeve Anchor ‘TW-1614’ or Readi-Tie-Drive ‘TD4-112’ tie wire anchor by ITW Ramset/Red Head.

2. Redi-Drive by ITW Ramset/Red Head, complete with galvanized angle clip.

3. Trubolt, or Dynabolt anchors by ITW Ramset/Red Head, complete with galvanized angle clip.

4. Kwik-Bolt 3 - HHDCA 1/4 Ceiling Hangers by Hilti.

e. Fasteners exposed to weather, condensation, and corrosion: Zinc-plated or stainless steel fasteners in applicable product lines specified in preceding paragraphs.

.5 Tie wire: 1.21 mm (0.0476") minimum zinc coated, soft-annealed wire, to ASTM A641/A641M-09a.

.6 Furring anchorages: 1.62 mm (0.0637galvanized wire ties, manufacturer's standard wire type clips, bolts, nails or screws as recommended by furring manufacturer and complying with ASTM C754-11.

.7 Runner (carry) channels: 1.367 mm (0.0538") thick cold rolled steel, primer painted or zinc coated for interior locations, to ASTM C754-11, with minimum 228 MPa yield strength:

a. 38 mm x 12.7 mm (1-1/2" x 1/2") where supported at centres of 914 mm (36") maximum.

b. 38 mm x 19 mm (1-1/2" x 3/4") where supported at centres of 1220 mm (48") maximum.

2.4 FURRING

.1 Furring channels: 0.752 mm (0.0296") minimum typical thickness, cold rolled steel, wiped coated, nominal size of 22 mm (7/8") depth x 35 mm (1-3/8") face, hat type with knurled face.

.2 Z-furring members: Manufacturer's standard screw type galvanized steel, z-shaped furring members; ASTM A653/A653M-06a, G60, 0.752 mm (0.0296") minimum thickness of base metal, of depth indicated, designed for mechanical attachment of insulation boards or blankets.

.3 Fasteners for furring members: Type and size recommended by furring manufacturer for substrate and application indicated.

2.5 ACCESSORIES

.1 Backer plates:

a. Metal backer plates: Steel, galvanized; minimum 150 mm (6") wide x gauge of metal as indicated (min. 25 ga. or thicker as required to suit items being attached.) Width to suit size of items to be attached; fastened to studs for attachment of surface mounted fittings and accessories.

.2 Elimination of backer plates or direct attachment of accessories or equipment to studs will not be permitted.

PART 3 EXECUTION

3.1 INSTALLATION GENERAL

.1 Comply with ASTM C754-11 and manufacturer's instructions, except as modified herein. Do not bridge building expansion joints with support system. Frame both sides of joints with furring and other supports as indicated.

.2 Provide and install studs, framing, shimming, and furring to provide proper support for gypsum board to achieve the following installation tolerances:

a. Do not exceed 3 mm (1/8") in 3 m (10') variation from plumb, level, and plane.

b. Do not exceed 10 mm (3/8") from drawings locations.

c. Do not exceed 1.5 mm (1/16") variation between planes of abutting edges or ends.

d. Install each framing member so fastening surfaces vary not more than 3.2 mm (1/8") from the plane formed by faces of adjacent framing.

e. In double stud walls, do not bridge across studs on opposite sides of wall with gypsum board or metal cross bracing.

.3 Give complete cooperation and direction to trades erecting framing and furring over which this work is applied. Coordinate finished joint location with framing.

.4 Coordinate installation and cooperate with mechanical and electrical work to accommodate mechanical electrical items and any other work required to be incorporated into or coordinated with the partitions, ceiling and soffit systems.

a. Where the presence of suspended ductwork or other mechanical or electrical services or devices above ceiling framing conflicts with ceiling framing suspension points from structure above, provide bridging framing below conflicting work as required to support ceiling framing on specified intervals.

b. Do not suspend ceiling framing from mechanical or electrical suspension systems unless agreement is obtained in writing from engineer for Subcontractor installing such framing that additional imposed loads are acceptable; obtain Consultant's acceptance before proceeding.

.5 Provide clearances between work of this section and structural elements to prevent transference of structural loads.

.6 Do not bridge building expansion joints with steel framing or furring members. Independently frame both sides of joints with framing of furring members or as indicated.

.7 Size framing systems according to manufacturer's engineered load tables, to meet allowable deflection without permanent deformation.

a. Maximum allowable deflection: L/240.

b. Maximum allowable deflection for tiled partitions: L/360.

3.2 BLOCKING AND SHEATHING

.1 Attach to framing adequate backer plates to support the load of, and to withstand the withdrawal and shear forces imposed by, items installed upon the work of this section.

.2 Min. 25 ga. Galvanized Sheet Metal backer plates.

3.3 FURRING - GENERAL

.1 Furring indicated in Contract Documents is schematic. Do not regard as exact or complete. Provide all necessary framing and furring to support gypsum board in accordance with manufacturers' specifications.

.2 Shim furring as required to achieve required installation tolerances.

.3 Leave finished work rigid, secure, square, level, plumb, curved to detailed radius and erected to maintain finish gypsum board line dimensions and contours. Make allowance for thermal movement.

.4 Thermally separate metal studs from exterior concrete or masonry.

3.4 SUSPENDED AND FURRED CEILINGS

.1 Arrange hangers for suspended gypsum board ceilings to provide support independent of walls, columns, pipes, ducts; erect plumb, and securely anchored to structural frame, or embed in concrete slabs.

.2 Keep lateral braces at hangers back 450 mm (18") minimum unless otherwise noted.

.3 Space hangers at 914 mm (36") on centre maximum along runner channels, and not more than 150 mm (6") from ends.

.4 Space runner channels at 1220 mm (48") on centre, maximum, and not more than 150 mm (6") from boundary walls, interruptions of continuity, and changes in direction. Run channels transversely to structural framing members.

.5 Where splices are necessary, lap members at least 200 mm (8") and wire each end with 2 loops. Avoid clustering or lining up of splices.

.6 Attach to rod hangers by bending hanger sharply under bottom flange of runner, and securely wiring in place with saddle tie.

.7 Erect cross furring channels transversely across runner channels at 400 mm (16") on centre maximum, 305 mm (12") on centre at fire rated assemblies, at not more than 150 mm (6") from boundary wall openings, interruptions in ceiling continuity, and changes in direction.

.8 Secure furring channels to each support with purpose-made slips or wire tie. Splice joints by lapping channels and tying together.

.9 Level cross furring channels to maximum tolerance of 3 mm in 3 m (1/8" in 10 ft).

.10 Install ceiling framing assemblies at interface with suspended acoustical ceilings specified in Section 09 51 23, to project minimum of 100 mm (4") above acoustic tile suspension assemblies.

3.5 WALL FURRING

.1 Install steel furring for braced walls, free standing walls, walls that are furred out as indicated.

.2 Frame openings and around built-in equipment, cabinets, access panels, on 4 sides, with channels. Extend furring into reveals. Check clearances with equipment suppliers.

.3 Provide bulkheads and boxed-in duct shafts, for beams, columns, pipes and around exposed services where indicated. Install 19 mm (3/4") channels at corners and at 305 mm (12") on centre.

3.6 METAL STUD PARTITION FRAMING

.1 Provide partition tracks (runners) at floor and underside of structural assembly and as follows:

a. Align accurately and lay out according to partition layout.

b. Secure runners to concrete access flooring and to concrete slabs, as applicable, with screwed or shot fasteners located 50 mm (2") from each end and spaced at maximum 610 mm (24") on centre.

c. At partition corners, extend one runner to end of corner and butt other runner to it, allowing necessary clearance for gypsum board thickness. Runners should not be mitred.

.2 Unless otherwise indicated, place interior studs vertically at centres as follows:

a. Provide studs at 400 mm (16") on centre, and as specially spaced in accordance with details indicated.

b. Provide studs not more than 50 mm (2") from abutting walls, openings and each side of corners.

c. Provide freedom for 19 mm (3/4") deflection under beams, structural slabs and the like to avoid transmission of structural loads to studs, or install 50 mm (2") leg ceiling tracks.

.3 Install studs in tracks at floor and ceiling.

.4 Where horizontal runs of service lines are scheduled to be installed, arrange with applicable trades and install studs simultaneously with services.

.5 At openings in stud walls, erect track at head and sills to accommodate intermediate studs. At each end of track, cut out flanges, turn up web, and fasten to studs. Install intermediate studs above and below openings in same manner and spacing as wall studs. Install double studs at each jamb, and double tracks at head of door openings.

.6 At partitions requiring fire rating, erect in accordance with requirements of listing.

.7 Size studs, connections, and runners to carry loads according to stud manufacturer's load tables, at 24 kg/m2 (5 lb/ft2) live load to meet maximum allowable deflection limits. Where depth of stud is indicated, size metal thickness to meet allowable deflection limits.

.8 Provide three studs at corner and intermediate intersections of partitions.

.9 Coordinate work with others installing horizontal runs of service lines so that work is done simultaneously. Where standard holes are too small for installed services, notch studs, and splice notched flanges with splice pieces 305 mm (12") longer than notches, each fastened with 2 screws.

.10 Provide metal studding to maximum tolerance of 3 mm in 3 m (1/8" in 10 ft).

.11 Coordinate simultaneous erection of studs with installation of service lines. When erecting studs ensure web openings are aligned.

.12 Coordinate erection of studs with installation of door/window frames and special supports or anchorage for work specified in other sections.

.13 Unless otherwise indicated, partitions, together with gypsum board facings, shall extend above ceilings to underside of structure above.

.14 Maintain clearance to avoid transference of structural loads to studs.

.15 Chase walls:

a. Provide chase walls where indicated, consisting of two parallel steel stud partitions.

b. Provide cross bracing consisting of metal furring, located at quarter points on each pair of studs. Attach cross bracing to studs with metal screws. Coordinate construction of partitions to suit installation of services.

.16 Lateral support bracing channels:

a. Stiffen partitions over 3 m (10') in vertical span, at mid-height to maximum vertical spacing of 2440 mm (8') on centre, with at least one 19 mm (3/4") horizontal bracing channel, extending full length of partition, overlapping at least two stud spaces at ends of bracing channels.

b. Stiffen partitions at not more than 150 mm (6") from the top and bottom of openings and across two full stud spaces at each side of openings with horizontal bracing channel.

3.7 CONTROL JOINTS

.1 Control joints: in accordance with Section 09 29 00.

3.8 CONCRETE ANCHORS

.1 Provide anchorage points in reinforced concrete floor slab underside in accordance with gypsum board manufacturer's suspension requirements. Drill holes with carbide-tipped drill bits conforming to ANSI B212.15-1994.

.2 Provide anchors; minimum installation depth, and method of expansion as recommended by the anchor manufacturer.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included:

a. Provide lead backed gypsum wallboard.

.2 Related Sections:

a. Radiation Protection – General: Section 13 49 00.

1.3 SUBMITTALS

.1 Certificate of Compliance: Provide manufacturer's certificate of compliance indicating that gypsum wallboard for this project has been produced in accordance with requirements specified herein and the radiation physicist shielding report.

1.4 REFERENCE STANDARDS

.1 Comply with requirements of National Council on Radiation Protection and Measurement (NCRP) Report No. 49 "Structural Shielding Design and Evaluation for Medical Use of X-Rays and Gamma Rays of Energies up to 10 MeV", and NCRP Report No. 147 "Structural Shielding Design for Medical X-Ray Imaging Facilities".

.2 Must Comply with requirements of local regulatory agencies where standards and criteria exceed NCRP Reports 49 and 147.

a. Lead Backed gypsum wallboard must meet or exceed the following specifications or standards:

b. QQ-L-201f, Grade C, 99.9% Pure – Federal Specification, Lead.

c. ASTM B749 Type L51121, American Society for Testing and Materials - Lead Sheet.

d. ASTM C36, American Society for Testing and Materials – Gypsum Wall Board, Type "X".

PART 2 PRODUCTS

2.1 MANUFACTURERS

.1 Acceptable manufacturers:

a. MarShield - Division of Mars Metal Company.
b. Mayco Industries, Inc.
c. Nelco.
d. Pitts Little Corporation.
e. Ray-Bar Engineering Corporation.

2.2 MATERIALS

.1 Lead Sheet: Rolled lead sheet: 99.9% pure unpierced virgin lead, free from dross, oxide inclusions, scale, laminations, blisters, and cracks, to ASTM B749-03. Thickness: 1.6 mm Pb. Variation in thickness not to exceed 3%.

.2 Sheet Size: Width and length as required for support spacing to prevent cracking during handling. Not to exceed 1220 mm x 2440 mm, Type X Standard (RB-LBG) also available in Abuse Resistant (AR), Mold Resistant (MR), Water Resistant (WR) and High Impact (HI) gypsum panels, where required.

.3 Thickness: Not less than 16 mm.

.4 Fire-rated lead backed drywall (Type RB-LBG) available as U.L. Classified to U.S. and Canadian Safety Standards (See complete marking on product must to be utilized at any fire rated lead lined partitions (such as partition design U430) and must identified with proper yellow U.L Label laminated on actual lead side indicating shielding material manufacturer and current fire resistance listing and U.L. classification per the current U.L. certification directory and as tested in accordance with the standard fire test of building construction and materials per ANSI / UL263 (ASTM E119, NFPA 251).

.5 Provide 50 mm wide lead strips for lapping at vertical joints same height and thickness as lead on boards.

.6 Provide lead discs or additional batten strips at intermediate studs for shielding of screw penetrations.

.7 Accessories and Fasteners: Manufacturer’s standards, maintaining equivalent protection as entire system.

2.3 FABRICATION

.1 Factory laminate under pressure to the backside of the gypsum panel with lead thickness value clearly labeled on lead side of each board.

PART 3 EXECUTION

3.1 INSTALLATION AT LEAD LINED WALLS

.1 Apply gypsum board vertically with long edges parallel to supports and lead lining facing supports. Provide blocking at end joints. Install vertical lead batten strips minimum 40 mm wide and same height and thickness as gypsum board lead lining to inside of face channel of stud supports and blocking where all vertical joints, inside and outside corners occur. Secure lead batten strips to studs, lead shielding thickness and height as specified in the health radiation physicist report for this project.

.2 Secure gypsum board to supports with fasteners spaced as recommended by board manufacturer. Drive fasteners slightly below exposed surface and shield with either lead discs, tabs or internally with 50 mm wide batten strips, and 30 mm long steel screws when appropriate per NCRP Report No. 147 and specifically approved by project physicist of record prior to beginning the installation.

a. All penetrations in lead lined walls must be properly backed with sheet lead of same thickness as on surrounding wall with proper overlaps as required.

b. Where outlet boxes, junction boxes, ducts, conduit and similar items prevent the use of shields, provide lead sleeves or lead lining or backing as required with proper overlaps. Provide lead lining, sleeves, shields and other protections or equivalent thickness of lead as used in the wall partition shielding system that each penetrations occurs in.

c. Install lead-laminated gypsum board on framing with screws spaced not more than 203 mm (8") on centre along edges of board and 305 mm (12") on centre in field of board.

d. Adhere lead discs to fastener heads. In each case, use method that provides continuous radiation shielding.

e. Adhere lead strips on face of studs at joints in lead-laminated gypsum board, including inside and outside corners. Use 50 mm wide strips by same thickness as sheet lead laminated on gypsum board.

.3 Installation – Wall Penetration Items:

a. Provide lead shields to maintain continuity of protection at penetrations of lead linings.

b. Provide lead linings, sleeves, shields, and other protection in thickness not less than that required in assembly being penetrated.

c. Cut wall penetration covers from lead sheet of equal or greater thickness than backing on adjacent wall panels. Cut wall penetration covers to size required to cover wall penetrations with laps 25 mm minimum wide.

d. Adhesive-apply lead sheet penetration covers on penetrating boxes and raceways and return penetration covers to backside of lead-backed wall panels with 25 mm minimum laps.

e. Do not use penetrating fasteners unless indicated otherwise.

f. Outlet boxes and conduit: Install between studs using steel telescoping mounting brackets. Cover or line with lead sheet lapped over adjacent lead lining at least 25 mm. Wrap conduit with lead sheet for a distance of 250 mm from box.

g. Piping: Wrap piping with lead sheet for 250 mm from point of penetration.

.4 Installation – Wall Penetration Covers:

a. Duct penetrations; with 8 psf or less of lead sheet.

1. Wrap ducts with wall penetration covers, lapping lead joints 25 mm.
2. Secure lead sheet in place with 25 mm minimum width steel bands spaced not more than 305 mm on centre.
3. Do not cut into lead sheet with tightening steel bands.

b. Duct penetrations; with greater than 8 psf of lead sheet and where duct shielding exceeds 610 mm in width.

1. Laminate wall penetration covers to plywood or other similar structural panels conforming to shape of duct, lapping lead joints 25 mm.
2. Secure lead laminated panels to ducts with mechanical fasteners located at duct seams and corners.
3. Where necessary to prevent lead laminated panels from overloading duct supports, independently suspend panels from hangers secured to overhead building structure.
4. Cover fastener heads with lead sheet matching thickness of adjacent lead.

.5 Recycle or disposed of all lead trimmings in compliance with applicable health, safety and environmental codes and regulations.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included:

a. Provide suspended ceiling system, hangers, tees, tiles and acoustical and non-acoustical ceiling panels and systems for a complete acoustic ceiling.

b. Provide luminous ceiling system.

.2 Related Work Specified Elsewhere:

a. Gypsum board ceilings by: Section 09 25 00

b. Mechanical: Division 24

c. Electrical: Division 26

1.3 QUALITY ASSURANCE

.1 Acoustic Ceiling System to be ASTM 635 Light Duty Standard, installed in accordance with ASTM 636.

1.4 SUBMITTALS

.1 Shop Drawings: Submit Shop Drawings indicating overall layout, pattern, and details.

.2 Samples: Submit duplicate full size samples of each type acoustical units of all patterns available in specified acoustic tiles to Architect for final selection.

.3 Maintenance Materials: Supply a minimum of one full carton of each type of acoustic tile, packed in original cardboard cartons, marked with manufacturer and product name, for future repairs and place where direct by the Architect.

.4 Reference Data: Provide finish materials catalogue cuts and maintenance instructions for insertion in Operating Manuals and Reference Data, Section 01 33 00.

1.5 MOCK-UP

.1 Construct mock-ups in accordance with Section 01 45 01 - Quality Control.

.2 Construct mock-up where directed.

.3 Allow two (2) working days for inspection of mock-up by Owner's Representative before proceeding with ceiling work.

.4 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of the finished work.

1.6 ENVIRONMENTAL REQUIREMENTS

.1 Permit wet work to dry before commencement of installation.

.2 Maintain uniform minimum temperature of 15°C and humidity of 20 - 40% before and during installation.

.3 Store materials in work area 48 hours prior to installation.

1.7 EXTRA MATERIALS

.1 Provide extra materials of acoustic units in accordance with Section 01 77 01 - Closeout Submittals.

.2 Provide acoustical units amounting to 2% of gross ceiling area for each pattern and type required for project.

.3 Extra materials to be from same production run as installed materials.

.4 Clearly identify each type of acoustic unit, including colour and texture.

.5 Deliver to Owner's Representative, upon completion of the work of this section.

.6 Store where directed by Owner's Representative.

1.8 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for acoustical ceilings for incorporation into manuals.

PART 2 PRODUCTS

2.1 MATERIALS

.1 Acoustic Tile ACT1: See Room Finish Schedule for Series and manufacturer.

.2 Luminous Ceiling Tile LCT1: Classic EcoPlus LED by Luminous SkyCeilings EP22 and EP24. See Room Finish Schedule for Series and manufacturer.

.3 Suspension system: Torsion spring system consisting of main tees and cross tees complete with panel location fin for panel alignment Ceilenico by Decoustics, or approved alternate.

a. Finish: All metal products steel galvanized to Z275, prepaint all exposed surfaces, CGSB 31-GP-116M, and then a baked-on factory finish with satin sheen enamel in white to match acoustic tile.

b. Main Tees: Nominal 3600 mm long, rectangular bulb at top of web, 38 mm high web, 19 mm face width designed to lock into consecutive lengths to function structurally

as a single unit with face at joint perfectly aligned and presenting a tight inconspicuous seam.

c. Cross Tees: 610 mm long, same design as main tee, except designed to connect at main tee to form positive lock without play, loss or gain in grid dimensions with offset over-ride of face over main tee face flange to provide flush tee faces at joints.

d. Edge Moulding: Min. of 0.46 mm thick steel, 14 mm wide legs, capable of supporting all superimposed loads.

e. Hold-Down Clips: Of 0.42 mm thick spring steel as recommended by acoustic tile manufacturer, and special access clips where specified.

f. Fixture Clips: As recommended by acoustic tile manufacturer.

g. Tie Wire: Min. 1.59 mm soft annealed steel wire.

PART 3 EXECUTION

3.1 PREPARATION

.1 Co-ordinate with Section 09 12 00 to ensure adequate and properly placed hangers.

.2 Co-operate with mechanical, electrical and other trades to accommodate fixtures, fittings and other items in acoustic ceilings.

3.2 INSTALLATION

.1 Neatly and symmetrically fit and run suspended ceiling to true lines, evenly balance in all areas to pattern as directed.

.2 Unless noted on drawings, centre ceiling system on room axis leaving equal border tiles or panels not less than 1/2 a full width.

.3 Cut recess into tiles at partition walls that are to be set up into tiles. Seal cut portion of tile with paint to match tile finish.

.4 Recessed items shall re be centered on acoustical panels, except where indicated otherwise. Consult with mechanical and electrical trades to co-ordinate the work. Provide support where required.

.5 Turn bottom of hanger rods or straps upwards at tees and securely wrap 3 times with tie wire, or wrap hanger wire around tees and double twist tie.

.6 Run main tees at right angles to length of light fixtures.

.7 Space main tees 600 mm o.c. in one direction and securely tie to hangers.

.8 Space cross tees 1220 mm o.c. at right angles to the main tees and properly lock at intersections.

.9 Level the suspended systems with a maximum tolerance of 1/8" (3 mm) over 3600 mm and 6 mm over all.

.10 Use the longest practical lengths of tees, furring and running channels to minimize joints. Make joints square, tight, flush and reinforced with concealed splines. Assemble framework to form a rigid and interlocking system.

.11 Use edge moulding where ceiling abuts vertical surface.

.12 Join abutting sections of main tees to unify sections structurally and present an unnoticeable joint.

.13 Intersections of all tees and edge moulding shall be flush on the exposed surface.

.14 Provide fixture clips at all four corners of electrical fixtures.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL INSTRUCTIONS

.1 Read and be governed by conditions of the Contract and sections of Division.

1.2 QUALITY ASSURANCE

.1 Qualifications: Provide work of this section, executed by competent installers with minimum 5 years experience in application of Products, systems and assemblies specified and with approval and training of Product manufacturers.

.2 Products installed as part of the work of this section shall be from same production run.

1.3 SUBMITTALS

.1 Submit required submittals in accordance with Section 01 33 00.

.2 Product data sheets:

a. Submit manufacturer’s Product data sheets for Products proposed for use in the work of this section, including but not limited to floor covering, heat-welding bead, cove cap, & cove fillet support.

.3 Samples:

a. In manufacturer's standard size, but not less than 150 mm x 230 mm (6" x 9") submit samples of each different color and pattern of floor covering proposed for use in the work of this section.

b. Submit samples of cove cap and cove fillet support strip proposed for use in the work of this section.

.4 Shop drawings:

a. Seaming and layout drawings: Submit for review drawings of seam locations, and the location and type of accessories and other information and details pertaining to the installation of sheet flooring.

.5 Flooring installation mock-up:

a. Prior to commencing flooring installation for this section, prepare full room mock-up (room size at least 10 m2 (100 ft2) in area) for acceptance by the Consultant.

b. Do not proceed with flooring specified in this section until mock-up has been accepted by Contractor and Consultant.

.6 Closeout submittals:

a. Submit closeout submittals in accordance with Section 01 77 00.

b. Maintenance data:
    1. Submit maintenance data for sheet flooring for incorporation into maintenance manual.
c. Maintenance materials:
    1. Submit flooring width x 4500 mm (flooring width" x 14'8") of each colour in full running length, pattern and type flooring material required for this project for maintenance use.
    2. Maintenance materials to be same production run as installed materials.
    3. Suitably package for protection and storage, each identified with name of manufacturer and flooring material.
    4. Tag and store where directed by Owner.

1.4 ENVIRONMENTAL REQUIREMENTS

.1 Install materials of this section only when surfaces and air temperatures have been maintained between 18°C and 32°C for 48 hours preceding installation, and will be so maintained during installation and for 48 hours thereafter. Maintain a minimum temperature of 13°C after above period.

.2 Ensure that adequate ventilation is provided during installation and curing of materials of this section.

.3 Ensure that spark-proof electrical equipment is provided in areas where flammable adhesives are used. Store materials to prevent spontaneous combustion.

.4 Conduct the tests in accordance with ASTM F710-11 and the following:

a. Test for moisture vapour transmission in accordance with ASTM F710-11 and ASTM F1869-11 or ASTM F2170-11 in accordance with manufacturer's written flooring installation instructions. Results must not exceed 170 µg/m2 (3 pounds per 1,000 square feet) in 24 hours when tested to ASTM F1869-11, or exceed 75% when tested to ASTM F2170-11.
b. Test for surface pH. Levels of pH shall not exceed the written recommendations of the flooring manufacturer and adhesive manufacturer. Test in accordance with ASTM F710-11.
c. For each test type: Conduct 3 tests for flooring applications up to 93 m2 (1000 square feet) in area, and 1 additional test for each additional 93 m2 (1000 square feet) of flooring area.
d. Testing shall be conducted by independent inspection and testing company and in accordance with Section 01 45 00.

.5 In areas that are exposed to intense or direct sunlight, Products shall be protected during the conditioning, installation, and adhesive curing periods, by covering the light source.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Package flooring materials and identify contents of each package.

.2 Store materials for a minimum of 24 hours immediately before installation at no less than 18°C.

1.6 WARRANTY

.1 Warrant work of this section for a period of 2 years, in accordance with Section 01 78 36.

PART 2 PRODUCTS

2.1 SHEET FLOORING

.1 Linoleum and/or vinyl sheet flooring:

a. Acceptable Product/manufacturer: Refer to Room Finish Schedule.

b. Colours: Refer to Room Finish Schedule.

2.2 MISCELLANEOUS MATERIALS

.1 Primers and adhesives: as recommended by flooring manufacturer.

.2 Substrate filler; for patching, smoothing, and levelling monolithic substrates: Type as recommended by manufacturer for subfloor on which this material is installed.

.3 Substrate filler for sloping substrate to drain: Quick setting, purpose-made for sloping to drain from approximately 50 mm (2") thickness to featheredge underneath finished flooring. Minimum compressive strength to be greater than 28.3 MPa (4000 psi) after 28 days. Type as recommended by manufacturer for subfloor on which this material is installed.

.4 Prefabricated flash cove base; (integral cove base with metal backing) where scheduled:

a. Acceptable manufacturer: FlashCove Prefabricated Bases Inc.

b. Description: 3 m (10’) factory fabricated lengths, with puncture resistant aluminium reinforcing attached through the cove radius, using project specific sheet flooring in run to match specified flooring material and colours.

c. Riser: 100 mm (4") riser with 75 mm (3") toe.

d. Cove cap: Vinyl “J” cap installed as per manufacturer’s written instructions.

e. Substitutions: Refer to Section 01 25 00.

.5 Seaming system: heat welding rod system as manufactured by flooring manufacturer. Colours as selected by Consultant.

.6 Temporary protection material: Heavy kraft paper with joints lapped and taped or as otherwise required to prevent damage to finished finishing application.

.7 Joint sealants: Sealant in accordance with Section 07 92 00.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Examine substrate to ensure clean lines, correct level and freedom from cracks, ridges, dusting, scaling and carbonation.

.2 Examine floors in advance of application of flooring to ensure that floors are protected against entry of water and moisture. Perform compatibility test with primer/adhesive and substrate.

.3 Ensure that environmental conditions have been provided as requested and specified.

3.2 PREPARATION

.1 Comply with recommendations of ASTM F710-11.

.2 Verify that substrates are dry and free of curing compounds, sealers, and hardeners.

.3 Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.

.4 Alkalinity and adhesion testing: Perform tests and proceed with installation only after substrates pass testing. Document tests performed and submit in writing to Consultant.

.5 Fill cracks, holes, and depressions in substrates with trowel-applied levelling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

.6 Do not install floor coverings until they are same temperature as space where they are to be installed.

a. Move floor coverings and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

.7 Sweep and vacuum clean substrates to be covered by floor coverings immediately before installation.

.8 Remove chalking and dusting from concrete surfaces with wire brushes.

.9 Where flooring adjoins thicker floor materials, apply levelling screed, feather out to make up difference in level between materials.

.10 Where substrate filler is required for sloping floor, Contractor shall perform a floor slope water flow test in the presence of the Consultant and obtain Consultant's review and acceptance of sloped floor prior to flooring application.

3.3 FLOORING APPLICATION

.1 Apply adhesive uniformly and install flooring in accordance with flooring manufacturer's instructions. Do not spread more adhesive than can be covered by flooring before initial set takes place.

.2 Lay out floor coverings as follows:

a. Lay flooring with joints parallel to building lines to produce symmetrical pattern and minimum joints. Use full sheet size to produce minimum joints. Lay sheet flooring centered in corridors, with equal sized sheet to either side of center sheet. Weld all joints.

b. Install in accordance with Consultant's floor pattern.

c. Maintain uniformity of floor covering direction.

d. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 150 mm (6") away from parallel joints in floor covering substrates.

e. Match edges of floor coverings for colour shading at seams.

f. Avoid cross seams.

.3 Install rolls in according with manufacturer's written instructions.

.4 Cut pieces to length allowing approximately 75 mm (3") excess for trimming.

.5 Cut the first piece to fit by freehand knife, direct scribing or pattern scribing method.

.6 Remove 12.7 mm (1/2") off the factory seam edge using an edge trimmer or straight edge and knife.

.7 Position all remaining sheets so that the top sheet overlaps the previous sheet by 12.7 mm (1/2"). Trim 12.7 mm (1/2") off opposite seam edge using an edge trimmer or straight edge and knife.

.8 Fold back the sheets and apply the adhesive to the subfloor and allow proper open time.

.9 Install flooring to entire area indicated or scheduled, including coverplates occurring within finished floor areas. Maintain overall continuity of colour and pattern with pieces of flooring installed on cover plates. Tightly butt edges to perimeter of floor around cover plates and to cover plates. Cut flooring to floor drains occurring within finished floor areas.

.10 Roll the flooring in both directions using 68 kg (150 lb) three-section roller. (Stay approximately 75 mm (3") from the seam.)

.11 Cut and fit neatly around fixed or excessively heavy objects.

.12 Terminate flooring at centerline of door in openings where adjacent floor finish or colour is dissimilar.

.13 Flooring installation shall not show telegraphing of substrate. Flooring installation shall be homogenous free of substrate lines, pockets, bumps and unevenness.

.14 Heat-welded seams:

a. Weld seams in accordance with ASTM F1516-08.

b. Wait minimum of 24 hours after flooring installation before grooving and heat welding seams.

c. Prepare, weld, and trim seams to produce flat surfaces flush with adjoining floor covering surfaces.

d. Rout joints to approximately 2/3 of the thickness of the material and use welding bead to permanently fuse sections into a seamless floor covering. Groove shall be between 3 mm (0.118") and 3.5 mm (0.138") wide.

e. Using a weld plate and skiving knife to make first cut and allow weld rod to fully cure to room temperature.

f. Using a skiving knife only, finish the trimming of the remainder of the weld. The finish should be smooth and on the same level as the flooring.

g. Trimming of welded joint while warm is not permitted unless final trimming is performed after weld has cooled to flooring temperature. Excess weld shall be removed using a heated standard putty knife.

h. Roll the seam area with 45 kg (100 lb) three-section roller.

i. Maximum variation of welds from plane or from straight: 6 mm (1/4") in 3 m (10 ft) length using a 3 m (10 ft) straight edge.

j. Use linoleum welding rod where vinyl sheet flooring and linoleum sheet flooring meet.

3.4 WALL BASE INSTALLATION

.1 Install bases in accordance with manufacturer’s written instructions.

.2 Prefabricated flash cove installation:

a. Butt joints to be square cut; inside and outside corners to be mitre cut on site using appropriate power mitre saw. Joints to be seam welded according to manufacturer’s instructions.

b. Seal ends of cove, where the cove meets a doorframe, walls, and other surfaces with colour matched sealant.

c. Terminate top of coving with purpose made rounded top resilient trim.

d. Taper/trim cove former to reduce radius to less than 12.7 mm (1/2") at door frame or similar abatement conditions.

e. Seal trim to wall substrate with sealant bead, colour to Consultant's selection.

f. Install cove bases straight and level to variation of 1:1000.

g. Scribe and fit to door frames and other obstructions. Joints shall be tightly fitted, straight and vertical, and not less than 610 mm (24") from corners. Provide joints in base over substrate control joints.

3.5 CLEANING

.1 Remove excess adhesive from surfaces of the sheet flooring and base as work progresses.

.2 Thoroughly clean surfaces and perform initial maintenance in accordance with manufacturer's printed instructions.

.3 Construction clean to be coordinated and paid for by the Contractor. Area of work is to be turned over in a clean state (walls, floors, windows, and surfaces wiped down and clear of any debris). Terminal clean and waxing of floors to be completed by Owner outside the Contract.

3.6 PROTECTION

.1 Protect new floors from time of final set of adhesive until final inspection. Install suitable protection sheeting, lap joints of material by 150 mm (6") and seal with non-asphaltic tape.

.2 Prohibit traffic on floor for 48 hours after installation. No heavy traffic, rolling loads, or furniture placement for 72 hours after installation.

.3 Install floor protection in areas where other work, repairs and installation of equipment, and foot traffic will occur.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included:

a. Exterior - Apply paint to ferrous (non-galvanized) metal and other surfaces.

b. Interior - Work shall generally include the following:

1. Paint all surfaces and objects within new and existing rooms, except where specifically indicated or specified otherwise. This includes grilles, pipes, ducts, etc.
2. In areas indicated as unfinished on Room Finish Schedule, painting is still required at doors and frames, elevator doors and trim (if applicable), exposed unprimed structural steel, and other items normally requiring protection.
3. Do not paint acoustical ceilings, architectural woodwork, manufactured casework, chalkboards, their trim, windows and window frames, baked enamel finished metals, toilet partitions, aluminum, copper, plastic laminate, hardware or other surfaces obviously not intended to be painted, unless otherwise specifically stated.

.2 Related Work Specified Elsewhere:

a. Shop priming is provided on some items by their respective Sections.

b. Identification and lettering of mechanical Work: Division 22, 23, 24

1.3 QUALITY ASSURANCE

.1 Comply with requirements of Ontario Painting Contractors Association (OPCA) Master Painters Institute (MPI) Architectural Specifications Manual, latest edition.

.2 Engage a qualified independent inspector, with MPI Level 3 certification and acceptable to the Architect, to verify that Work conforms to Contract Documents. Include cost of inspection in Contract.

.3 Job Mock-Up:

a. Prepare small sample room for painted finish, giving prime coat to one wall, two coats to second wall, and three coats to third wall. Leave sample room for that

purpose until majority of Work is finished. Each coat to be tinted a different colour from previous coat.

b. Prepare small one wall mock-up for each individual paint colour as requested by Architect.

1.4 MATERIAL STANDARDS

.1 Conforming to ECP-07-89/ECP-12-89:

a. Interior Latex Type, Flat Paint: CAN/CGSB-1.100-M

b. Primer-Sealer, Wall, Interior Latex Type: CAN/CGSB-1.119-M

c. Paint, Exterior, Latex Type, Flat: CGSB 1-GP-138M

d. Emulsion Type Filler Masonry Block: CAN/CGSB-1.188-M

e. Interior Semigloss Latex Paint: CAN/CGSB-1.195-M

f. Primer, Exterior, Latex Type: CGSB 1-GP-203Ma

g. Stain, Pigmented, Exterior Latex Type: CGSB 1-GP-204M

1.5 SUBMITTALS

.1 List of Materials: Before ordering materials, submit in writing a complete list of all types and brands of materials to be used for this job and adjacent to each type state surface and/or location of application. Paint list shall bear manufacturer's certification that materials listed are premium quality. Do not order materials or commence Work until list is approved by Architect. On request of Architect, produce invoices from time to time covering all materials on job.

.2 Samples: Provide 300 mm x 300 mm samples of each coat of each paint colour as selected by the Architect. Work must match approved samples.

.3 Reference Data: Provide data to Operating Manuals and Reference Data.

.4 Maintenance Materials: Provide the Owner with all opened, but not completely used materials in resealed containers, minimum 2 litres of each colour, marked with colour number for maintenance purposes.

1.6 JOB CONDITIONS

.1 Inspection: Inspect all surfaces before commencement of this Work and verify their readiness for this Work.

.2 Scheduling: Commence interior Work only when building is completely enclosed and sealed, all Sections creating dirt have completed their Work, room doors are installed,

heating and ventilation is provided or permanent systems are working and Work areas can be closed to traffic until Work cures.

.3 Environmental Requirements: Follow manufacturer's recommendations. Do not paint exterior surfaces during cold, windy, rainy or frosty weather when temperature is likely to drop below 10 deg C, when surfaces are damp or exposed to hot sun. Interior temperatures shall be at least 15 deg C, 21 deg C preferable, before commencing interior Work.

1.7 WARRANTY

.1 Provide OPCA 2 year warranty.

PART 2 PRODUCTS

2.1 MATERIALS

.1 Standards:

a. Water Based Paint Standard:

1. In accordance with Environmental Choice Program guideline ECP-07-89, water based paint shall be formulated or manufactured free from formaldehyde, halogenated solvents, aromatic hydrocarbons, mercury or mercury compounds, or be tinted with pigments of lead, cadmium, chromium VI and their oxides.
2. Paint must have Flash Point of 61.0 deg C or greater, and not contain Volatile Organic Compounds in excess of 250 grams per litre (g/L).

b. Solvent Base Paint Standard:

1. In accordance with ECP guideline ECP-12-89, solvent based paint shall not be formulated with formaldehyde, halogenated solvents, aromatic hydrocarbons in excess of 10% of weight, mercury or mercury compounds, or be tinted with pigments of lead, cadmium, chromium VI and their oxides.
2. Paint shall have Flash Point of 37.8 deg C or greater, and not contain Volatile Organic Compounds in excess of 380 g/L.

.2 Manufacturer: The quality of paint shall be equal to the ECO label formulas prepared by Benjamin Moore “Pristine EcoSpec”, Canadian Industries Limited EcoLogo, Glidden, Para Paints Eco Logo, Sherwin Williams EcoLogo, or approved similar, and applied in strict accordance with the manufacturer's directions.

.3 Colours: Refer to room finish legend.

PART 3 EXECUTION

3.1 PREPARATION

.1 Protection:

a. Use sufficient drop cloths and protective coverings for full protection of floors and Work not being painted. Clean any components paint spotted or soiled.

.2 Coating Removal:

a. Apply to manufacturers written instructions. Repeat as required for complete removal of existing paints from glazed blocks and mortar joints.

.3 Surface Preparation:

a. Surfaces shall be dry, clean, smooth, free from dust, dirt, grease, rust, loose crystals, or extraneous matter. Wire brush metal castings before first coat.

b. Check non-metallic surfaces with moisture meter, do not proceed if reading is higher than 12-15% without written directions. If substrate is steel, do not apply coatings over moisture or when surface temperature is within 3 degrees Celsius of dew point.

c. Wash unpainted or shop painted metal free of grease, dirt or oil; remove rust; then prime or spot prime where material is exposed, with rust inhibitive primer. Feather our edges to make touch up paint inconspicuous.

d. Allow galvanized metal to weather minimum of 26 weeks and Xylene clean or abrade surface with bronze wool prior to coating.

e. Test masonry surfaces to be painted for alkalinity. Ensure neutral pH before painting.

f. If concrete to be painted is less than 26 weeks old, etch normal concrete surfaces with muriatic acid solution (1 part commercial 331.45% to 3 parts water). Rinse 2 or 3 times with clean water and bring pH of surface to neutral using Tri-Sodium-Phosphate (TSP) and flush and allow to dry to moisture content of 12-15% or less, read with electronic moisture meter. Confirm that no curing agents have been used on surfaces to be painted.

g. Inspect millwork to assure surfaces are smooth, free from machine or surface marks and that nailheads have been countersunk. Seal all knots and sapwood where painted.

h. Ensure shop sealer has been applied to glue-laminated beams.

i. Inspect gypsum board to ensure joints are completely filled and sanded smooth. Fill small nicks or holes with patching compound and sand smooth. Remove dust prior to painting.

j. Nail holes, splits or scratches shall be puttied or speckled smooth after prime coat. Where same occurs on transparent finish, putty shall be coloured to match finish.

k. If woodwork, metal or any other surface to be finished, cannot be put in proper condition for finishing by customary cleaning, sanding, puttying operations, notify Architect in writing, or assume responsibility for and rectify any unsatisfactory finish resulting.

l. For exposed steel in high humidity areas, prepare steel in accordance with Steel Structures Painting Council Standard SSPC.SP 6 for a Commercial Blast.

3.2 APPLICATION

.1 Use same brand of paint for primer, intermediate and finish coats. Use approved sealer for knots and sappy areas under enamels.

.2 Permit paint to dry before applying succeeding coats. Touch-up suction spots after application of first coat. Sand lightly between coats with No. 120 sandpaper.

.3 Painting coats specified are intended to cover surfaces completely. If materials and colours require additional coats to ensure adequate and uniform coverage, apply further coats until complete satisfactory coverage is achieved. Minimum finish shall be Premium (three coats) as defined by OPCA. Some deep hues or bright colours may require four coats.

.4 Areas exhibiting incomplete or unsatisfactory coverage shall have entire plane painted. Patching not acceptable. Paint entire plane of areas which have been cut and patched.

.5 Work application:

a. By skilled tradespeople in accordance with manufacturer’s directions and supervision.

b. In dust-free and suitable conditions for production of good results.

c. Even, uniform in sheen, colour and texture, free from brush or roller marks, sags, crawls, runs or other defects.

.6 Apply materials by brush or roller. Airless spray painting may be permitted in specific areas but Architect must be consulted and approve each area before Work commences. Architect may at any time prohibit use of spray painting for such reasons as carelessness, poor masking or protective measures, drifting paint fog, disturbance to other trades or failure to obtain dense, even opaque finish.

.7 Mechanical and Electrical Work:

a. Paint all convectors, grilles, conduit, pipes, ducts, panels, switch boxes, access panels, mechanical and electrical equipment which are not prefinished. Remove grilles, covers, access panels for mechanical and electrical systems from installed location and paint separately, if these items are not prefinished.

b. Paint Work to match surfaces they are seen against unless directed otherwise.

c. Finish interior surface of ventilation ducts where visible through grilles, diffusers, louvres, etc. Apply two coats of flat black paint to limit of site line.

d. Protect gauges, identification plates and similar items from being painted over or paint splattered.

3.3 GENERAL FINISHING

.1 Apply primer coat to unprimed ferrous metal surfaces.

.2 Prime woodwork designated for painting immediately upon delivery to site. Prime all surfaces of such woodwork, whether exposed or not, before installation. Back prime woodwork which is to receive transparent finish with 1 coat of transparent finish reduced 25%.

.3 Re-seal all cut edges of wood to be painted or finished, if material was cut subsequent to initial sealing. Ensure tops and bottoms of wood doors sealed.

3.4 LIST OF FINISHES

a. Exterior Galvanized Steel: Unpainted.

b. Exterior Steel: Rust inhibitor paint by Tremclad or Rust-oleum or Devoe.

c. Interior and Exterior Metal (Ferrous): Exposed Structural and Miscellaneous Steel:

1. 1 coat shop applied, oil Alkyd primer (metal surfaces already primed need only touchup).
2. 1 coat 100% Acrylic emulsion, waterborne, corrosion resistant paint as tie-coat at 1.5 - 2 mils Dry Film Thickness (DFT).
3. 2 coats semi-gloss acrylic emulsion finish at 1.2 mils/coat DFT. Total 3.9 - 4.4 mils DFT.

d. Interior Galvanized Steel (Hollow Metal Doors, Screens and Deck):

1. 1 coat 100% Acrylic emulsion, waterborne, corrosion resistant primer at 2 mils DFT.
2. 2 coats water reducible Latex house and trim paint at 1.2 mils/coat DFT. Total 4.4 mils DFT. Semi-gloss finish at doors and screens/Flat finish at steel deck.

e. Gypsum Board:

1. 1 coat Latex primer sealer at 1.0 mil DFT.
2. 2 coats interior Latex enamel at 1.5 mils/coat DFT. Total 4.0 mils DFT.

f. Painted Woodwork:

1. 1 coat undercoater, low-odour, pigmented, interior alkyd primer at 1.5 mil DFT. VOC complying. Back paint wood base.
2. 2 coats interior Latex enamel at 1.5 mils/coat DFT. Total 4.5 mils DFT.

g. Clear Finish for Wood: Penetrating wood stain by Behr, Minwax or Sikkens or Sansin for glulam and CLT.
   1. 1 coat stain.
   2. 2 coats water-based Urethane gloss varnish at 2.0 mils/coat. Total 4.0 mils DFT.

h. Knot and Sapwood Sealer: White shellac.

i. Concrete Block:
   1. 1 coat high-solids, pigmented block filler used full body, VOC complying, 3 mils DFT.
   2. 2 coats vinyl acrylic Latex enamel, VOC complying, 1.5 mils/coat DFT. Total 6 mils DFT.

j. Painted Concrete: 2 coats high-solids purpose made floor paint with non-slip surface.

k. Insulated and Uninsulated Pipes, Ducts, Conduit, Valves, Fittings and Equipment and Ancillary Items where “Exposed” in Completed Work:
   1. Insulated Work: 1 coat Latex primer sealer, 1 mil DFT. 2 coats interior Latex enamel, 1.5 mils/coat. Total 4.0 mils DFT.
   2. Non-insulated Work: 1 coat structural steel primer, 1 mil DFT. 2 coats interior Latex enamel, 1.5 mils/coat. Total 4.0 mils DFT.

l. Specific Areas:
   1. Existing previously painted walls: including Concrete block, drywall, vinyl faced and Interior Metal (Ferrous) surfaces:
      a. Prepare existing paint by removing all loose and peeling paint. Prep surfaces to be gloss free and clean of grease and dirt. Sand entire surface using 80–100 grit sandpaper followed by a wash of TSP and water and rinsed with clean warm water and allowed to dry.
      b. Apply:
         – 1 coat Devflex 4020 primer by Devoe or ICI Paints (Canada) Inc. or Sherwin-Williams, back roll to force and fill all pin holes to 3 mils DFT.
         – 2 coats Devflex 4216 to 5 mils DFT by Devoe or ICI Paints (Canada) Inc. or Sherwin-Williams.

3.5 FIELD QUALITY CONTROL

.1 Submit to OPCA, at least 4 weeks prior to commencement of Work on OPCA forms:

a. Request for Assignment of Inspector.

b. List of Paint Products.

.2 Provide and pay for OPCA inspector to requirements of Chapter 7 of OPCA Manual and submit written reports to Consultant.

END OF SECTION

PART 1 GENERAL

1.1 SUMMARY

.1 Section includes:

a. Folding privacy screen.

b. Vertical rack storage.

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Coordination:

a. Supply manufacturer's handling instructions, anchorage information, roughing-in dimensions, templates and service requirements for installation of the work of this section, and assist or supervise, or both, the setting of anchorage devices and construction of other work incorporated with Products specified in this section in order that they function as intended.

1.3 SUBMITTALS

.1 Submit required submittals in accordance with Section 01 33 00.

.2 Product data sheets:

a. Submit manufacturer's Product data sheets for Products proposed for use in the work of this section.

.3 Samples:

a. Submit 3 samples of each finish specified.

.4 Shop drawings:

a. Clearly indicate, materials, finishes, fabrication details, dimensions, thicknesses, plans, elevations, hardware, and installation details.

1.4 CLOSEOUT SUBMITTALS

.1 Submit closeout submittals in accordance with Section 01 77 00.

.2 Operation and maintenance data:

a. Submit manufacturer's operation and maintenance instructions for inclusion in the operation and maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Package or crate, and brace products to prevent damage during shipment and handling. Label packages and crates, and protect finish surfaces from environmental conditions where required.

.2 Deliver products to location at the Place of the Work designated by Contractor.

PART 2 PRODUCTS

2.1 GENERAL

.1 Incorporate reinforcing, fastenings and anchorage required for building in of Products.

2.2 POLE MOUNTED FOLDING PRIVACY SCREEN

.1 Acceptable Product:

a. Silentia Folding Screen, Wall, Standard, 06355-D

.2 Size: 2.4 M (L) x 1.85 M (H)

.3 Provide panels complete with casters, supports, spaces, and hardware.

.4 Number of panels: as indication on drawings.

.5 Finish: Daylight.

.6 Wall Distance: 0 M

.7 Weight: 15.3 kg

2.3 VERTICAL RACK STORAGE

.1 Welded steel storage racks with restraint chain, powder coated finish.

.2 Acceptable Product:

a. Grainger Rack Storage Vertical Bar + Pipe, as manufactured by Vestil.

b. Substitutions: in accordance with Section 01 25 00.

.3 Maximum load capacity: 680 kg (1500 lb) per bay.

PART 3 EXECUTION

3.1 PREPARATION

.1 Ensure that rough-in dimensions and blocking or back-up has been provided to comply with product manufacturer’s written requirements.

3.2 INSTALLATION

.1 Submit manufacturer's information and templates required for installation of work of this section, and assist or supervise, or both, the setting of anchorage devices, and construction of other work incorporated with Products specified in this section in order that they function as intended.

.2 Install work to meet manufacturers' recommended specifications, true, tightly fitted, and level or flush to adjacent surfaces, as suitable for installation.

.3 Include reinforcing, anchorage and mounting devices required for the installation of each Product.

.4 Fit joints and junction between components tightly and in true planes, conceal and weld joints where possible.

.5 Fabricate Products with materials and component sizes, metal gauges, hardware, reinforcing, anchors, and fastenings of adequate strength to ensure that specified items will remain free of warping, buckling, opening of joints and seams, and distortion within limits of intended use.

.6 Supply handling instructions, anchorage information, roughing-in dimensions, templates and service requirements for installation of the work of this section, and assist or supervise, or both, the setting of anchorage devices and construction of other work incorporated with Products specified in this section.

.7 Back paint components where contact is made with building finishes to prevent electrolysis.

3.3 ADJUSTING AND CLEANING

.1 Verify under work of this section that installed Products function properly, and adjust them accordingly to ensure satisfactory operation.

.2 Do not remove protective coatings until final cleaning in accordance with Section 01 77 00, or earlier if directed by Consultant.

.3 Refinish damaged or defective work so that no variation in surface appearance is discernible. Refinish work at Place of the Work only if approved.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included:

a. Recess-mounted horizontal medical headwall systems.

b. Factory-installed medical gas outlet stations.

c. Electrical power receptacles, grounding systems, and wiring devices.

d. Nurse call, code blue, and low-voltage device provisions.

e. Horizontal equipment management rails and accessories.

f. Decorative, cleanable fascia panels and removable covers.

.2 Related Sections:

a. Section 22 00 00 – Plumbing (Medical Gas Systems).

b. Section 26 00 00 – Electrical.

c. Section 27 00 00 – Communications.

d. Section 28 00 00 – Electronic Safety and Security.

1.3 REFERENCES

.1 CSA Z7396.1 – Medical Gas Pipeline Systems.

.2 NFPA 99 – Health Care Facilities Code.

.3 CSA C22.1 – Canadian Electrical Code.

1.4 SUBMITTALS

.1 Shop Drawings: Indicate headwall configuration, dimensions, recessed backbox requirements, medical gas outlet locations, electrical devices, low-voltage provisions, equipment rails, and coordination requirements with adjacent construction.

.2 Product Data: Manufacturer’s technical data, component descriptions, finishes, and installation instructions.

.3 Samples: Full range of available decorative laminate fascia finishes for Architect’s selection.

.4 Test Reports: Medical gas outlet testing and certification in accordance with CSA Z7396.1 and/or NFPA 99.

.5 Maintenance Data: Operation and maintenance manuals for installed systems.

1.5 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Manufacturer shall specialize in medical headwall systems with a minimum of five (5) years documented experience.

.2 Regulatory Requirements:

a. Medical gas outlets shall be factory-installed and tested in accordance with CSA Z7396.1 and/or NFPA 99.

b. Electrical components shall be CSA/UL listed and suitable for hospital use.

1.6 WARRANTY

.1 Provide manufacturer's standard warranty covering defects in materials and workmanship for a minimum period of one (1) year from date of Substantial Performance.

PART 2 PRODUCTS

2.1 MANUFACTURERS

.1 Acceptable Manufacturer:

a. Interspec Systems Limited – ARIA RM Recess-Mounted Horizontal Medical Headwall System.

b. Class 1 Inc.

c. Amico

2.2 MEDICAL HEADWALL SYSTEMS

.1 Description:

a. Recess-mounted, single-tier or double-tier horizontal medical headwall system, custom-manufactured to project requirements.

b. System designed for patient care environments providing integrated medical gas, electrical, and low-voltage services.

.2 Construction:

a. Enclosure constructed of extruded, satin clear anodized aluminum sections forming a modular recessed wall unit.

b. Backboxes constructed of minimum 16-gauge galvanized steel with double knockouts at top and bottom for primary conduit routing.

c. Horizontal conduits factory-assembled and wired to include specified mechanical and electrical components.

d. All secondary wiring enclosed within built-in conduits, colour-coded, labelled, and neatly tie-wrapped for circuit identification.

e. Removable anodized aluminum fascia allowing access to internal components.

.3 Medical Gas Components:

a. Factory-installed medical gas outlets as indicated on drawings, including oxygen, medical air, and vacuum.

b. All outlets and manifolds tested and certified by manufacturer in accordance with CSA Z7396.1 and/or NFPA 99.

c. Singular terminal connections provided for primary supply line connections by the mechanical contractor.

.4 Electrical Components:

a. Hospital-grade duplex receptacles, CSA/UL listed, quantity and configuration as indicated on drawings.

b. Internal grounding bus provided with a minimum of eight (8) screw fasteners.

c. External grounding jacks provided where required, with spring-loaded solid brass receptacles in non-conductive housings.

.5 Low-Voltage and Communications:

a. Provisions for nurse call, code blue, code white, code pink, voice/data, monitor mounts, dimmers, switches, and other low-voltage devices as indicated.

b. Devices by others; coordinate rough-in and mounting provisions within headwall.

.6 Equipment Management:

a. Universal horizontal equipment management rails integrated into headwall fascia to accommodate accessories and patient care equipment.

.7 Finishes:

a. Laminated aluminum decorative fascia panels, resilient and easy to clean, available in a wide selection of colours and patterns.

b. Finish selection by Architect from manufacturer’s standard range.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Verify wall construction, rough-in conditions, and recessed opening dimensions prior to installation.

.2 Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

.1 Install headwall systems in accordance with manufacturer's written instructions and approved shop drawings.

.2 Coordinate installation with mechanical and electrical trades for medical gas piping, electrical conduits, and low-voltage wiring.

.3 Ensure headwalls are installed plumb, level, secure, and flush with surrounding wall finishes.

3.3 TESTING AND COMMISSIONING

.1 Coordinate testing and certification of medical gas outlets by qualified personnel.

.2 Verify proper operation of electrical receptacles, grounding, and low-voltage provisions.

3.4 CLEANING AND HANDOVER

.1 Clean exposed surfaces of headwalls upon completion to remove dust, fingerprints, and construction debris.

.2 Demonstrate access to internal components and review maintenance procedures with Owner's representative.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included:

a. Provide fully adhered wall covering for the Work.

.2 Related Work Specified Elsewhere:

a. Gypsum Wall board: Section 09 20 15

1.3 QUALITY ASSURANCE

.1 Requirements of Regulatory Agencies:

a. Ontario Building Code 2024.

b. ASTM.

c. CAN/ULC-S102.2-M88, Canadian Flammability Testing.

1.4 SUBMITTALS

.1 Samples:

a. Provide samples of wall covering colour and texture range to Architect for choice.

b. Shop drawings showing locations, extent and installation details of wall covering products.

c. Samples for verification purposes: Submit the following samples, as proposed for this work, for verification of color, texture, pattern and thickness:

1. Sample of each product specified.

d. Product data and detailed specifications for each system component and installation accessory required, including installation methods for each type of substrate.

e. Product test reports from a qualified independent testing laboratory showing compliance of each component with requirements indicated.

f. Maintenance data for wall protection system components for inclusion in the operating and maintenance manuals specified in Division 1.

g. Shop drawings showing locations, extent and installation details of wall covering products.

1.5 PERFORMANCE REQUIREMENTS

.1 Code compliance: Assemblies should conform to all applicable codes including NBC (2010), IBC, UBC, SBCCI, BOCA and Life Safety.

.2 Fire performance characteristics: Provide engineered PVC-FREE wall protection system with components tested to Canadian Required CAN/ULC S102.2, "Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies" with results listed below:

a. Flame Spread: 40

b. Smoke developed: 245

.3 Impact Strength: Provide assembled wall protection units that have been tested in accordance with the applicable provisions of ASTM F476.

.4 Chemical and stain resistance: Provide wall protection system components with chemical and stain resistance in accordance with ASTM D-543.

.5 Color match: Provide wall protection components that are color matched in accordance with Delta Ecmc of no greater than 1.0 using CIELab color space.

.6 Single source responsibility: Provide all components of the wall protection system manufactured by the same company to ensure compatibility of color, texture and physical properties.

.7 Indoor Air Quality: Provide material that meets CDPH 01350 v1.2. Wall Protection shall meet the requirements of Intertek's Clean Air Gold Standards for Low-Emitting Products.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

.1 Deliver materials to the project site in unopened original factory packaging clearly labeled to show manufacturer.

.2 Store materials in original, flat, undamaged packaging in a clean, dry place out of direct sunlight and exposure to the elements. A minimum room temperature of 40ºF (4ºC) and a maximum of 100ºF (38ºC) should be maintained.

1.7 JOB CONDITIONS

.1 Materials must be acclimated in an environment of 65-75ºF (18-24ºC) for at least 24 hours prior to beginning the installation.

1.8 WARRANTY

.1 Product: Warrant product for a total period of 5 years against fade, delamination, including full product replacement in areas of wear to include the whole room when defined by 3

interior walls or visible area of open office. Warranty not to be pro-rated and to include product re-installation.

.2 Installation: Warrant installation for a total period of Two years, including seaming and delamination.

PART 2 PRODUCTS

2.1 MATERIAL

.1 Wall Covering:

a. Wall Covering: CS Acrovyn 4000 Rigid Sheet 0.060". See Room Finish Schedule on Drawings.

b. Acrovyn Wall Covering shall be furnished as a complete packaged system, including trims and appropriate standard adhesive.

.2 Materials: Engineered PVC FREE: Rigid sheet should be high impact Acrovyn in standard Sueded texture with nominal .060" (1.52mm) thickness. Supplied in 4' x 8' or 10' (1.22m x 2.44m or 3.05m) sheet sizes. Select from one of Acrovyn ® solid colours or Acrovyn ® Woodgrains, Acrovyn ® Brushed Metals with post-consumer recycled content. Specify colour-matched caulk, clear caulk, and Acrovyn trims or aluminum trims as needed for joints/transitions.

.3 Trims: Aluminum trims, alloy 6063 T5 with clear or coloured anodized finish; minimum strength and durability porperties as specified in ASTM B221. The coloured anodized finish is available in eight colours and is not covered under 1.04.G. Acrovyn trim offering is available for Vertical, Wainscot, Inside and Outside corner trims in 10' lengths. Visible trim wdith is 3/8" (9.53mm Selected by Architect.

.4 Sealants: Cured ColorFlex® II Bacteria Resistanat Caulk has a Shore A value of greater than 55 (product considered "pick-resistant" based on industry standards) testing conducted by independent lab in accordance with ASTM C661 and ASTM C920.

2.2 FABRICATION

.1 General: Fabricate wall covering to comply with requirements indicated for design, dimensions, detail, finish and sizes.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Examine Work of other Sections affecting Work of this Section, and report any defects or discrepancies to the Consultant.

.2 Commencement of installation shall constitute acceptance of substrates as satisfactory.

3.2 PREPARATION

.1 Surface preparation: Prior to installation, clean substrate to remove dirt, debris and loose particles. Perform additional preparation procedures as required by manufacturer's instructions. Minimum Level 3 wall finish is required; for surfaces with Level 5 finish, ensure the surface and any surface coatings are fully dry and cured.

a. Protection: Take all necessary steps to prevent damage to material during installation as required in manufacturer's installation instructions.

3.3 INSTALLATION

.1 Install the work of this section in strict accordance with the manufacturer's recommendations, using approved adhesive.

.2 Temperature at the time of installation must be between 65-75ºF (18-24ºC) and be maintained for at least 48 hours after the installation to allow for proper adhesive set up.

.3 Relative humidity shall not exceed 80%.

.4 Do not expose wall covering to direct sunlight during or after installation. This will cause the surface temperature to rise, which in turn will cause bubbles and delamination.

3.4 ADJUST AND CLEAN

.1 Cleaning:

a. Immediately following installation, clean wall covering and accessories in accordance with manufacturer's recommended cleaning method.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL INSTRUCTIONS

.1 Read and be governed by conditions of the Contract and sections of Division 1.

1.2 SECTION INCLUDES

.1 Corner guards.

.2 High impact sheeting.

.3 Door protection.

.4 Crash rails.

1.3 SECTION EXCLUDES

.1 Custom stainless steel crash rails installed on glass: in accordance with Section 08 42 26.

1.4 QUALITY ASSURANCE

.1 Custom architectural metal fabrications: Execute work of this section only by a Subcontractor, shop foreperson, and Place of the Work installation foreperson who have adequate plant, equipment, and skilled tradespersons to perform work expeditiously, and is known to have been responsible for installations similar to that specified during a period of at least the immediate past 10 years. Fabricators shall have experience working with all metal types specified in this section.

.2 Welding; custom architectural metal fabrications:

a. Weld components in steel to conform to requirements of CSA W59, and by a fabricator fully certified by the Canadian Welding Bureau to conditions of CSA W47.1 and W55.3 as applicable.

b. Weld stainless steel components to conform to requirements of CSA W59 and ANSI/AWS D1.6/D1.6M-2007 as applicable, and by a fabricator fully certified by the Canadian Welding Bureau to conditions of CSA W47.1.

1.5 SUBMITTALS

.1 Submit required submittals in accordance with Section 01 33 00.

.2 Product data sheets:

a. Submit manufacturer’s Product data sheets for Products proposed for use in the work of this section.

.3 Samples:

a. Submit 2 samples, 300 mm (12") long or 300 x 300 mm (12 x 12") in size as applicable, for each Product or fabrication in specified finish.

.4 Shop drawings:

a. Submit shop drawings, and colour and finish samples for work of this section in accordance with Section 01 33 00.

b. Clearly indicate fabrication details, plans, elevations, hardware, and installation details.

c. Custom architectural metal fabrications:

1. Include plans, sections and large scale details, and indicate materials, including material characteristics, and profiles of each metal fabrication member, methods of assembly, fittings, joinery, fastenings, finishes, anchorages, welds, and their structural characteristics relative to their purpose, accessory items, and other fabrication information required.
2. Submit coordination drawings indicating locations of concealed grounds, cutouts, plates, and other required fabrications.

.5 Templates:

a. Submit templates to Contractor for use by installers and fabricators as required for proper location and installation of hardware.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Package or crate, and brace Products to prevent distortion in shipment and handling. Label packages and crates, and protect finish surfaces by sturdy wrappings.

.2 Deliver Products to location at the Place of the Work designated by Contractor.

1.7 WARRANTY

.1 Warrant work of this section in accordance with Section 01 78 36.

PART 2 PRODUCTS

2.1 GENERAL

.1 Incorporate reinforcing, fastenings and anchorage required for building-in of Products.

2.2 CORNER GUARD PROTECTION

.1 Single corner guards installed at wall partition corners:

a. Surface mounted, 90 mm x 90 mm (3.5" x 3.5") legs, 1.3 mm thick (0.05") (16 gauge) stainless steel angle in accordance with ASTM A276-10, Type 304, AISI No. 4 satin finish, radius edge.

b. Acceptable Products:

1. Acrovyn Model CO-8 by C/S Construction Specialties.
2. Substitutions: In accordance with Section 01 25 00.

.2 End wall partition corner guards:

a. Surface mounted, 89 mm (3-1/2") legs, 1.3 mm thick (0.05"), (16 gauge) stainless steel angle in accordance with ASTM A276-10, Type 304, AISI No. 4 satin finish, radius edge.

b. Acceptable Products:

1. Acrovyn Model SCO-8, by C/S Construction Specialties Inc.
2. Substitutions: In accordance with Section 01 25 00.

.3 Custom-formed stainless steel corner guards:

a. Gauge, stainless steel type and finish as indicted finish on exposed sides (face and edges).

b. Adhesive: PL Premium Polyurethane Construction Adhesive by OSI Sealants.

c. Fabricate in accordance with paragraph 2.8 architectural metal requirements.

2.3 HIGH IMPACT SHEETING

.1 High impact sheeting:

a. Acceptable Products: Refer to Room Finish Schedule.

2.4 DOOR PROTECTION

.1 Door edge guard protection:

a. Custom-formed one-piece edge guard; part of finish hardware: in accordance with Section 08 71 00.

1. Material shall be supplied with factory applied double sided tape.

b. Height: as indicated or scheduled.

.2 Door frame guard protection:

a. Custom-formed one-piece frame guard; part of finish hardware: in accordance with Section 08 71 00.

1. Material shall be supplied with factory applied double sided tape.

.3 Door face protection:

a. Mop plate; part of finish hardware: in accordance with Section 08 71 00.
    1. Material shall be supplied pre-cut to size with de-burred edges. Material shall be supplied with factory applied double sided.
    2. Mount on push and/or pull side of door.
b. Kick plate; part of finish hardware: in accordance with Section 08 71 00.
    1. Material shall be supplied pre-cut to size with de-burred edges. Material shall be supplied with factory applied double sided.
    2. Mount on push and/or pull side of door.
c. Armour plate; part of finish hardware: in accordance with Section 08 71 00.
    1. Material shall be supplied pre-cut to size with de-burred edges. Material shall be supplied with factory applied double sided.
    2. Mount on push and/or pull side of door.

2.5 CRASH RAILS

.1 Crash rails; pre-manufactured:
a. Acceptable Products: Refer to Room Finish Schedule.
    1. Accessories: Fasteners, manufacturer's standard self-tapping stainless steel screws to provide, concealed, flush mounting.

2.6 CUSTOM CRASH RAILS

.1 Stainless steel, custom crash rail; wall mounted:
a. Custom-formed stainless steel crash rail, thickness as indicated, Type 304, AISI No. 4 satin finish.
b. Fasteners: same metal as that being fastened. Match finish of exposed heads with material being fastened.
c. Fabricate in accordance with paragraph 2.8 architectural metal requirements.

.2 Stainless steel wrapped on MDF, custom crash rail; wall mounted:
a. Custom-formed stainless steel crash rail, 24 gauge, Type 304, AISI No. 4 satin finish on exposed sides (face, edges and ends).
b. Medium density fibreboard; MDF: Premium Grade, medium density fiberboard to ANSI/NPA A208.2-2009, 750 kg/m3 density.
c. Fasteners: Exposed fasteners are not permitted.
d. Adhesive: PL Premium Polyurethane Construction Adhesive by OSI Sealants.
e. Fabricate in accordance with paragraph 2.8 architectural metal requirements.

2.7 FABRICATION CUSTOM ARCHITECTURAL METAL

.1 General:

a. Fabricate with machinery and tools specifically designed for intended manufacturing processes and by skilled workers.

b. Fit and assemble architectural metal fabrications in shop. When this is not possible, make a trial shop assembly.

c. Incorporate means for fastenings of other work secured to work of this section.

d. Do welding work in accordance with CAN/CSA W59 ANSI/AWS D1.6/D1.6M-2007 as applicable, unless specified otherwise.

.2 Construction:

a. Fabricate with materials, component sizes, metal thicknesses (gauges), reinforcing, anchors, and fasteners of adequate strength to withstand intended use, and within allowable design factors imposed by jurisdictional authorities. Fabricate items from steel unless otherwise noted.

b. Ensure that work will remain free of warping, buckling, opening of joints and seams, distortion, and permanent deformation to expansion and contraction forces and loads.

c. Fasten work with concealed methods unless otherwise indicated.

.3 Finish work:

a. Incorporate holes and connections for work installed under other sections.

b. Cleanly and smoothly finish exposed edges of materials including holes. Edges shall be rounded and smoothed, so they are not capable of snagging, catching, or scraping skin or clothing.

.4 Architectural grade (exposed) fabrications:

a. In additional to the above requirements for fabrication, workmanship shall be of architectural furniture quality. Where welds are noted, provide continuous welds. Grind welds smooth and flat. Polish finish to match adjacent metal finish. Welds shall be indiscernible when exposed to view. Unless indicated otherwise, conceal fastenings.

b. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

c. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.

d. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the work.

e. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.

f. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1 mm (0.040") unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

g. Mill joints to a tight, hairline fit. Cope or mitre corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.

h. Weld behind finished surfaces without distorting or discolouring exposed side. Clean exposed welded joints of flux, and dress exposed and contact surfaces. Where welding cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 Welds: no evidence of a welded joint.

i. Surface preparation; non-ferrous metals: Remove tool and die marks and stretch lines, or blend into finish. Grind and polish surfaces to produce uniform finish, free of cross scratches. Run grain of directional finishes with long dimension of each piece.

PART 3 EXECUTION

3.1 INSTALLATION

.1 Install work to meet manufacturer's recommended specifications, true, tightly fitted, and level or flush to adjacent surfaces, as suitable for installation.

.2 Clean substrates to remove dirt, debris and loose particles prior to installation.

.3 Fit joints and junction between components tightly and in true planes.

.4 Install units on solid backing as indicated, and erect with materials and components straight, tight and in alignment.

.5 Crash rails:

a. Install crash rails in accordance with manufacturer's written recommendations.

b. Install straight and level to a tolerance of plus or minus 3 mm (1/8") over 3000 mm (10') straight edge, non-cumulative.

.6 Corner guards:

a. Adhere corner guards with continuous adhesive beads in accordance with manufacturer's written instructions.

b. At half height corner guards:

1. Round and smooth edges on site with file so they are not capable of snagging, catching, or scraping skin or clothing.

.7 High impact sheeting:

a. Install sheet wall protection in accordance with sheet manufacturer's written recommendations.

b. Provide required cut-outs for electrical outlets and wall penetrations.

c. Where crash rail is installed, high impact sheeting is to extend from top of floor base to centreline of crash rail. Cut around clips as required.

d. Where crash rail is not present, high impact sheeting is to extend from top of floor base to 900 mm above finished floor.

.8 Door edge, door frame, and door face protection:

a. Install door protection components in accordance with door protection manufacturer's written instructions or finish hardware manufacturer's written requirements.

b. At half height door protection:

1. Round and smooth edges on site with file so they are not capable of snagging, catching, or scraping skin or clothing.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included:

a. Supply lockers for the Work.

.2 Related Work Specified Elsewhere:

a. Installation: Section 06 20 00

1.3 SUBMITTALS

.1 Shop Drawings: Submit Shop Drawings in accordance with Section 01 30 00.

.2 Templates: Submit templates and instructions where recesses, openings, fastenings or anchors have to be built in by others.

.3 Samples: Submit samples of Products upon request.

.4 Reference Data: Provide data to Operating Manuals and Reference Data specified in Section 01 30 00.

PART 2 PRODUCTS

2.1 MATERIALS

.1 Manufacturer:

a. Approved Manufacturers: Artopex c/w Noki lock.

2.2 FABRICATION

.1 Construction: Knock down 16 gauge construction with individual top, bottom, side, back and shelves with a common side separating compartment.

a. Single and two-tier units:

1. 305 mm wide x 380 mm deep x 1830 mm high c/w integral 100 mm high galvanized metal ‘box’ base.
2. Three (3) singles and Three (3) two-tier for a total of 9 lockers.

b. Continuous hinged doors.

c. Single point latching/locking device for padlocks.

d. Continuous slopped metal tops and closed end base.
e. 3 separate coat hooks – one on each wall of locker.
f. Fixed upper shelf.
g. Ends, top and base.

.2 Fastening: Concealed fastenings and heavy-duty anchors suited to wall construction.

.3 Colour: Selected by Architect from complete range.

PART 3 EXECUTION

3.1 INSTALLATION

.1 Install in accordance with manufacturer's written instructions to plumb, level and rigid installation.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01, General Requirements.

1.2 DESCRIPTION

.1 Work Included:

a. Supply washroom accessories for the Work.

b. Coordinate with Owner supplied accessories (soap dispensers, toilet tissue dispensers, paper towel dispenser).

.2 Related Work Specified Elsewhere:

a. Installation: Section 06 20 00

1.3 SUBMITTALS

.1 Shop Drawings: Submit Shop Drawings in accordance with Section 01 33 00.

.2 Templates: Submit templates and instructions where recesses, openings, fastenings or anchors have to be built in by others.

.3 Samples: Submit samples of Products upon request.

.4 Reference Data: Provide data to Operating Manuals and Reference Data to Section 01 33 00.

PART 2 PRODUCTS

2.1 MATERIALS

.1 Example Manufacturers:

a. SC Johnson.

b. Bobrick Washroom Equipment of Canada Ltd.

c. Bradley Corporation.

d. Frost Products Limited.

.2 Although the following ‘examples’ have been provided as ‘Bobrick’ the final Products provided must come from the same manufacturers noted above.

.3 Soap Dispensers (WA2):

a. Supplied by Owner.

.4 Toilet Tissue Dispenser (WA3):

a. Supplied by Owner.

.5 Surface Mounted Paper Towel Dispenser (WA4):

a. Supplied by Owner.

.6 Mirror (WA7): Two (2) Required.

a. Bobrick B-290 2448 MBLK

.7 Grab Bar Set (WA10 & WA11): At universal washroom – one (1) set required.

a. A set is made up of the following quantities:

1. Bobrick: B-6806.99 x 24 – 38 mm dia. straight bar.
2. Bobrick: B-6898.99 – 1 1/2" dia. 760 x 760 mm 'L' shaped.

.8 Feminine product dispenser (WA1): Two (2) required.

.9 Hand Dryer (WA6): None.

.10 Accessible Mirror (WA7a):

a. Bobrick B-290 MBLK

.11 Sanitary Napkin Disposal (WA5):

a. Frost Surface Mount

.12 Robe Hook (WA8):

a. Richelieu 51124170 (black)

.13 Barrier Free Shelf (WA9):

a. Bobrick B-295x16

2.2 FABRICATION

.1 Construction: All joints welded with welds ground smooth. Polish welds in stainless steel to #4 finish.

.2 Fabricate all units with smooth, round corners and edges, without burrs or sharp edges.

.3 Locks: Provide tamper-proof tumbler locks.

.4 Fastening: Use concealed and vandal proof and shall secure Products in place for long life under heavy use. Provide heavy duty anchors suited to wall construction.

PART 3 EXECUTION

3.1 INSTALLATION

.1 By Section 06 20 00.

.2 Standard Accessory Height: Install standard accessories in washrooms and other spaces as per manufacturer's direction. Coordinate with mounting heights on sheet A1.1.

.3 Barrier-free Accessories Height and Placement: Install accessories in conformance with the Code, Section 3.8.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Conform to Division 01 – General Requirements.

.2 Provide labour, materials, equipment, and services necessary for the supply and installation of rooftop guardrail systems as specified.

.3 Work includes freestanding counterweighted guardrail systems designed to provide fall protection at rooftop edges and elevated surfaces.

1.2 SECTION INCLUDES

.1 Non-penetrating rooftop guardrail system.

.2 Guardrail posts, rails, fittings, and connectors.

.3 Counterweight baseplates and protective pads.

.4 Hardware and accessories required for a complete installation.

.5 Engineering review and layout assistance where required.

1.3 RELATED SECTIONS

.1 Section 01 33 00 – Submittal Procedures.

.2 Section 01 61 00 – Common Product Requirements.

.3 Section 07 50 00 – Membrane Roofing (for coordination with roof protection).

1.4 DEFINITIONS

.1 Delegated Design Professional: A professional engineer engaged by the manufacturer or contractor responsible for reviewing system performance and providing sealed documentation where required by the authority having jurisdiction.

1.5 REFERENCE STANDARDS

.1 Ontario Occupational Health and Safety Act (OHSA).

.2 National Building Code of Canada (NBC).

.3 Ontario Building Code (OBC).

.4 CSA safety and fall protection standards.

.5 ANSI safety standards.

.6 Other provincial or jurisdictional fall protection regulations as applicable.

1.6 ACTION SUBMITTALS

.1 Product Data: Submit manufacturer's literature describing materials, dimensions, finishes, and performance characteristics.

.2 Shop Drawings: Indicate guardrail layout, post spacing, baseplate locations, tieback locations, and edge protection configuration.

.3 Delegated Design Submittals: Where required, provide calculations and drawings signed and sealed by a qualified professional engineer.

.4 Samples: Provide material samples if requested by Consultant.

1.7 INFORMATIONAL SUBMITTALS

.1 Installation instructions issued by manufacturer.

.2 Certificates indicating compliance with applicable safety standards.

.3 Manufacturer's warranty documentation.

1.8 QUALITY ASSURANCE

.1 Guardrail system shall comply with applicable North American fall protection standards including OHSA, NBC, OBC, ANSI, and CSA.

.2 Manufacturer shall have demonstrated experience producing rooftop guardrail systems.

.3 Provide professional engineering assistance for custom layouts where required.

1.9 DELIVERY, STORAGE, AND HANDLING

.1 Deliver products in manufacturer's original packaging with identification labels intact.

.2 Store materials off the ground and protect from moisture, corrosion, and physical damage.

.3 Handle materials in accordance with manufacturer's recommendations.

1.10 WARRANTY

.1 Provide manufacturer's standard warranty of five (5) years against defects in materials and workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

.1 Basis of Design: RoofGuard Rooftop Guardrail System manufactured by Liftsafe Group of Companies.

.2 Substitutions: Submit requests in accordance with Division 01 requirements.

2.2 SYSTEM DESCRIPTION

.1 Modular freestanding guardrail system designed to prevent falls from rooftops and elevated surfaces.

.2 System shall be non-penetrating and utilize counterweighted baseplates to avoid damage to roof membranes.

.3 Components shall allow for easy assembly, disassembly, and reconfiguration.

2.3 MATERIALS

.1 Rails and Posts: 1-1/2 inch (1.9 inch OD) Schedule 40 aluminum pipe, alloy 6061-T6.

.2 Fittings: 1-1/2 inch aluminum magnesium fittings.

.3 Hardware: Stainless steel fasteners and connectors.

.4 End Caps: Plastic inserts for open pipe ends.

.5 Baseplates: Galvanized steel counterweight plates, approximately 40 lb each.

.6 Protective Pads: 14 in x 20 in x 0.125 in masticated rubber pads installed beneath each baseplate.

.7 Finish: Mill finish aluminum unless otherwise specified. Powder coating available as optional finish.

2.4 SYSTEM PERFORMANCE REQUIREMENTS

.1 Guardrail Height: 42 inches to top rail.

.2 Mid-Rail: Located approximately 20 inches below top rail.

.3 Post Spacing: Maximum 8 ft for CAL/WA OSHA requirements and 9 ft maximum where permitted by jurisdiction.

.4 Tiebacks: Provide at system ends and at intervals not exceeding three rail bays.

.5 Edge Protection: Tiebacks located within 6 ft of roof edge shall be configured as edge protection.

.6 Setback: Guardrail system to be installed minimum 18 inches from roof edge where no parapet exists.

2.5 FABRICATION

.1 Fabricate guardrail components to allow rigid assembly and alignment.

.2 Provide components free of sharp edges, burrs, or defects that may affect safety or performance.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Verify roof conditions and substrate are suitable for installation.

.2 Report unsatisfactory conditions to Consultant and do not proceed until corrected.

3.2 INSTALLATION

.1 Install guardrail system in accordance with manufacturer's written instructions.

.2 Place masticated rubber pads beneath each baseplate to protect roofing membrane.

.3 Assemble posts, rails, fittings, and counterweights to achieve required height and spacing.

.4 Ensure guardrail system is level, aligned, and stable.

.5 Do not penetrate roofing membrane unless specifically approved by Consultant.

3.3 FIELD QUALITY CONTROL

.1 Inspect installation to verify compliance with spacing, height, and layout requirements.

.2 Correct deficiencies prior to completion of work.

3.4 PROTECTION

.1 Protect installed guardrail system from damage during construction.

.2 Replace damaged components prior to project completion.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL INSTRUCTIONS

.1 Conform to Division 01, General Requirements.

1.2 SUMMARY

.1 Work Included: Provide both manual chain operated roller shades including but not limited to following:

a. Roller shade (RS1)

b. Roller shade blackout (RS2)

1.3 RELATED SECTIONS

.1 Following description of work is included for reference only and shall not be presumed to be complete:

a. Section 09 21 16: Gypsum Board

1.4 SUBMITTALS

.1 Product Data: Provide data on compatibilities, and limitations of product.

.2 Maintenance Data: Provide data on maintenance of installed system.

1.5 QUALITY ASSURANCE

.1 Qualifications: Provide work of this Section executed by competent installers with minimum of 5 years experience in application of Products, systems and assemblies specified and with approval and training of the Product manufacturers.

1.6 WARRANTY

.1 Warrant work of this Section for period of 2 years against defects and/or deficiencies in accordance with General Conditions of the Contract. Promptly correct any defects or deficiencies which become apparent within warranty period, to satisfaction of the Owner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

.1 Products of following manufacturers are acceptable subject to conformance to requirements of Drawings, Schedules and specifications:

a. Nysan Shading Systems Ltd.; www.nysan.com by Commercial Vision, Toronto, 1 800 565 9718.

b. Or approved equal prior to tender close.

c. Approved equal Hunter Douglas Contract, Brampton, tel 877-265-6802.

.2 Design of roller blinds is based on product by Nysan Shading Systems Ltd.

.3 Provide installation brackets that facilitate easy removal and replacement of blinds.

2.2 MATERIALS

.1 Roller Shade (RS1): Face mounted chain operated with fascia, 3% fabric:

a. Operation:

1. Manual shade chain drive unit shall consist of a tension activated lifting mechanism with multi-layer concentric constant tension. Ensure lifting mechanism contains a memory tension lock which is pre-tensioned and when removed for shade cleaning, does not require re-tensioning. Ensure mechanism is internally free-floating along a grooved non-corrosive shaft and reversible for on site future alterations and maintenance.
2. Internal tension idler (I.T.I) limiter automatically adjusts and controls amount of torque being generated for constant smooth operation of shade system. I.T.I automatically releases during down-travel and automatically engages during up-travel of shade system.
3. Lifting mechanism must accommodate tension modules - (type D) for maximum shade performance when necessary. Ensure tension modules contain a memory lock for torque retention.
4. Use noise reduction seals for sound isolation and absorption of mechanism.
5. Ensure drive sprocket contains a planetary gear system for increased operational performance, speed ratio control, smoothness of lift and balance to chain and shade system.

b. Assembly:

1. Supply shade unit to site fully assembled in a 1 piece fully extruded aluminum cassette closed on all 4 sides, top, back, sides and bottom return.
2. Mounting Detail: Wall mounted on drywall returns at windows.
3. Shade Orientation: Regular-roll, shade cloth to roll at window side of roller.

c. Shade Roller Tube: All aluminum extruded available in 32 mm (1-1/4"), or 50 mm (2") with reinforced internal ribs to provide maximum span without tube deflection. Tube sizes will depend on shade size.

d. Tube End Plug: Internal tension idler (I.T.I) limiter automatically adjusts and controls amount of torque being generated for constant smooth operation of shade system. I.T.I must automatically release during down-travel and automatically engage during up-travel of shade system.

e. Chain Drive: Heavy duty commercial grade sprocket. Drive sprocket must contain a planetary gear system for increased performance, speed ratio, smoothness and balance to chain and shade system.

f. Operating Chain: No. 10 qualified heavy-duty stainless-steel bead chain 90 lb load test, with specially engineered chain joiner at 400 N breaking strength.

g. Exposed Hembar: Extruded aluminum with end caps. Screw end plugs securely on ends showing no exposed aluminum.

h. Chain Hold Down: Fully secure operating chain to SP chain holder.

i. Mounting Brackets: Provide galvanized steel brackets for face and ceiling mounting.

j. Shade Holder: Design shade holder from 1 piece aluminum extruded unit, which will accept shade brackets and form a single unitized assembly when complete.

k. Cassette Box: Cassette design shall be a 1-piece aluminum extruded box closed on all 4 sides top, back, sides and bottom return. Cassette sections to be 79 mm in square profile. Cassette section with internal groove to accommodate a self-cleaning brush to ensure fabric maintenance as well as a gap brush on top back side of cassette to provide for a light seal. Wall thickness to be 1.52 mm (16 ga). Cassette end caps shall be 2 mm Delrin plastic with 4 countersunk flat headed screw holes.

l. Fascia: 75 mm aluminum fascia. Extruded aluminum alloy 6063-T5, pre-finished, 105 mm x 10 mm x 1.6 mm wall thickness (4.13" x 0.394" x 0.063"), custom designed closure to fit onto pre-moulded end mounting brackets without exposed fasteners. Colour: clear anodized. Fascia shall allow for continuous placement across multiple shades (to a maximum length of 6.1 m (20 ft.) without exposed fasteners. Fascia shall conceal the mounting hardware, power and control cables, drive mechanism, roller tube, and all fabric rolled on the tube.

m. Finishes: All exposed aluminum shall be clear anodised finish according to AA-M12C22A31 or coloured to match window framing. Unexposed aluminum unless otherwise specified: mill finish.

n. Shade Fabrics:

1. Green Screen Eco 3% Series by Nysan: Fabric weight 8 oz/yd^2, Fabric Thickness 19 mil, Break Strength warp 240 daN/5cm weft 200 daN/5cm, Flame Res. 0.0 sec after flame, Fuel contributed value: 0, Average Openness: ±3% (ECO), Colorfastness to light: 7/8, Composition: Fabric made with 100% Polyester yarn, PVC free, and VOC free.
2. Shade Fabric Colour: To be selected by Consultant from manufacturer's full colour range.
3. Provide a weighted hem bar to maintain a straight bottom and a flat shade surface.

.2 Roller Shade Blackout (RS2): Dual chain operator with 100 mm fascia, 3% fabric and blackout:

a. Operation:

1. Manual shade chain drive unit shall consist of a tension activated lifting mechanism with multi-layer concentric constant tension. Ensure lifting mechanism contains a memory tension lock which is pre-tensioned and when removed for shade cleaning, does not require re-tensioning. Ensure mechanism is internally free-floating along a grooved non-corrosive shaft and reversible for on site future alterations and maintenance.
2. Internal tension idler (I.T.I) limiter automatically adjusts and controls amount of torque being generated for constant smooth operation of shade system. I.T.I automatically releases during down-travel and automatically engages during up-travel of shade system.
3. Lifting mechanism must accommodate tension modules - (type D) for maximum shade performance when necessary. Ensure tension modules contain a memory lock for torque retention. Use noise reduction seals for sound isolation and absorption of mechanism.
4. Ensure drive sprocket contains a planetary gear system for increased operational performance, speed ratio control, smoothness of lift and balance to chain and shade system.

b. Assembly:

1. Supply shade unit to site fully assembled in a 1 piece fully extruded aluminum cassette closed on all 4 sides, top, back, sides and bottom return with plastic injected-molded end caps.
2. Mounting Detail: Ceiling mounted. Mounted on GWB head of window opening.

3. Shade Orientation: Regular-roll, shade cloth and blackout to roll at window side of roller. Blackout shade mounted closest to window.

c. Shade Roller Tube: All aluminum extruded available in 32 mm (1-1/4"), or 50 mm (2") with reinforced internal ribs to provide maximum span without tube deflection. Tube sizes will depend on shade size.

d. Tube End Plug: Internal tension idler (I.T.I) limiter automatically adjusts and controls amount of torque being generated for constant smooth operation of shade system. I.T.I must automatically release during down-travel and automatically engage during up-travel of shade system.

e. Chain Drive: Heavy duty commercial grade sprocket. Drive sprocket must contain a planetary gear system for increased performance, speed ratio, smoothness and balance to chain and shade system.

f. Operating Chain: No. 10 qualified heavy-duty stainless-steel bead chain 90 lb load test, with specially engineered chain joiner at 400 N breaking strength.

g. Flat Fabric Wrapped Hembar (blackout) and Exposed Hembar (3% fabric): Extruded aluminum with end caps. Screw end plugs securely on ends showing no exposed aluminum.

h. Chain Hold Down: Fully secure operating chain to SP chain holder.

i. Mounting Brackets: Provide galvanized steel brackets for ceiling or wall mounting.

j. Shade Holder: Design shade holder from 1 piece aluminum extruded unit, which will accept shade brackets and form a single unitized assembly when complete.

k. Cassette Box: Cassette design shall be a 1-piece aluminum extruded box closed on all 4 sides top, back, sides and bottom return. Cassette sections to be 103 mm x 148 mm. Cassette section with internal groove to accommodate a self-cleaning brush to ensure fabric maintenance as well as a gap brush on top back side of cassette to provide for a light seal. Wall thickness to be 1.52 mm (16 ga). Cassette end caps shall be 2 mm Delrin plastic with 4 countersunk flat headed screw holes.

l. Fascia: 100 mm aluminum fascia. Extruded aluminum alloy 6063-T5, pre-finished, 105 mm x 10 mm x 1.6 mm wall thickness (4.13" x 0.394" x 0.063"), custom designed closure to fit onto pre-moulded end mounting brackets without exposed fasteners. Colour: clear anodized. Fascia shall allow for continuous placement across multiple shades (to a maximum length of 6.1 m (20 ft.) without exposed fasteners. Fascia shall conceal the mounting hardware, power and control cables, drive mechanism, roller tube, and all fabric rolled on the tube. Fascia shall not fit snug against side channels to prevent thermal shock to the glazing system.

m. Blackout Side Channels:

1. Side channel shall be a slim line design 2-piece side channel inside mount 50 mm x 13 mm. Provide sealant for light tight seal. Colour: Clear Anodized aluminum.

n. Fabric Retainer System: Fabric shall be reinforced at edges with a frequency thermo-weld seal to prevent edges from fraying. Fabric retainers are positioned laterally on edge of fabric every 200 mm (8") to 300 mm (12") to prevent fabric escaping or being pulled out of the side channel.

o. Finishes: All exposed aluminum shall be clear anodised finish according to AA-M12C22A31 or coloured to match window framing. Unexposed aluminum unless otherwise specified: mill finish.

p. Shade Fabrics:

1. Green Screen Eco 3% Series by Nysan: Fabric weight 8 oz/yd^2, Fabric Thickness 19 mil, Break Strength warp 240 daN/5cm weft 200 daN/5cm, Flame Res. 0.0 sec after flame, Fuel contributed value: 0, Average Openness: ±3% (ECO), Colorfastness to light: 7/8, Composition: Fabric made with 100% Polyester yarn, PVC free, and VOC free.
2. Green Screen X-Lite Series by Nysan: Fabric weight 8 oz/yd^2, Fabric Thickness 19 mil, Break Strength warp 240 daN/5cm weft 200 daN/5cm, Flame Res.: 0.0 sec after flame, Fuel contributed value: 0, Average Openness: Black out Material – 0% Open, Colorfastness to light: 7/8, Composition: Fabric made with 60% Polyester yarn 40% Acrylic, PVC free, and VOC free.
3. Shade Fabric Colour: To be selected by Architect from manufacturer's full colour range.
4. Provide a weighted hem bar to maintain a straight bottom and a flat shade surface.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Site Verification of Conditions: Verify actual site dimensions and location of adjacent materials prior to commencing work. Notify Consultant in writing of any conditions which would be detrimental to the installation. Commencement of work implies acceptance of previously completed work.

3.2 INSTALLATION

.1 Coordinate location of support framing and blocking for installation of roller blinds with Section 09 21 16 Drywall.

.2 Install blinds in accordance with manufacturer's printed installation instructions and with concealed anchorage.

.3 Install roller blinds free of twist, warp or distortion.

.4 Install roller blinds plumb, square, evenly spaced, in alignment and parallel with window plane.

END OF SECTION

Division 21 – Fire Suppression

21 01 01 General Requirements
21 01 05 Demolition And Renovations
21 05 00 Common Work Results
21 05 16 Piping Expansion Control
21 05 30 Supports And Anchors
21 05 48 Vibration Controls
21 05 49 Seismic Restraints
21 07 19 Piping Insulation
21 13 13 Sprinkler Systems

Division 22 – Plumbing

22 01 01 General Requirements
22 01 05 Demolition And Renovations
22 05 00 Common Work Results
22 05 16 Piping Expansion Control
22 05 30 Supports And Anchors
22 05 48 Vibration Controls
22 05 49 Seismic Restraints
22 07 19 Piping Insulation
22 11 19 Plumbing Specialties
22 14 13 Plumbing Piping
22 63 13 Medical Gas And Vacuum Systems

Division 23 – HVAC

23 01 01 General Requirements
23 01 05 Demolition And Renovations
23 05 00 Common Work Results
23 05 16 Piping Expansion Control
23 05 30 Supports And Anchors
23 05 34 Heat Tracing For Piping And Equipment
23 05 48 Vibration Controls
23 05 49 Seismic Restraints
23 05 93 Testing, Adjusting And Balancing
23 07 13 Duct Insulation

23 07 19 Piping Insulation
23 08 00 Commissioning
23 09 00 Instrumentation and Control for HVAC
23 21 13 Hydronic Piping
23 22 13 Steam And Condensate Piping
23 22 16 Steam And Condensate Specialties
23 31 00 Ductwork
23 32 48 Sound Attenuators
23 33 00 Air Duct Accessories
23 37 00 Air Outlets And Inlets
23 74 13 Custom Roof Top Units
23 81 26 Ductless Split Air Conditioning System
23 84 19 Humidifiers, Electric

Division 25 – Controls and Instrumentation

25 30 00 Controls and Instrumentation

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 The Contract CCDC 2-2008, Stipulated Price Contract as amended,
  .2 Division 1 requirements and documents refered to therein.
.2 This Section applies to and governs the work of all Sections of Division 21.
.3 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work..
.4 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.
.5 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the most costly arrangement.
.6 Ensure Sub-contractors undertaking the work of Division 21 provide a 50% performance bond and a 50% labour and materials payment bond. In addition, ensure Sub-contractors employed to undertake any part of the work of Division 21 that is $50,000.00 or greater in contract value provide a 50% performance bond and a 50% labour and materials bond to the party they are in contract with.

1.2 WORK INCLUDED

.1 Products and methods mentioned or shown in the Contract Documents complete with incidentals necessary for a complete operating installation. Provide all tools, equipment and services required to do the work.
.2 Cutting and patching of new or existing work
.3 Identification of equipment, piping, ductwork, and valves and controllers
.4 Motors required for equipment supplied under this Division.
.5 Take such measures and include in Bid Price for the proper protection of the existing building and its finishes at all times during alterations and constructionof the new addition. Coordinate this protective work with all trades.
.6 Refer to Mechanical/Electrical Equipment Schedule for extent of wiring and electrical characteristics.
.7 Verify the correct operation of each equipment item provided and/or altered and each system in total and obtain the Owner's approval prior to starting and/or returning to operation.

1.3 SUBMITTALS

.1 Approval Drawings: Prepare and submit drawings necessary for approval to any authority having jurisdiction, and obtain two (2) copies of approved drawings for retention by Consultant prior to commencement of work under this Division.

.2 Shop Drawings: Prepare and submit two (2) copies of shop drawings of major equipment items (including those items specifically indicated under Part 1: General of each Section), to the Consultant for review. The Consultant will return one copy, marked with comments and his review stamp as he deems appropriate. Prepare the necessary number of copies of the returned set and distribute to the Owner, the Prime Consultant, the General Contractor, the site, and to subcontractors and suppliers.

.1 Clearly indicate manufacturer's and supplier's names, catalogue model numbers, details of construction, accurate dimensions, capacities and performance. Prior to submission check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of the shop drawings, reviewed by Consultant, has been returned to Contractor.

.2 Clearly indicate the weight, location, method of support and anchor point forces and locations for each piece of equipment on shop drawings.

.3 The Consultant will not review shop drawings that fail to bear the Contractor's stamp of approval or certification.

.4 Read the following in conjunction with the wording on the shop drawing review stamp applied to each and every drawing submitted:

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

.3 As-Built Records: Prepare and submit complete as-built records prior to Substantial Performance of the Contract. Refer to paragraph 3.2.5 and to Division 1 for requirements.

.4 Requests for Shut-Down: Obtain permission for systems shut-down and/or service interruption from the Owner prior to disruption of any system or service in use by the Owner. Employ the Owner's standard form of request where available. Refer to Division 1 for additional requirements.

.5 Requests for Start-up: Obtain permission from the Owner to start-up or to return to service any item of equipment, system or service installed new or previously shut-down. Refer to Division 1 for additional requirements.

.6 Contractor's Material and Test Certificates: Prepare and submit certificates for each system installed. Where certificates are prescribed by regulations, codes or standards ensure they conform to the requirements of those documents (eg. NFPA-standards). Include a copy of each certificate in the Operation and Maintenance manual. Certificates shall include the following:

.1 description of the system (description and type),
.2 description of the tests conducted and results observed, including re-testing, where necessary,
.3 description of any corrective measures undertaken,
.4 description of materials used (pipe and fittings),
.5 list of witnesses for each test conducted,
.6 date system left ready for service,
.7 signature of installing Contractor.

1.4 QUALITY ASSURANCE

.1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.
.2 Ensure materials supplied under this Division conform to minimum requirements and recommendations or better of applicable standards of the following:
  .1 NFPA National Fire Protection Association
  .2 OBC Ontario Building Code
  .3 OFC Ontario Fire Code
  .4 OFM Ontario Fire Marshall
.3 Use latest editions and amendments in effect on date of bid call subject to requirements of OBC.
.4 Arrange and pay for permits and inspections by authorities having jurisdiction, required in the undertaking of this Division. Make modifications required by authorities.
.5 All tradesmen employed on the project shall hold valid trade certificates/licenses and shall make a copy available for review by the Consultant and/or Owner when requested.

1.5 JOB CONDITIONS

.1 Visit site and examine existing conditions which may affect work of this Division.
.2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
.3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
.4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.6 WARRANTY

.1 Refer to General Conditions.
.2 Arrange with each manufacturer/supplier to extend warranties as necessary to coincide with warranty period or those periods specified.

2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

.1 Ensure materials and equipment provided under this Division are new and free from defects and bear labels of approval as required by codes referred to in this Division and/or by inspection authorities.

.2 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products are suitably labeled and supplied with Material Safety Data sheets. Obtain the Owner's approval in writing to bring hazardous materials onto the site prior to doing so.

.3 When utilizing any products that are hazardous, keep Material Safety Data sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide Workplace Labels on such containers.

2.2 ACCEPTABLE PRODUCTS

.1 First item named or specified by catalogue number meets specifications regarding performance, quality of material and workmanship, and is acceptable to the Consultant.

.2 Items, other than first named, meeting specifications regarding quality of materials and workmanship are acceptable to the Consultant, only, if they also meet performance and/or capacities specified and can be accommodated within the space allotted.

.3 General approval indicated by inclusion of other manufacturers named is subject to final review of shop drawings, performance data and test reports.

2.3 EQUIVALENTS AND ALTERNATIVES

.1 Suppliers wishing approval for additional equipment items as equivalent to those specified must submit complete description, technical and performance data to Consultant at least ten (10) working days prior to Bid closing date. Such equivalent equipment, if accepted, to conform to specifications with regard to all details, accessories, modifications, features and performance. Deviations from specifications must be stated in writing at time of submission for approval.

.2 Bid Prices shall include only products specified or approved equivalents. Contractors may propose unsolicited alternatives to the products specified. Alternative proposals shall be submitted in sealed envelope at time of general contract Bid submission and shall include full description and technical data, and a statement of the related increase or decrease in Bid Price should alternatives be accepted. All additional costs associated with unsolicited alternative proposals such as larger motor starters, larger power feeders, space revisions to associated equipment,

controls, etc. shall be included in alternative price. Prior approval by Consultant is not required for unsolicited alternative proposals.

.3 Where the Contractor uses equipment other than that first named, on which the design is based, he shall be responsible for all details of installation including equipment size, arrangement, fit, and maintenance of all required clearances. Contractor shall prepare and submit revised layouts to iindicate arrangement of all affected piping, ductwork, conduit, lighting, equipment, etc. Failure by Contractor to provide such drawings will be considered indication that original arrangements and space allocations are adequate. All additional costs associated with equivalent equipment such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in Bid Price.

2.4 SUBSTITUTIONS DURING PROGRESS OF WORK

.1 If during the progress of work, specified products are not obtainable, equivalent or similar products by other manufacturers may be permitted by Consultant.

.2 Apply, in writing, to Consultant for substitution of any products, indicating the following:

.1 Manufacturer's name, model number, details of construction, accurate dimensions, capacities and performance of proposed products.

.2 Reason for substitution.

.3 Any revisions to the contract price made necessary by substitution.

.4 Any revisions to the contract time made necessary by substitution.

.5 Any revisions to layout, arrangement or services made necessary by substitution.

.3 No substitutions will be permitted without written authorization from the Consultant.

2.5 CONSULTANT'S REVIEW

.1 The consultants will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor. Such review and evaluation work will be undertaken by the Consultant on an additional fee basis. The Contractor shall reimburse the Owner for all costs associated with such reviews and evaluations.

.2 The Contractor shall also reimburse the Owner for any and all costs incurred in updating Contract Documents to reflect such changes.

3 EXECUTION

3.1 RELATIONSHIP WITH OTHER TRADES

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.

3.2 INSTALLATION REQUIREMENTS

.1 The Consultant's drawings and instructions govern the location of all items. Prepare

fully coordinated installation drawings prior to installation.

.2 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.

.3 Do not use powder activated tools except as permitted by the Prime Consultant and the Owner's workplace health and safety policies.

3.3 CONTRACT DRAWINGS

.1 The drawings of this Division are performance drawings and indicate general arrangement of the work. They are diagrammatic except where specific details are given.

.2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement. Location and elevation of services are approximate. Verify them before construction is undertaken.

.3 Make changes where required to accommodate structural conditions, (beams, columns, etc.). Obtain Consultant's approval before proceeding.

.4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. Note that outlets and/or equipment may be relocated up to 10 feet (3 m) in any direction without a change to the contract price.

.5 Note that the layout and orientation of the ceiling outlets on the architectural reflected ceiling drawings may differ from that shown on the mechanical drawings. Make the installation in accordance with the latest architectural ceiling drawings. Provide the equipment as specified and/or shown on the documents of this Division.

.6 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the mechanical documents. If there is a difference in quantity between the architectural and drawings of this Division, base the contract price on the greater quantity.

.7 Prepare installation (construction) drawing to reflect the latest architectural ceiling layout.

3.4 EXTRAS AND CREDITS

.1 Accompany all price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:

- .1 Materials, quantities and unit costs including any applicable contractors trade discount clearly identified.
- .2 Labour hours and unit costs.
- .3 Total materials and labour costs.
- .4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

3.5 INSTRUCTION

.1 Instruct and familiarize Owner's operating personnel with the various mechanical systems. Arrange instruction for each system separately.
.2 Provide instruction for each system on two separate occasions, coordinated with the Owner's staff operating schedule, in order that interested personnel may arrange to attend.
.3 Ensure each instruction period includes, but is not limited to the following;
  .1 a classroom seminar with operating manuals, product and system drawings and such other audio/visual aids as may be appropriate,
  .2 instruction during the classroom seminar by the manufacturer's representative regarding the proper operating and maintenance procedures for each item of equipment,
  .3 demonstration of the proper operating procedures for each item of equipment,
  .4 explanation of the purpose and function of all safety devices provided,
  .5 demonstration of all measures required for safe and proper access for operation and maintenance.
.4 Provide a period of follow-up instruction (on two occasions) approximately one month after completing Owner's instruction to clarify and reinforce earlier instructions.
.5 Submit a letter from the Owner's management staff indicating the instruction has been given satisfactorily to the Consultant prior to substantial completion of the project.

3.6 COMMISSIONING

.1 Refer to Section 01 80 50 Commissioning.
.2 The Contractor shall start-up and completely commission all equipment and systems installed and/or modified under this contract. Commissioning work shall be completed to the satisfaction of the Consultant prior to acceptance of the Work or any part thereof.
.3 Commissioning shall conform to CAN/CSA Z318.0 Commissioning of Health Care Facilities
.4 The Commissioning Team shall be comprised of;
  .1 Representatives of the Commissioning Coordinator (Commissioning Agent if available)
  .2 The individual, company or agency undertaking the work of each Section,
  .3 Representatives of the Contractor and his sub-contractors as required,
  .4 Representatives of equipment manufacturers,
  .5 Representatives of the Consultants,
  .6 Representatives of the Owner.
.5 The Contractor and his sub-contractors shall each assign an individual representing each of the relevant trades to the commissioning team and shall ensure that representatives of the equipment manufacturers are present during the relevant commissioning tasks.

.6 The Contractor shall provide all necessary labour, materials, equipment, testing apparatus and incidentals necessary to completely start-up, verify, test and commission each system provided as part of the Work.

.7 Each Section shall prepare Check Sheets in accordance with the standards listed above and shall issue them to the commissioning team for use during the commissioning process.

.8 Three (3) copies of commissioning manuals shall be provided, bound in hard cover D-ring binders with transparent cover on front and spine personalized to indicate;

.1 name and logo of Health Care Facility,

.2 name of the project,

.3 the Owner's project number,

.4 identification of the system commissioned,

.5 the date that the system was commissioned.

.9 Commissioning manuals shall include machine printable index dividers to organize each manual by system and by commissioning stage.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 01 22 00.

1.2 WORK INCLUDED

.1 Identification of existing services and utility connections.
.2 Installation, protection and maintenance of temporary services as required to support continuing operation of the facility.
.3 Disconnection and removal of various mechanical equipment in areas to be turned over to the Owner.
.4 Disconnection and making safe of various mechanical systems and equipment in areas to be demolished and/or renovated.
.5 Disposal of waste materials in accordance with waste management requirements.
.6 Re-certification and inspection of changes made to any equipment, machine or apparatus by authorities having jurisdiction including requirements for marking of equipment.

1.3 REGULATORY REQUIREMENTS

.1 Notify all authorities of intent to demolish and schedule for the work. Obtain required permits from authorities.
.2 Conform to all codes for demolition work, dust control, products requiring disconnection and re-connection.
.3 Do not close or obstruct egress width to any building or site exit.
.4 Do not disable or disrupt building fire or life safety systems without 3 days prior written notice to Owner.
.5 Conform to procedures applicable when hazardous or contaminated materials are discovered.
.6 Arrange for re-certification and inspection of changes made to any equipment, machine or apparatus by authorities having jurisdiction. This includes requirements for marking of equipment under rules 2-100 and 2-102 of the Ontario Electrical Safety Code.

1.4 JOB CONDITIONS

.1 Visit site and examine existing conditions which may affect work of this Division.
.2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
.3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
.4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.5 INTERRUPTIONS

.1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.
.2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.
.3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.
.4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.
.5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

1.6 PHASING AND SCHEDULING

.1 Refer to Division 1 PHASING AND SCHEDULING OF THE WORK.
.2 Coordinate with the work of all Sections of Division 23 with other trades and assist in the development of the Phasing Strategy.

3 3 EXCECUTION

3.1 PREPARATION

.1 Prior to start of work under this Section, ensure that the General Trades;
  .1 Provide, erect, and maintain temporary barriers at locations indicated.
  .2 Erect and maintain weatherproof closures for exterior openings.
  .3 Erect and maintain temporary partitions to prevent spread of dust, odours, and noise to permit continued Owner occupancy.
  .4 Prevent movement of structure; provide bracing and shoring.
.2 Install, protect and maintain temporary services as required to support continuing operation of the facility.
.3 Protect services and equipment which are not to be demolished.
.4 Coordinate all service shut downs with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.
.5 Notify affected utility companies before starting work and comply with their requirements.
.6 Mark location and termination of utilities.
.7 Provide appropriate temporary signage including signage for exit or building egress.

3.2 RELATIONSHIP WITH OTHER TRADES

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.

.2 Remove and dispose of built-in items such as sleeves, anchors, and inserts.
.3 Remove and dispose of bases, supports and anchors for piping, equipment and ductwork mounted on or in walls, supported above floors and/or suspended from the structure.

3.3 PROTECTION

.1 Protect existing and new work to remain free from damage due to execution of work under this Division with tarpaulins and other protective coverings as necessary.
.2 Repair any and all damage to the building and components resulting from failure to provide suffcient protection, to the satisfaction of the Consultant.
.3 All existing air intake and exhaust openings that may be affected by dust and/or debris from the construction work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from construction work with new filters.
.4 In the event that dust and debris from construction work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.
.5 Temporary filters shall be removed on completion of the construction works.

3.4 DEMOLITION

.1 Notify all authorities of intent to demolish and schedule for the work.
.2 All demolition work shall conform to all codes, regulations, standards and by-laws applicable to the work.
.3 Isolate and drain systems as required to effect demolition. Disconnect, cap and make safe all mechanical services to the building including, but not limited to; sanitary sewer(s), storm sewer(s), water service, natural gas service, steam service, condensate return, water supply to standpipe and sprinkler systems, fire suppression systems hot water heating systems, steam and condenstae systems.
.4 Protect existing equipment and services to remain from debris and unwanted materials. Clean as necessary to maintain service during demolition period and on completion of the work.
.5 Coordinate all service shut downs with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.
.6 Remove and dispose of all redundant mechanical services and equipment within the limits of the demolition site and where demolished systems extend beyond these limits.
.7 Turn over items identified for recovery by the Owner.
.8 All demolition work shall conform to Occupational Health & Safety and Envronmental regulations. Ensure that all parties are familiar with requirements and experienced in the work to be undertaken.
.9 Waste disposal shall conform to the requirements of Division 1, municipal By-Laws

and Ministry of the Environment regulations and standards.

.10 All existing air intake and exhaust openings that may be affected by dust and/or debris from the demolition work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from demolition work with new filters.

.11 In the event that dust and debris from demolition work does penetrate the building and/or its air distribution systems, this Section shall be responsible for cleaning the affected areas and/or systems.

.12 Disconnect remove, cap and identify all utilities within demolition areas.

.13 Demolish in an orderly and careful manner. Protect existing supporting structural members.

.14 Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.

.15 Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

.16 Remove temporary Work.

3.5 RENOVATIONS

.1 Isolate and drain systems as required to effect renovations, modifications and/or repairs. On completion of renovations, modifications and/or repairs, test entire system as if new. Report repairs or replacements required of existing equipment, piping, fittings or devices that are not included in contract to Consultant and Owner for instruction. Flush, clean and refill renovated systems as specified for new.

.2 Relocate or remove existing items so designated unless specifically indicated to be relocated or removed under other Sections.

.3 Existing items to be relocated shall be cleaned and repaired or altered as required to suit new location. All damaged or ineffective parts shall be replaced and the item made "as new".

.4 Existing items to be removed remain the property of the owner and shall be delivered to a location on site designated by the owner. If the owner declares no interest in the removed items, assume ownership and remove the items from the site.

.5 Make good all surfaces and finishes in areas from which items have been removed and in which items are relocated. Cap all existing services required to be severed to effect alterations and do all other work necessary to make good such areas to satisfaction of consultant.

.6 Openings in existing floor assemblies and vertical fire separations necessitated by installation of equipment and systems or construction in general must be temporarily sealed with fire barrier materials such as mineral wool or other noncombustible insulation.

.7 If during alteration work existing asbestos material, other than known asbestos, is discovered (e.g. fireproofing, acoustic or thermal insulation, tank covering), stop

work in the affected area and immediately notify consultant.

.8 Existing refrigerant indicated to be removed shall not be discharged to the atmosphere, but shall be salvaged and reclaimed or disposed of following the guidelines of the authority having jurisdiction.

.9 All existing air intake and exhaust openings that may be affected by dust and/or debris from the renovation work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary.The Contractor shall replace existing filters that become contaminated with dust and/or debris from renovation work with new filters.

.10 In the event that dust and debris from renovation work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.

.11 Temporary filters shall be removed on completion of the renovation work.

3.6 INSPECTION AND RE-CERTIFICATION

.1 Where any equipment, machine or apparatus is modified, rebuilt or rewound with any change resulting in its performance or capacity rating and characteristics it shall be inspected and re-certified as required by authorities having jurisdiction.

.2 A nameplate giving the name of the person or firm making the change and the resulting changes in performance or capacity shall be provided and afixed to the equipment, machine or apparatus adjacent to the original nameplate. Where the original nameplate is removed, the original manufacturer's name and original identifying data, such as serial numbers, shall be added to the nameplate.

.3 Refer to rules 2-100 and 2-102 of the Ontario Electrical Safety Code.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 21 01 01.

1.2 COMMON WORK RESULTS

.1 Section 21 05 00 applies to and governs all work of Division 21.

1.3 REFERENCE STANDARDS

.1 Provide all work in accordance with requirements of Regulatory Agencies and conform to:
- .1 Local and district by-laws, regulations and published engineering standards.
- .2 the Ontario Building Code as amended,
- .3 Regulations for Construction Projects under The Occupational Health and Safety Act.
- .4 Fire Code made under the Fire Marshal's Act.

.2 Conform to following CSA Standards:
- .1 CSA B242 Groove and Shoulder Type: Mechanical Pipe Couplings.
- .2 CAN1-B149.1 Natural gas and propane installation code.
- .3 CSA B64.1 Manual for the Selection and Installation of Backflow Prevention Devices
- .4 CSA B64.1 Manual for the Maintenance and Field Testing of Backflow Prevention Devices.

.3 Conform to following National Research Council Canada publications:
- .1 National Building Code of Canada and Supplements to National Building Code of Canada
- .2 National Fire Code of Canada.

.4 Provide work where indicated in conformance with guide Specification of the Victaulic System for Building Services, G-100.

.5 Conform to following National Fire Protection Association standards;
- .1 NFPA 13 - Installation of Sprinkler Systems.
- .2 NFPA 14 - Installation of Standpipe, Private Hydrants, and Hose Systems.

1.4 SUBMITTALS

.1 Submit shop drawings in accordance with Section 01 22 00 & 21 01 01.

2 PRODUCTS

2.1 1 PIPING SPECIALTIES

.1 Cast brass, pressure, copper to copper unions shall be used with seamless copper tubing smaller than 3" (75 mm).

.2 Cast brass flanges shall be used with seamless copper tubing, type L for tubing 3" (75 mm) and larger.
.3 Dart type, 125 lb. (860 kPa) black malleable iron unions shall be used with all steel pipe for piping 2-1/2" (65 mm) and smaller.
.4 Slip-on, 150 lb. (1000 kPa) carbon steel flanges with 1/16" (4 mm) raised face shall be used with all steel pipe for piping larger than 2-1/2" (65 mm).
.5 Gaskets for joining flanged steel pipe shall be 1/16" (4 mm) Cranite ring type gaskets.
.6 Piping specialties including backflow preventers, strainers, valves etc. shall be line size unless indicated otherwise on drawings.

2.2 ADHESIVES, SEALANTS, PAINTS AND COATINGS

.1 Adhesives, Sealants, Paints and Coatings: Use only low VOC emitting materials meeting following criteria;
  .1 Paint for Mechanical Identification: maximum VOC emission of 250g/L
  .2 Touch-Up Paint: maximum VOC emission of 250g/L
  .3 Zinc-Rich Primer: maximum VOC emission of 250g/L
  .4 Adhesives for Mechanical Identification: maximum VOC emission of 70g/L
  .5 Sealants for service penetrations: maximum VOC emission of 650g/L clear and 350 g/L pigmented
  .6 Sealants for Firestopping: max. VOC emission of 650g/L clear and 350 g/L pigmented
  .7 Acrylic Sealant for supports and anchors: maximum VOC emission of 250g/L
  .8 Insulation Vapour Barrier Lap Adhesive: maximum VOC emission of 80g/L
  .9 Insulation Joint Sealer: maximum VOC emission of 250g/L
  .10 Insulation Vapour Barrier Mastic: maximum VOC emission of 400g/L
  .11 Flame Retardent Adhesive: maximum VOC emission of 650g/L clear and 350 g/L pigmented

3 EXCECUTION

3.1 INSPECTION

.1 Inspect installed work of other trades and verify that such work is complete to point where work under this Division may properly commence.
.2 Verify that work of this Division may be executed in accordance with pertinent codes and regulations, specifications, drawings, and referenced standards.
.3 Review drawings and verify dimensions at the site. Report discrepancies immediately to Consultant before proceeding with any construction work or shop drawings.

3.2 PREPARATION

.1 Existing services and equipment shall be relocated or removed to suit new construction and renovation work.

.2 Services that are no longer required shall be removed or cut back and capped to the satisfaction of Consultant.

.3 Obtain written authorization from Consultant for renovation work that is not specifically indicated.

.4 Where modifications or connections to existing systems require shutdown of the system the Contractor shall submit a request for system shutdown describing the system or part to be shutdown, the duration of the shutdown, the work planned and steps to be taken to reinstate the system to full operation. The request shall be submitted in the format stipulated by the Owner.

.5 All work required to prepare systems for shutdown and/or re-instatement, such as draining, chemical treatments, and re-filling shall be included in the Bid Price.

3.3 PIPING INSTALLATION - ABOVE GROUND

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays. Provide all materials to be built-in such as sleeves, anchors, etc., together with accurate dimensions or templates, promptly.

.2 Layout all work accurately, installing piping parallel to lines of building.

.3 Install piping, wherever possible, in partitions and above ceiling. Do not install piping in outside walls unless so shown on drawings. Wrap uninsulated piping in masonry walls with building paper.

.4 Install concealed piping close to building structure to minimize furring dimensions.

.5 Provide adequate space around piping to facilitate application of insulation.

.6 Use dielectric couplings where piping of dissimilar metals connect.

.7 Where piping passes through concrete floors, or walls, sleeves shall be sized to permit the pipe to expand freely without binding or crushing pipe insulation.

.8 Where branch pipes are welded into main without the use of "T" connections, torch cut openings must be cut true, bevelled and filed smooth. Branch pipes must not be allowed to project inside of main pipe. Openings must not be cut large enough to permit entry of welding metal and slag within the pipe.

3.4 PIPING JOINTS

.1 Make joints in piping installed under this Division using persons familiar with the particular materials being used and in accordance with NFPA Standards, manufacturer's instructions, and as specified herein.

.2 Use only welder and/or brazer operators, with a valid identification card, as issued under The Boiler and Pressure Vessels Act, to make joints in Registered Piping Systems.

.3 Carefully ream joints in threaded pipe and paint with approved graphite type joint sealer on male connections only. Make connections with proper wrench to suit pipe size. Where leaks occur, the joint shall be disassembled and corrected if possible, or replaced. Over-tightening, caulking or peening will not be acceptable.

.4 When using Victaulic Grooved Piping Method: make joints in grooved piping with couplings and gaskets in accordance with Victaulic Company of Canada Ltd,

General Catalogue G-100, latest edition. Cut or roll grooves using tools specifically designed for that purpose.

.5 Use butt welding and/or schedule 40 carbon steel welding fittings to join sections of steel piping with welding ends.

3.5 FLUSHING AND CLEANING

.1 Flush water mains in accordance with procedures established by NFPA 24.
.2 Thoroughly flush all other piping installed by this Division.
.3 Remove, clean and replace all strainers in systems after flushing.
.4 Thoroughly clean and lubricate all equipment, and leave all items in perfect order ready for operation.

3.6 ELECTRICAL WIRING

.1 Conform to requirements of Division 26 for all wiring included in Division 21, including pre-wired equipment provided by Sections under Division 21.
.2 Ensure that all pre-wired electrical equipment is CSA approved. Arrange and pay for special approval where this is not possible.
.3 Coordinate all wiring requirements with other Divisions. Line voltage wiring from power distribution panels to starters and from starters to motors will be provided under Division 26. All ther field wiring for equipment shall be included under Division 21.

3.7 EQUIPMENT TESTING AND INSPECTION

.1 Test operation of equipment installed under this Division according to instructions in appropriate articles of this Division. Make any required adjustments or replacements to ensure equipment is operating as intended. Retest equipment requiring adjustment or replacement.
.2 Pay all fuel consumption charges for equipment under testing and during commissioning.
.3 Arrange and pay for inspections by authorities as required by code and complete any changes or alterations required by such inspections.
.4 Conduct tests in the presence of:
    .1 Authorized inspector(s) for authorities having jurisdiction.
    .2 The Testing and Balancing Agency.
    .3 The Commissioning Agent.
    .4 The Consultant.
    .5 The Owner's Representative.
.5 Notification must be given at least 48 hours in advance of tests being conducted, to all persons required to be present.

3.8 PIPING SYSTEMS TESTING AND INSPECTION

.1 Prior to tests, isolate all equipment or other parts which are not designed to withstand

test pressures.

.2 Test all piping at the completion of roughing-in, before connecting to existing systems, and prior to concealment.

.3 Make tests, that are required by any authority having jurisdiction, in the presence of the authority's authorized inspector and shall be certified by him.

.4 Conduct tests in the presence of:

.1 Authorized inspector(s) for authorities having jurisdiction.

.2 The Commissioning Agent

.3 The Owner's Representative

.4 The Consultant

.5 Notification must be given at least 48 hours in advance of tests being conducted, to all persons required to be present.

.6 Repair all leaks exposed during testing and retest. If defects in pipe or fittings are discovered in the system, they shall be removed and replaced.

.7 Certify tests not required by authorities having jurisdiction.

3.9 TESTING AND BALANCING

.1 Allow sufficient time for testing and verification prior to substantial completion. Notify Testing and Balancing Agency on completion of adjusting and balancing of systems.

.2 Adjust systems and components (drives, sheaves, belts, etc.) as required by Testing and Balancing Agency.

.3 Maintain systems in full operation during testing and verification.

.4 Make adjustments to control systems as required to facilitate verification. Maintain all safety controls in operation.

.5 Check and correct alignment of drive shaft coupling, drives, etc. as required by Testing and Balancing Agency.

3.10 PROTECTION

.1 Protect finished and unfinished work by tarpaulins, or other covering, from damage due to execution of work under this Division.

.2 Repair to satisfaction of Consultant, damage to building resulting from failure to provide such protection.

.3 All existing air intake and exhaust openings that may be affected by dust and/or debris from the construction work of this Division shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from construction work with new filters.

.4 In the event that dust and debris from construction work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.

.5 Temporary filters shall be removed on completion of the construction works.

3.11 CUTTING AND PATCHING

.1 Include cutting and patching as required in execution of work under respective Sections of this Division.

.2 Holes through the structure will not be permitted without written approval of the Consultant. Any and all openings required through the completed structure must be clearly and accurately shown on a copy of the relevant structural drawing(s). Exact locations, elevations and size of the proposed opening must be identified well in advance of the need for the work.

.3 All sleeved or formed openings through the structure must be shown on sleeving drawings and must be approved by the Structural Consultant prior to construction.

.4 The Contractor shall conduct exploratory work including x-ray of the existing structure, shall mark the location of embedded reinforcements, anchors, conduits and piping on exposed surfaces of adjacent floors and/or walls and shall pay all associated costs.

.5 Reinforcing shall not be cut or modified without prior approval of the Structural Consultant. Should reenforcement be cut without such prior approval, the cost of any additional reenforcement deemed necessary by the Structural Consultant shall be the responsibility of this Contractor.

.6 Alternative imaging techniques are subject to the approval of the Structural Consultant.

.7 Ensure that cutting and patching of roofs and reinforced concrete structures is executed by specialists familiar with the materials affected, and is performed in a manner to neither damage nor endanger the work. Coordinate and supervise such cutting and patching.

.8 Maintain the integrity of fire rated assemblies where they are pierced by ducts and pipes.

.9 Make good surfaces affected by this work and repair finish to satisfaction of Consultant.

.10 Stop work immediately upon discovery of any hazardous material and report discovery to the Owner and Consultant. Obtain instruction prior to proceeding with the work.

3.12 PAINTING

.1 Repair minor damage to finish of equipment with standard factory applied baked enamel finish under the appropriate Sections of this division. Replace entirely, items suffering major damage to finish if too extensive to be repaired in the opinion of the Consultant.

.2 Apply at least one coat of corrosion resistant primer paint to supports, and equipment fabricated from ferrous metals.

3.13 SUPPORT AND ATTACHEMENT

.1 Support piping and equipment from load bearing structures such as beams, joists,

reinforced concrete slabs and concrete block walls, and do not support from or attach to steel roof deck and/or wall or ceiling finishes.

3.14 DISSIMILAR METALS

.1 Separate dissimilar metals in order to prevent galvanic corrosion.
.2 Provide gaskets or shims of approved materials to avoid electrolytic action.
.3 Use dielectric unions and/or flanges where piping of dissimilar metals are connected.

3.15 EQUIPMENT BASES AND CURBS

.1 Supply and erect structural work required for installation of fire suppression equipment.
.2 Build concrete bases 6" (150 mm) high, providing all necessary inserts, anchor bolts and other fasteners required, for floor mounted tanks, pumps, etc. Make concrete bases 2" (50 mm) larger all around than the base of the supported equipment and trowel finish to a neat smooth finish. Anchor equipment to pads using 8" (200 mm) cast-in-place anchor bolts. Ensure concrete supplied under this Division is 2500 psi (17 MPa) compressive strength after 28 days.
.3 Build 4" (100 mm) high concrete curbs around all openings through mechanical room floors for piping. Ensure joint between curb and floor is watertight and maintains integrity of floor membrane where applicable.

3.16 SERVICE CONNECTIONS

.1 Include in Bid Price all amounts required by municipality and/or utilities for service connections and /or modifications to service connections for water services. Ensure amounts include fees, assessments, charges, etc., required in relation to service connection. Do not include acreage or frontage charges.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 21 01 01.

1.2 SECTION INCLUDES

.1 Flexible pipe connectors.
.2 Expansion joints and compensators.
.3 Pipe loops, offsets, and swing joints.
.4 Anchors and guides

1.3 REFERENCES

.1 CSA B51 Boiler, Pressure Vessel and Pressure Piping Code
.2 ASME B31.1 Code for Power Piping
.3 ASME B31.3 Process piping
.4 MIL-E-17814E - Expansion Joints, Pipe, Slip-Type, Packed.

1.4 PERFORMANCE REQUIREMENTS

.1 Provide structural work and equipment required to control expansion and contraction of piping.
.2 Verify that anchors, guides, and expansion joints provided, adequately protect system.
.3 Arrange all piping so that expansion and contraction of any piping may take place without placing undue strain on the piping or connections to the equipment. Use swing joints and suitable expansion joints wherever necessary due to field conditions and where indicated on the drawings.
.4 This Section shall analyze each section of pipe installed between constraints and shall determine the potential for expansion of the pipe based on pipe temperature at installation and pipe temperatures throughout the pipe's operating range. Where potential expansion exceeds 1" (25 mm) over the length of the pipe section, expansion compensators shall be installed. Pipe sections are constrained where they penetrate walls, partitions, floors, ceilings, roofs and movement of the pipe is restricted and where the pipe is anchored to the building structure.
.5 Expansion Calculations:
  .1 Safety Factory: 30 percent.
  .2 Installation Temperature: 50°F (10°C).
  .3 Hot Water Heating: 210°F (99°C).
  .4 Domestic Hot Water: 140°F (60°C).
  .5 Steam (100psig WP): 350°F (177°C).
  .6 Steam (15psig WP): 300°F (150°C).
  .7 Condensate (to 125 psig): 350°F (177°C).
  .8 Condensate & feedwater (to 300 psig): 500°F (260°C)

1.5 SUBMITTALS

.1 Refer to Section 21 01 01.
.2 Product Data:
  .1 Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per metre and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
  .2 Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
.3 Design Data: Submit detailed construction drawings for expansion compensation and piping anchors, signed and sealed by a professional engineer licenced in Ontario. Provide selection criteria used.
.4 Manufacturer's Installation Instructions: Indicate special procedures, and external controls.

1.6 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.
.2 Design expansion compensating system under direct supervision of a Professional Engineer experienced in design of this work and licenced in the Province of Ontario.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Transport, handle, store, and protect products.
.2 Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.
.3 Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.8 WARRANTY

.1 Warranty: 5-year replacement warranty.

1.9 EXTRA MATERIALS

.1 Section 21 01 01: Submittals for project closeout.
.2 Provide two 340 gm containers of packing lubricant and cartridge style grease gun.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Manufacturers must be certified by the Expansion Joint Manufacturers Association (EJMA)
.2 Flexible Pipe Connectors

.1 Flex-Pression Ltd.
.2 Sr. Flexonics
.3 Ontario Hose
.4 Colton Industries

.3 Expansion Joints
.1 Flex-Pression Ltd.
.2 Hyspan Precision Products, Inc.
.3 Sr. Flexonics

.4 Pipe Alignment Guides
.1 Flex-Pression Ltd.
.2 Hyspan Precision Products, Inc.
.3 Sr. Flexonics

2.2 PIPE ALIGNMENT GUIDES

.1 Steel Pipe:
.1 radial "spider" type, minimizing piping motions in non-axial planes.
.2 constructed of carbon steel with a 360-degree two-piece bolted housing, and 360-degree two-piece bolted clamps with spider type legs.
.3 provide an insulation clearance of 1.5" on sizes 6" IPS and under, and 2.0" on sizes 8" IPS and over.
.4 axial travel shall be 3" for sizes 2" IPS and under, and 6" for sizes 2-1/2" IPS and over.
.5 refer to piping and expansion joint schedules for specific insulation and motion requirements.
.6 Basis of design: Hyspan Series 9500.

.2 Copper Pipe:
.1 radial "spider" type, minimizing piping motions in non-axial planes.
.2 constructed of carbon steel with non-metallic coating on the tube clamps, and a 360-degree two-piece bolted housing, and 360-degree two-piece bolted clamps with spider type legs.
.3 provide an insulation clearance of 1.5".
.4 axial travel shall be 3" for sizes 2-1/2" and under, or 6" for sizes 3" and 4".
.5 refer to piping and expansion joint schedules for specific insulation and motion requirements.
.6 Basis of design: Hyspan Series 9500.

2.3 FLEXIBLE PIPE CONNECTORS

.1 Copper Piping:
.1 Inner Hose: Bronze
.2 Exterior Sleeve: Braided bronze.
.3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).
.4 Joint: As specified for pipe joints.
.5 Size: Use pipe sized units

.6 Maximum offset: 3/4" (20 mm) on each side of installed centre line.

.2 Steel Piping, 2" (50 mm) diameter and smaller:
- .1 Inner Hose: braided bronze.
- .2 Exterior Sleeve: None.
- .3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).
- .4 Joint: Threaded.
- .5 Size: Use pipe sized units.
- .6 Maximum offset: 3/4" (20 mm) on each side of installed centre line.

.3 Steel Piping, 2-1/2" to 3-1/2" (65mm to 90mm) diameter :
- .1 Inner Hose: braided bronze.
- .2 Exterior Sleeve: None.
- .3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).
- .4 Joint: Flanged.
- .5 Size: Use pipe sized units.
- .6 Maximum offset: 3/4" (20 mm) on each side of installed centre line.

.4 Steel Piping, 4" (100mm) diameter and larger:
- .1 Inner Hose: braided 321 stainless steel.
- .2 Exterior Sleeve: None.
- .3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).
- .4 Joint: Flanged.
- .5 Size: Use pipe sized units.
- .6 Maximum offset: 3/4" (20 mm) on each side of installed centre line.

2.4 EXPANSION JOINTS - COPPER PIPING

.1 Bronze Bellows Type:
- .1 Construction: 2-ply bronze with anti-torque device, limit stops, internal guides.
- .2 Pressure Rating: 125 psi (862 kPa) WSP and 400°F (204°C).
- .3 Maximum Compression: 1-3/4" (45 mm).
- .4 Maximum Extension: 1/4" (6 mm).
- .5 Joint: Soldered.
- .6 Size: Use pipe line sized units
- .7 Application: Copper piping.

2.5 EXPANSION JOINTS - DESIGN 150 PSIG / 500°F

.1 Ratings
- .1 Design Pressure: 150 psig (1035 kPa)
- .2 Test Pressure: 225 psig (1552 kPa)
- .3 Design Temperature: 500 °F (260°C)

.2 Stainless Steel Bellows Type:
- .1 Construction multi-ply ASTM A240 type 321 stainless steel bellows, ASME A53, Gr. B carbon steel housing,
- .2 Pressure Rating: 150 psi (1035 kPa) WSP and 500°F (260°C).
- .3 Maximum Compression: 1-3/4" (45 mm).

.4 Maximum Extension: 1/4" (6 mm).
.5 Joint: Flanged.
.6 Size: Use pipe line sized units
.7 Application: Steel piping 2-1/2" (65 mm) and smaller.

.3 Externally Pressurized:
.1 Construction: Self-equalizing type with three or four ply ASTM A240 type 321 stainless steel bellows; ASME A53, Grade B carbon steel housing and pipe nipples; ASME-A36 steel plate guide rings and flanges; ASME A105, 3000-lb thread-o-let drain port & plug.
.2 Pressure Rating: 300 psi (2070 kPa) WOG and 500°F (260°C).
.3 Maximum Compression: 8" (200 mm).
.4 Maximum Extension: 2" (50 mm).
.5 Joints: Flanged.
.6 Size: Use pipe line sized units
.7 Application: Steel piping 3" (75 mm) and larger.

3 EXECUTION

3.1 INSTALLATION

.1 Install flexible pipe connectors and expansion joints to manufacturer's instructions.
.2 Ratings and bolt patterns for flanges shall suit design pressure and design temperature of piping system and match those of installed components.
.3 Construct spool pieces to exact size of flexible connection for future insertion.
.4 Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.
.5 Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
.6 Pipe anchors shall be installed securing the piping system to the building structure in order to control the direction and the amount of pipe movement. In addition, pipe anchors shall be installed to prevent separation of pipe due to hydraulic pressures. Pipe anchors shall be designed by the Contractor to accommodate all forces experienced. Prepare calculations for each anchor and submit to Consultant for review and approval. Provide pipe guides so movement is directed along axis of pipe only. Not less than two guides shall be provided on each side of an expansion joint. Erect piping such that strain and weight is not on cast connections or apparatus.
.7 Provide support and equipment required to control expansion and contraction of piping. Provide pipe offsets, and swing joints, or expansion joints where required. The Contractor may elect to install expansion loops in place of expansion compensators where there is adequate space to do so; subject to the approval of the Consultant. The Contractor shall prepare and submit detailed design calculations for each expansion loop proposed to the Consultant for review and approval prior to

installation.

3.2 MANUFACTURER'S FIELD SERVICES

.1 Prepare and start systems to Section 21 01 01.
.2 Provide inspection services by manufacturer's representative for final installing and certify installation is to manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION

1 ENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 21 01 01.

1.2 SECTION INCLUDES

.1 Pipe and equipment hangers and supports.
.2 Equipment bases and supports.
.3 Sleeves and seals.
.4 Flashing and sealing equipment and pipe stacks.

1.3 REFERENCES

.1 ASME B31.1 - Power Piping.
.2 ASME B31.2 - Fuel Gas Piping.
.3 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
.4 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
.5 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
.6 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
.7 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
.8 NFPA 13 - Installation of Sprinkler Systems.
.9 NFPA 14 - Installation of Standpipe, Private Hydrants, and Hose Systems.
.10 UL 203 - Pipe Hanger Equipment for Fire protection Service.

1.4 SUBMITTALS

.1 Refer to section 01 33 00 & 21 01 01
.2 Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
.3 Product Data: Provide manufacturers catalogue data including load capacity.
.4 Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
.5 Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 REGULATORY REQUIREMENTS

.1 Conform to CSA B-51 for support of piping.

2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

.1 Manufacturers:
  .1 Anvil
  .2 Myat

.3 Hunt

.2 Hydronic Piping:

.1 Conform to CSA B-51 and ASME B31.9.

.2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.

.3 Hangers for Cold Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.

.4 Hangers for Hot Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.

.5 Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.

.6 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.7 Multiple or Trapeze Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Steel channels with welded spacers and hanger rods, cast iron roll.

.8 Wall Support for Pipe Sizes to 3" (76 mm): Cast iron hook.

.9 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.

.10 Wall Support for Hot Pipe Sizes 6" (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

.11 Vertical Support: Steel riser clamp.

.12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.13 Floor Support for Hot Pipe Sizes to 4" (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.14 Floor Support for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

.15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.3 Steam and Steam Condensate Piping:

.1 Conform to CSA B-51 and ASME B31.1.

.2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.

.3 Hangers for Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.

.4 Hangers for Pipe Sizes 6" (150 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.

.5 Multiple or Trapeze Hangers for Pipe Sizes to 4" (100 mm): Steel channels with welded spacers and hanger rods.

.6 Multiple or Trapeze Hangers for Pipe Sizes 6" (150 mm) and Over: Steel channels with welded spacers and hanger rods; cast iron roll and stand.

.7 Wall Support for Pipe Sizes to 2-3/4" (70 mm): Cast iron hook.

.8 Wall Support for Pipe Sizes 4" to 5" (100 to 125 mm): Welded steel bracket and wrought steel clamp.

.9 Wall Support for Pipe Sizes 6" (150 mm) and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll.

.10 Vertical Support: Steel riser clamp.
.11 Floor Support for Pipe Sizes to 4" (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
.12 Floor Support for Pipe Sizes 6" (150 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
.13 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.4 Refrigerant Piping:
.1 Conform to ASME B31.5.
.2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
.3 Hangers for Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
.5 Wall Support for Pipe Sizes to 3" (75 mm): Cast iron hook.
.6 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
.7 Vertical Support: Steel riser clamp.
.8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
.9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.2 ACCESSORIES

.1 Hanger Rods: galvanized, carbon steel continuous threaded.
.2 Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.3 EQUIPMENT ROOF CURBS

.1 Fabrication: Welded 0.05" (1.2 mm) galvanized steel shell and base, mitred 3" (75 mm) cant, variable step to match roof insulation, factory installed wood nailer.

2.4 ROOFTOP PIPE/DUCT SUPPORTS

.1 Acceptable manufacturers;
.1 Portable Pipe Hangers, Inc.
.2 Unistrut

.2 Pre-enginnered pipe/duct support system including;
.1 Bases: weather resistant and UV radiation resistant with seismic attachments
.2 Framing: 1-5/8" (41.3mm) strut or 1-7/8" (47.6mm) strut, fabricated of steel to ASTM A570, Grade 33., roll formed of 12-gauge (2.7mm thick) steel into 3-sided or tubular shape.
.3 Pipe Supports and Hangers: Conform to MSS SP-58 and MSS SP-69, fabricated of carbon steel. Single roller supports for piping subject to expansion and

contraction.

.4 Finishes:
  .1 Plastics as moulded with UV radiation protection.
  .2 Metal surfaces hot dip galvanized free of roughness, whiskers, unsightly spangles, icicles, runs, barbs, sags, droplets and other surface blemishes. Galvanizing shall conform to ASTM A123 for tubing and to ASTM A153 for hardware and accessories.

.5 Shop Drawings: Manufacturer to provide detailed shop drawings to indicate layout and supporting capacities of system components with installation and assembly instructions for each application. Shop drawings shall bear the signature and seal of a professional engineer licenced in Ontario.

3 EXECUTION

3.1 INSTALLATION

.1 Install to manufacturer's instructions and best trade practises.

3.2 INSERTS

.1 Provide inserts for placement in concrete formwork.
.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.3 PIPE HANGERS AND SUPPORTS

.1 Support horizontal piping as scheduled.
.2 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.
.3 Place hangers within 12" (300 mm) of each horizontal elbow.
.4 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment.
.5 Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.
.6 Support vertical piping at every other floor. Support vertical cast iron pipe at each floor at hub.
.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
.8 Support riser piping independently of connected horizontal piping.
.9 Provide copper plated hangers and supports for copper piping.
.10 Design hangers for pipe movement without disengagement of supported pipe.

.11 Prime coat exposed steel hangers and supports. Refer to Section 09 91 10. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.4 EQUIPMENT BASES AND SUPPORTS

.1 Provide housekeeping pads of concrete, minimum 4" (100 mm) thick and extending 6" (150 mm) beyond supported equipment. Refer to Section 03 30 00.
.2 Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
.3 Construct supports of steel members. Steel pipe and fittings. Brace and fasten with flanges bolted to structure.
.4 Provide rigid anchors for pipes after vibration isolation components are installed.

3.5 ROOFTOP PIPE/DUCT SUPPORT

.1 Coordinate installation of supports and bases with roofing work. Ensure that roofing surfaces are smooth and flat and are ready to receive work.
.2 Use care in installation of support systems not to damage roofing, flashing, equipment or related materials.
.3 Install and secure support systems in strict accordance with manufacturer's written instruction.
.4 Consult manufacturers of roofing system to determine if walk pads are required. Provide and fully adhere walk pads to roof system where required.
.5 Bases and support framing shall be located as indicated on shop drawings provided by support system manufacturer and as specified herein. The support of all piping shall be complete and adequate, whether or not all required devices are shown.
.6 The use of wood or wire for supporting piping will not be permitted.
.7 Deflection of pipes shall not exceed 1/240th of the span.
.8 Accurately locate and align bases. Where applicable, replace gravel around bases. Set framing posts into bases and assemble framing structure as indicated.
.9 Use galvanized fasteners for galvanized framing, and use stainless steel fasteners for stainless steel framing.

3.6 FLASHING

.1 Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
.2 Flash vent and soil pipes projecting 3" (75 mm) minimum above finished roof surface with lead worked 1" (25 mm) minimum into hub, 8" (200 mm) minimum clear on sides with 24" x 24" (600 x 600 mm) sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.
.3 Flash floor drains in floors with topping over finished areas with lead, 10" (250 mm) clear on sides with minimum 36" x 36" (910 x 910 mm) sheet size. Fasten flashing to drain clamp device.

.4 Seal roof, floor, shower and mop sink drains watertight to adjacent materials.

.5 Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed to manufacturer's instructions for sound control.

.6 Provide curbs for mechanical roof installations 14" (350 mm) minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

.7 Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 SLEEVES

.1 Set sleeves in position in formwork. Provide reinforcing around sleeves.

.2 Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

.3 Extend sleeves through floors 1" (25 mm) above finished floor level. Caulk sleeves.

.4 Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing insulation and caulk. air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

.5 Install chrome plated steel escutcheons at finished surfaces.

3.8 SCHEDULES

.1 Imperial Measure (IP)

Pipe Size (in)	Rod Diameter (in)	Support Spacing (ft)	
		Steel Pipe	Copper Tube
1/2	3/8	7	6
3/4	3/8	7	6
1	3/8	7	6
1-1/4	3/8	7	6
1-1/2	3/8	9	8
2	3/8	10	9
2-1/2	3/8	12	10
3	3/8	12	10
4	5/8	14	12
6	7/8	17	
8	7/8	19	
10	7/8	21	

12	7/8	23	
14	1	25	
16	1	27	
18	1	28	

.2 Metric Measure (SI)

Pipe Size (mm)	Rod Diameter (mm)	Support Spacing (m)	
		Steel Pipe	Copper Tube
13	10	2.1	1.8
20	10	2.1	1.8
25	10	2.1	1.8
32	10	2.1	1.8
38	10	2.7	2.4
50	10	3	2.7
65	10	3.6	3
75	10	3.6	3
100	16	4.2	3.6
150	22	17	
200	22	5.7	
250	22	6.4	
300	22	7	

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 21 01 01.

1.2 SECTION INCLUDES

.1 Vibration control of piping, ductwork and equipment.
.2 Inertia bases.
.3 Coordination with Supports and Anchors section.
.4 Coordination with Seismic Restraint of Piping & Equipment section.

1.3 REFERENCES

.1 Ontario Building Code.
.2 SMACNA "HVAC Duct Construction Standards"

1.4 PERFORMANCE REQUIREMENTS

.1 Provide vibration isolation on motor driven equipment over 1/2 HP (0.35 kW), plus connected piping and ductwork.
.2 Provide minimum static deflection of isolators for equipment as indicated.
  .1 Basement, Under 20 HP (15 kW)
    .1 Under 400 rpm: RIS
    .2 400 - 600 rpm: 1" (25 mm)
    .3 600 - 800 rpm: 1/2" (12 mm)
    .4 800 - 900 rpm: 1/4" (5 mm)
    .5 1100 - 1500 rpm: 1/8" (4 mm)
    .6 Over 1500 rpm: 1/8" (3 mm)
  .2 Basement, Over 20 HP (15 kW)
    .1 Under 400 rpm: RIS
    .2 400 - 600 rpm: 2" (50 mm)
    .3 600 - 800 rpm: 1" (25 mm)
    .4 800 - 900 rpm: 1/2" (12 mm)
    .5 1100 - 1500 rpm: 1/4" (5 mm)
    .6 Over 1500 rpm: 1/8" (4 mm)
  .3 Upper Floors, Normal
    .1 Under 400 rpm: 1-1/2" (40 mm)
    .2 400 - 600 rpm: 3-1/2" (90 mm)
    .3 600 - 800 rpm: 2" (50 mm)
    .4 800 - 900 rpm: 1" (25 mm)
    .5 1100 - 1500 rpm: 1/2" (12 mm)
    .6 Over 1500 rpm: 1/4" (5 mm)
  .4 Upper Floors, Critical
    .1 Under 400 rpm: 1-1/2" (40 mm)

.2 400 - 600 rpm: 2" (50 mm)
.3 600 - 800 rpm: 3-1/2" (90 mm)
.4 800 - 900 rpm: 2" (50 mm)
.5 1100 - 1500 rpm: 1" (25 mm)
.6 Over 1500 rpm: 1/2" (12 mm)

.3 Consider upper floor locations critical unless otherwise indicated.

.4 Use concrete inertia bases for fans having static pressure in excess of 3.4 IN. WG (0.85 kPa) or motors in excess of 40 HP (30 kW), and on base mounted pumps over 10 HP (7.5 kW).

.5 Provide seismic restraints in accordance with Ontario Building Code requirements for Post Disaster Buildings. Seismic restraints shall be designed, installed and reviewed under the direct supervision of a professional engineer licensed in the Province of Ontario.

1.5 SUBMITTALS

.1 Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.

.2 Product Data: Provide schedule of vibration isolator type with location and load on each.

.3 Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.

.4 Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Manufacturer shall be a member of VISCMA.

.2 Acceptable manufacturers;
.1 Kinetics [Vibron]
.2 Vibroacoustics
.3 VAW Systems.
.4 Korfund
.5 Masdom

2.2 VIBRATION ISOLATORS

.1 Isolators and bases shall be as tabulated on the equipment schedule.

.2 Type 1 Isolators: Model KIP Precompressed Molded Fiberglass Noise and Vibration Isolation Pads, individually coated with a flexible moisture-impervious elastomeric membrane. Pads shall be fine (0.00027"/6.9 micron diameter) bonded annealed glass fibers which have been stabilized during manufacture by compressing the material ten times. Pads shall have a constant natural frequency over the operating

load range, and the stiffness shall increase proportionately with load applied. Pads shall be no taller than the shortest horizontal dimension. Where the equipment base does not provide a uniform load surface, steel plates shall be bonded to the top of the pads. Alternatively, Model RD Neoprene Mounts, incorporating completely enclosed metal inserts to permit bolting to the supported unit, may be used.

.3 Type 2 Floor Isolators: Model FDS Free-Standing, Unhoused, Laterally Stable Steel Springs incorporating levelling bolts and 1/4 in. (6 mm) thick ribbed noise isolation pads.To assure stability, the spring shall have a lateral spring stiffness greater than 1.0 times the rated vertical stiffness, and shall be designed to provide 50% overload capacity. In capacities up to 5,000 lbs. (2268 kg), springs shall be replaceable. In capacities over 5,000 lbs. (2268 kg), springs shall be welded to the top and bottom load plate assemblies.

.4 Type 2 Hangers: Model SFH Combination Spring and Fiberglass Hangers, incorporating pre-compressed moulded fiberglass noise and vibration isolation pads, coated with a moisture impervious elastomeric membrane in series with springs, all encased in welded steel brackets. Springs shall be as specified above. Isolators shall be designed to accommodate rod misalignment over a 30 degree arc. Brackets shall be designed to carry 500% overload without failure.

.5 Type 3 Isolators: Model FLS, Free-Standing, Laterally Stable, Spring Isolators, similar to Type FDS, but incorporating vertical limit stops to assure a constant operating height if the supported weight is removed, and to reduce movement due to wind loads. Limit stops shall be isolated from the housing to prevent short-circuiting.

.6 Type 4 Bases: No base required. Isolators may be attached directly to the supported equipment.

.7 Type 5 or 6 Bases: Model SFB or SBB Structural Steel Bases, designed and supplied by the isolator manufacturer. Bases shall be designed with isolator brackets to reduce the mounting height of the equipment. To assure adequate stiffness, the height of the members shall be a minimum of 8% of the longest span between isolators, or at least 6 inches (152 mm). Where thinner sections are necessary due to head room limitations, etc., the section modulus of the members selected shall equal or exceed the section modulus of wide flange steel members whose thickness is 8% of the longest span between isolators.

.8 Type 7 Bases: Model CIB Reinforced Concrete Inertia Bases, the steel members of which are designed and supplied by the isolator manufacturer. The concrete shall be poured into a welded steel frame, incorporating prelocated equipment anchor bolts, 1/2 in. (13 mm) diameter reinforcing bars on nominal 8 in. (203 mm) centers each way, and recessed isolator mounting brackets to reduce the mounting height of the equipment, but yet remain within the confines of the base. The thickness of the base shall be a minimum of 8% of the longest span between isolators, at least 6 inches (152 mm), or as indicated on the drawings. Where inertia bases are used to mount pumps, the bases shall be large enough to support piping elbows.

.9 Type 8 Bases: Model KSR, KSCR or ESR Isolation Rail System, consisting of two parallel rail systems, incorporating steel spring isolators designed for the specified static deflection, all fabricated to be installed as a part of the roof curb system, and

provide continuous support for the isolated equipment.

.10 Piping: All piping 1 in. (25 mm) diameter and over in the mechanical equipment room, and all piping three supports away from other mechanical equipment shall be isolated from the structure by means of vibration and noise control isolators. Suspended piping shall be isolated with Type 2 Hangers as described above. Floor-mounted piping shall be isolated with Type 2 Spring Isolators as described above.

.11 Flexible members shall be incorporated in the ductwork adjacent to all reciprocating equipment, and shall be approved construction.

.12 Flexible connections shall be incorporated in the ductwork adjacent to all air-moving units. The connections shall be neoprene or canvas of approved construction. High pressure ductwork, for a distance of 50 feet (1270 mm) from high pressure fans shall be isolated from the ductwork by means of Type 2 Hangers as described above.

3 EXECUTION

3.1 INSTALLATION

.1 Install to manufacturer's instructions.

.2 Install isolation for motor driven equipment.

.3 Bases:

.1 Set steel bases for 1" (25 mm) clearance between housekeeping pad and base.

.2 Set concrete inertia bases for 2" (50 mm) clearance between housekeeping pad and base.

.3 Adjust equipment level.

.4 Install spring hangers without binding.

.5 On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

.6 Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

.7 Provide pairs of horizontal limit springs on fans with more than 1.5 kPa static pressure, and on hanger supported, horizontally mounted axial fans.

.8 Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.06" (1.5 mm) maximum clearance. Provide other snubbers with clearance between 1/8" and 1/4" (4 mm and 7 mm).

.9 Support piping connections to isolated equipment resiliently as follows:

.1 Up to 4" (100 mm) Diameter: First three points of support.

.2 5" to 8" (125 to 200 mm) Diameter: First four points of support.

.3 10" (250 mm) Diameter and Over: First six points of support.

.4 Select three hangers closest to vibration source for minimum 1" (25 mm) static deflection or static deflection of isolated equipment. Select remaining

isolators for minimum 1" (25 mm) static deflection or 1/2 static deflection of isolated equipment.

.10 Connect wiring to isolated equipment with flexible hanging loop.

3.2 MANUFACTURER'S FIELD SERVICES

.1 Inspect isolated equipment after installation and submit report. Include static deflections.

3.3 VIBRATION ISOLATOR SELECTIONS

.1 Based on Kinetics Selection Guide. Copied with permission.

.2 Kinetics Products Meeting Selection Guide .

.1 Type 1
Fiberglass Isolation Pad, Model KIP
Fiberglass Isolation Mount, Model AC
Elastomer Isolation Pad, Model NG
Machinery Mount, Model KLM
Vibration Isolation Mount, Model RD
Isolation Hanger, Model RH

.2 Type 2
Free-standing Steel Spring, Model FDS
Isolation Hanger, Model SH
Isolation Hanger, Model SFH
Isolation Hanger, Model SRH

.3 Type 3
Restrained Spring Isolator, Model FLS

.4 Type 4
No Base Required

.5 Type 5
Structural Rail Base, Model SBB

.6 Type 6
Integral Structural Beam Base, Model SFB

.7 Type 7
Concrete Inertia Base, Model CIB-L
Concrete Inertia Base, Model CIB-H
Concrete Inertia Base, Model CIB-SS

.8 Type 8
Roof Curb Rail, Model KSR, Model KSCR, Model ESR

.3 Notes to Selection Guide

.1 Provide Type 5 or 6 base if required to support equipment properly.

.2 Provide Type 5, 6 or 7 base if required to stabilize supported equipment.

.3 Isolator natural frequency to be 40% of the lowest equipment operating

speed.

.4 Provide HSR thrust restraints for air-moving equipment operating at 2.1in. (501 Pa) static pressure and above..5 Provide 12 in. (305 mm) thick Type 7 inertia base for 75 HP (56 kW) and over pumps

.5 Provide Type 7 inertia base weighing a minimum of 10 times the maximum equipment unbalanced forces.

.6 Provide Type 7 inertia base large enough to provide elbow support.

.7 If RTU weight causes additional roof deflection >0.25" (6 mm), stiffen roof structure or relocate RTU so additional deflection is <=0.25" (6mm). RTUs over noise-sensitive areas may require additional acousticaltreatment too reduce airborne noise below.

.8 Extreme care must be taken for equipment located on spans of over 20ft, especially if construction is open web joints or thin, lightweight slabs. The recommended procedure is to determine the additional deflection caused by equipment in the roof. If additional roof deflection is 0.25 in. or less, the isolator should be selected for 10 times the additional roof deflection. If additional roof deflection is over 0.25 in., supplemental roof stiffening should be installed to bring the roof deflection down below 0.25 in., or the unit should be relocated to a stiffer roof position

* Reference notes do not apply.

\+ Reference note #1 does not apply.

Taken from Kinetics Selection Guide	EQUIPMENT ITEM	Horsepower and Other (Shaft Power, kW and Other)	RPM	GRADE SUPPORTED SLAB			UP TO 20 FT. (6 M) FLOOR SPAN			20-30 FT. (6-9 M) FLOOR SPAN			30-40 FT. (9-12 M) FLOOR SPAN			REFERENCE NOTES
				BASE TYPE	ISOLATOR TYPE	MIN. DEFLECTION IN. (MM)	BASE TYPE	ISOLATOR TYPE	MIN. DEFLECTION IN. (MM)	BASE TYPE	ISOLATOR TYPE	MIN. DEFLECTION IN. (MM)	BASE TYPE	ISOLATOR TYPE	MIN. DEFLECTION IN. (MM)	
AIR COMPRESSORS AND VACUUM PUMPS	Tank-Mounted	up to 10 (7.5)	All	4	2	0.75 (19)	4	2	0.75 (19)	4	2	1.75 (44)	4	2	1.75 (44)	--
		15 (11) and over	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	1.75 (44)	--
	Base-Mounted	All	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	1.75 (44)	6
	Large Reciprocating	All	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	1.75 (44)	7
PUMPS	Close Coupled	up to 7.5 (5.6)	All	5/6*	1	0.25 (6)	7	2	0.75 (19)	7	2	0.75 (19)	7	2	0.75 (19)	5, 7
		10 (7.5) and over	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	1.75 (44)	--
	In Line	5 to 25 (3.7 to 19)	All	4	2	0.75 (19)	4	2	1.75 (44)	4	2	1.75 (44)	4	2	1.75 (44)	2.5
		30 (22) and over	All	4	2	1.75 (44)	4	2	1.75 (44)	4	2	1.75 (44)	4	2	2.50 (64)	7
	End Suction	up to 40 (30)	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	1.75 (44)	5, 7
		50 to 125 (37 to93)	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	2.50 (64)	5, 7
		150 (110) and over	All	7	2	0.75 (19)	7	2	1.75 (44)	7	2	1.75 (44)	7	2	2.50 (64)	7
	Split Case	up to 40 (30)	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	1.75 (44)	5, 7
		50 to 125 (37 to 93)	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	2.50 (64)	5, 7
		150 (110) and over	All	7	2	0.75 (19)	7	2	1.75 (44)	7	2	1.75 (44)	7	2	2.50 (64)	1, 3
AH, AC AND H & V UNITS	All	up to 10 (7.5)	All	4	2	0.75 (19)	4	2	0.75 (19)	4	2	0.75 (19)	4	2	0.75 (19)	1, 4
		15 (11) and over, up to 4" (1 kPa) static pressure	up to 300	4	2	0.75 (19)	4	2	3.50 (89)	4	2	3.50 (89)	7+	2	3.50 (89)	4
			301 to 500	4	2	0.75 (19)	4	2	2.50 (64)	4	2	2.50 (64)	4	2	2.50 (64)	4
			501 and over	4	2	0.75 (19)	4	2	1.75 (44)	4	2	1.75 (44)	4	2	1.75 (44)	1, 3, 4
		15 (11) and over, 4" (1 kPa) static pressure and over	up to 300	5/6	2	0.75 (19)	7	2	3.50 (89)	7	2	3.50 (89)	7	2	3.50 (89)	1, 4
			301 to 500	5/6	2	0.75 (19)	7	2	1.75 (44)	7	2	2.50 (64)	7	2	2.50 (64)	1, 4
			501 and over	5/6	2	0.75 (19)	7	2	1.75 (44)	7	2	1.75 (44)	7	2	2.50 (64)	8
PACKAGED ROOFTOP EQUIPMENT	All	All	All	4/8	1	0.25 (6)	8	2	0.75 (19)	See note #9			See note #9			

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 21 01 01.

1.2 SECTION INCLUDES

.1 Engineering, design and calculations for seismic restraint
.2 Seismic restraints for equipment, piping and ductwork
.3 Coordination with Supports and Anchors section.
.4 Coordination with Vibration Isolation section.

1.3 REFERENCES

.1 Ontario Building Code
.2 National Building Code
.3 ASHRAE Standard "A Practical Guide to Seismic Restraint",
.4 NFPA 13,
.5 SMACNA "HVAC Duct Construction Standards"
.6 Good engineering practice.

1.4 SUBMITTALS

.1 All vibration isolation and seismic restraint systems shall be by one manufacturer. Basis of this design is Vibro-Acoustics.
.2 Submit shop drawings for all devices specified herein and as indicated on the drawings. Submittals shall include dimensions, materials, attachment and anchorage requirements. Indicate compliance with each specification item herein.
.3 Provide calculations for selection of seismic restraints, certified by a qualified professional engineer licensed in the province where the project is located.
.4 Shop Drawings:
    .1 Provide detailed drawings of all seismic control measures for equipment, duct, and piping.
    .2 Provide separate shop drawings for each isolated system complete with performance and product data, indicating all calculations for loads and deflections.
    .3 Indicate inertia bases and locate vibration isolators, with static and dynamic loads on each.
    .4 Shop drawings shall include engineering calculations for all seismic restraints and attachment. A Professional Engineer registered in the province of the project shall sign, seal and date the calculations.
.5 Product Data: Provide schedule of vibration isolator type with location and load on each.
.6 Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.

.7 Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed design requirements.

1.5 PROJECT RECORD DOCUMENTS

.1 Record actual locations of seismic restraints including attachment points.

1.6 SEISMIC DESIGN

.1 For post-disaster buildings;
  .1 Importance factor for wind load, IW, is 1.25
  .2 Importance factor for earthquake loads and effects, IE, is 1.5.
.2 Site classification for seismic site response is unknown.
.3 Climatic and Seismic Data from the Ontario Building Code for specific location:

Location	Sa(0.2)	Sa(1.0)	q (1/50)
Hamilton	0.33	0.058	0.46

.4 Terms:
  .1 Sa(0.2): Spectral response acceleration for short periods.
  .2 Sa(1.0): Spectral response acceleration for 1-second periods.
  .3 q(1/50): The reference hourly wind velocity pressure in kPa.

1.7 SEISMIC ENGINEER

.1 Professional Engineer holding a Certificate of Authorization in the Province of Ontario with a minimum of 5 years experience in seismic design, and a minimum of $1 million Professional Liability Insurance including Errors and Omissions Insurance.
.2 At the completion of the project, the Seismic Engineer shall review the installations on site, and shall prepare a written report, with a letter signed, sealed and dated by the Seismic Engineer, certifying that the installations have been completed in accordance with their design and shop drawings.

1.8 SEISMIC CONTROL MEASURES

.1 A single Supplier shall provide seismic design, vibration isolation, and seismic restraint. Coordinate with Section 21 01 01.
.2 Seismic restraints are to be provided for all operational and functional components of building services in accordance with current requirements of the Ontario Building Code.
.3 Cable restraint systems, rod stiffener clamps and seismic isolator capacities shall be verified by an independent test laboratory.
.4 Connection materials shall be selected by and site specific designs to be prepared by the Seismic Engineer. The Seismic Engineer may select and specify materials and anchors to be provided by the contractor where this is appropriate.
.5 Contractor shall ensure that the Seismic Engineers' requirements and specification are met.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Manufacturer shall be a member of VISCMA.
.2 Coordinate selection of Manufacturer with Section 15190.
.3 Acceptable manufacturers;
  .1 Vibron/Kinetics.
  .2 VAW Systems
  .3 Korfund
  .4 Masdom

2.2 GENERAL

.1 All isolation and seismic restraint products supplied by common manufacturer / supplier.
.2 All isolators are to be seismic rated or to be used with a bracing or snubber system.
.3 Colour code springs for load carrying capacity.
.4 Outdoor springs and housings to be corrosion resistant.
.5 Units containing water that can be drained are to use a vertical limiting spring as F-2.

3 EXCECUTION

3.1 SEISMIC RESTRAINT

.1 Pipes: the following pipe and duct sizes, and larger, must be restrained:
  .1 2.5" (64 mm) diameter pipe in general areas
  .2 1.25" (32 mm) diameter pipe in mechanical rooms
  .3 1" (25 mm) diameter pipe containing hazardous materials and medical piping (ie natural gas, oil, medical vacuum, etc)
  .4 6 square feet face area for duct
  .5 any trapeze with a component combined weight that exceeds the above items
.2 Pipes and ducts hung with hanger rods less than 12" (300 mm) in length do not require seismic restraint provided the following conditions are all satisfied:
  .1 All hanger rods in the "run" are attached to the structure with non-moment generating connections; and
  .2 At least 12" (300 mm) clearance on each side of the pipe or duct is provided for the entire "run" so that the pipe or duct can swing freely and will not contact anything; and
  .3 All hanger rods in a "run" of pipe or duct must be less than 12" (300 mm) in length. If one hanger rod exceeds 12" (300 mm) in a "run", this exception cannot be applied.
  .4 The 12" (300 mm) rule does not apply to suspended equipment.
.3 Base Mounted Equipment: all base mounted equipment requires attachments and

seismic restraint as specified by the Seismic Engineer.

.4 Suspended Equipment: all suspended equipment requires seismic restraint.

.5 Roof mounted equipment shall be installed on a structural frame, seismic rated roof curb, or structural curb or frame mechanically connected to the structure. Items shall not be mounted on sleepers or pads that are not mechanically attached to the structure.

.6 Roof mounted piping and ductwork is to be installed on curbs or frames mechanically connected to the building structure. Roof anchors and seismic cables or frames shall be used to resist seismic and wind loading. Wind loading forces shall be determined by the Seismic Engineer.

3.2 INSTALLATION - GENERAL

.1 Install to manufacturer's instructions and adjust mountings to level equipment.

.2 Ensure pipe, duct and electrical connections to isolated equipment do not reduce system flexibility. Ensure that pipe, conduit and duct passing through walls and floors do not transmit vibrations.

.3 Install isolation for motor driven equipment.

.4 Bases:

- .1 Set steel bases for 1" (25 mm) clearance between housekeeping pad and base.
- .2 Set concrete inertia bases for 2" (50 mm) clearance between housekeeping pad and base.
- .3 Adjust equipment level.

.5 Install spring hangers without binding.

.6 On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

.7 Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

.8 Provide pairs of horizontal limit springs on fans with more than 1.5 kPa static pressure, and on hanger supported, horizontally mounted axial fans.

.9 Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.06" (1.5 mm) maximum clearance. Provide other snubbers with clearance between 1/8" and 1/4" (4 mm and 7 mm).

.10 Block and shim level bases so that ductwork and piping connections can be made to a rigid system at the operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

.11 Connect wiring to isolated equipment with flexible hanging loop.

3.3 INSTALLATION - EQUIPMENT

.1 Rigid Mounted Equipment:

.1 Anchor floor and wall mounted equipment to structure as per the seismic shop drawings.
.2 Suspended equipment shall be restrained using sway bracing, or struts, and hanger rods as per the seismic shop drawings.

.2 Vibration isolated equipment:
.1 Seismic control measures shall not compromise the performance of noise control, vibration isolation or fire stopping systems.
.2 Equipment supported by vibration-isolation hangers shall be detailed and installed with isolation hangers tight to the structure and upward limit stops located directly below the hangers.

3.4 INSTALLATION - PIPING AND DUCT SYSTEMS

.1 Provide seismic control measures with spacing and anchorage engineered for the specific project. Provide rod stiffeners where required.
.2 Maximum Restraint Spacing
.1 Piping: transverse spacing 40 ft (12 m), longitudinal spacing 80 ft (24 m).
.2 Duct: transverse spacing 40 ft (12 m), longitudinal spacing 80 ft (24 m).
.3 Hazardous Material and Medical Piping: transverse spacing 20 ft (6 m), longitudinal spacing 40 ft (12 m).
.3 Support piping connections to isolated equipment resiliently as follows:
.1 Up to 4" (100 mm) Diameter: First three points of support.
.2 5" - 8" (125 to 200 mm) Diameter: First four points of support.
.3 10" (250 mm) Diameter and Over: First six points of support.
.4 Select three hangers closest to vibration source for minimum 1" (25 mm) static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1" (25 mm) static deflection or 1/2 static deflection of isolated equipment.
.5 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 2" (50 mm).
.6 Deflection shall be not less than that for the equipment to which the piping is connected.
.4 Seismic systems are to be compatible with requirements for anchoring and guiding of piping systems.
.5 Drilled or power driven anchors or fasteners not permitted for use with seismic control measures.
.6 Outdoor and roof mounted systems must be mechanically attached to structure. This attachment must account for seismic and wind loading.
.7 Friction due to gravity does not constitute a seismic attachment.
.8 Where equipment is mounted on concrete housekeeping pads the design of reinforcement and anchorage of the pad to the structure shall be performed by the Seismic Engineer. Alternatively, the equipment must be attached through the pad to the base structure, at the Seismic Engineer's discretion.
.9 Do not brace equipment to separate portions of the structure that may act

differently in response to an earthquake. For example, do not connect a transverse brace to a wall and a longitudinal brace to a floor or roof at the same brace location.

.10 All duct over 6 square feet is to be hung with a double trapeze at restraint locations, one angle on the top and one angle on the bottom of the duct.

.11 Unless noted otherwise on seismic shop drawings, all duct is to be screwed to the trapeze (top and bottom) with #10 screws at 12" (300 mm) spacing for every trapeze.

.12 All pipes must be attached to trapeze with pipe clamps.

.13 Where pipe or duct size reduces below required dimensions noted in Section 2.3.1, the final restraint shall be installed at the transition location.

.14 Items mounted into T-bar suspended ceiling grids require 4 wires to attach the unit to the structure. The wires and their attachment do not form part of the seismic restraint system. If the ceiling grid is seismically restrained, then the item does not require independent seismic restraint. This design in not in this scope of work, as the ceiling grid is an architectural component.

.15 Sleepers for roof mounted pipes, duct, and equipment require mechanical connection to the building. The forces imposed on this attachment are to be provided by the seismic engineer.

.16 Seismic restraint connections are not to be connected to the bottom chord of steel joists or the bottom flange of steel beams.

.17 Rod stiffeners are required where the hanger rod exceeds the maximum length as shown in the seismic calculation sheets. They are only required at restraint locations.

.18 Standard beam clamps can only be used on seismically restrained components; they cannot be used to connect the seismic restraint to the structure - only for the hanger rods.

.19 Horizontal penetrations through walls should be through a pre-fabricated metal sleeve with a compressible material between the pipe and the sleeve. Vertical penetrations through floors/roofs should use an oversize hole in the structure with compressible material between the hole and the pipe and the pipe should be supported by a clamp resting on two steel load-distributing plates.

.20 Block walls can be used for transverse restraints if the item penetrates the wall at 90 degrees and is a snug fit. If angles are attached to the item around its perimeter and attached to the wall, then the wall can act as a transverse and longitudinal restraint. Metal stud walls cannot be used for restraint unless specifically designed.

3.5 MANUFACTURER'S FIELD SERVICES

.1 Examine systems to Section 21 01 01.

.2 Inspect isolated equipment after installation and submit report. Include static deflections.

3.6 PIPE ISOLATION SCHEDULE

Pipe Size (mm)	Isolated Distance from Equipment
25	120 diameters (3.0 m)
50	90 diameters (4.5 m)
80	80 diameters (6.0 m)
100	75 diameters (7.5 m)
150	60 diameters (9.0 m)
200	60 diameters (12.0 m)
250	54 diameters (13.5 m)
300	50 diameters (15.0 m)
400	45 diameters (18.0 m)
600	38 diameters (23.0 m)
Over 600	To be determined by Seismic Engineer

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 21 01 01.

1.2 SECTION INCLUDES

.1 Piping insulation.
.2 Jackets and accessories.

1.3 REFERENCES

.1 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
.2 ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
.3 ASTM C195 - Mineral Fibre Thermal Insulating Cement.
.4 ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
.5 ASTM C449/C449M - Mineral Fibre Hydraulic-setting Thermal Insulating and Finishing Cement.
.6 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
.7 ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
.8 ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
.9 ASTM C547 - Mineral Fibre Pipe Insulation.
.10 ASTM C552 - Cellular Glass Thermal Insulation.
.11 ASTM C578 - Rigid, Cellular Polystyrene Thermal Insulation.
.12 ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
.13 ASTM C591 - Unfaced Preformed Cellular Polyisocyanurate Thermal Insulation.
.14 ASTM C610 - Moulded Expanded Perlite Block and Pipe Thermal Insulation.
.15 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
.16 ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
.17 ASTM D1667 - Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Foam).
.18 ASTM D2842 - Water Absorption of Rigid Cellular Plastics.
.19 ASTM E84 - Surface Burning Characteristics of Building Materials.
.20 ASTM E96 - Water Vapour Transmission of Materials.
.21 NFPA 255 - Surface Burning Characteristics of Building Materials.
.22 UL 723 - Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

.1 Product Data: Provide product description, list of materials and thickness for each service, and locations.

.2 Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

.1 Materials: Flame spread/smoke developed rating of 25/50 or less to ULC S102 and ASTM E84.

1.6 QUALIFICATIONS

.1 Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Transport, handle, store, and protect products.
.2 Deliver materials to site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
.3 Store insulation in original wrapping and protect from weather and construction traffic.
.4 Protect insulation against dirt, water, chemical, and mechanical damage.

1.8 ENVIRONMENTAL REQUIREMENTS

.1 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
.2 Maintain temperature during and after installation for minimum period of 24 hours.

2 PRODUCTS

2.1 GLASS FIBRE

.1 Manufacturers:
  .1 Manufacturer: Owens Corning Fiberglas
.2 Other acceptable manufacturers offering equivalent products:
  .1 Manson
  .2 Knauf Fiber Glass
  .3 Johns Manville
.3 Insulation: ASTM C547; rigid moulded, noncombustible.
  .1 'ksi' value : ASTM C335, 0.035 at 75°F (24°C).
  .2 Minimum Service Temperature: -20°F (-28.9°C).
  .3 Maximum Service Temperature: 302°F (150°C).
  .4 Maximum Moisture Absorption: 0.2 percent by volume.
.4 Vapour Barrier Jacket
  .1 ASTM C921, White kraft paper reinforced with glass fibre yarn and bonded to aluminized film.

.2 Moisture Vapour Transmission: ASTM E96; 0.02 perm.
.3 Secure with self sealing longitudinal laps and butt strips.
.4 Secure with outward clinch expanding staples and vapour barrier mastic.

.5 Tie Wire: 1.3 mm stainless steel with twisted ends on maximum 12" (300 mm) centres.

.6 Vapour Barrier Lap Adhesive
.1 Compatible with insulation.

.7 Insulating Cement/Mastic
.1 ASTM C195; hydraulic setting on mineral wool, VOC content not to exceed 80 g/L.

.8 Fibrous Glass Fabric
.1 Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
.2 Blanket: 1.0 lb/cu ft (16 kg/cu m) density.

.9 Indoor Vapour Barrier Finish
.1 Vinyl emulsion type acrylic, compatible with insulation, white colour, VOC content not to exceed 250 g/L.

.10 Outdoor Vapour Barrier Mastic
.1 Vinyl emulsion type acrylic, compatible with insulation, white colour.

.11 Insulating Cement
.1 ASTM C449, VOC content not to exceed 80 g/L.

2.2 JACKETS

.1 PVC Plastic
.1 Jacket: ASTM C921, One piece moulded type fitting covers and sheet material.
.1 Minimum Service Temperature: -31°F (-35°C).
.2 Maximum Service Temperature: 151°F (66°C).
.3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.
.4 Maximum Flame Spread: ASTM E84; 25 or less.
.5 Maximum Smoke Developed: ASTM E84; 50 or less.
.6 Thickness: 20 mil (0.4 mm) minimum.
.2 Colour: standard off-white
.3 Covering Adhesive Mastic
.1 Compatible with insulation, maximum VOC content of 50 g/L.
.4 Manufacturer;
.1 Ceel-Co 300 series
.2 Speedline *Smoke Safe*

.2 Aluminum Jacket: ASTM B209.
.1 Thickness: 0.02" (0.40 mm) sheet.
.2 Finish: Smooth.
.3 Joining: Longitudinal slip joints and 2" (50 mm) laps.
.4 Fittings: 0.02" (0.40 mm) thick die shaped fitting covers with factory attached protective liner.
.5 Metal Jacket Bands: 3/8" (10 mm) wide; 0.01" (0.38 mm) thick aluminum.

2.3 REMOVABLE / REUSABLE INSULATION COVERS

.1	Material:	Teflon coated, woven fibreglass fabric
.2	Weight:	16.5 oz/sq.yd. (± 10%)
.3	Thickness:	0.015" (± 10%)
.4	Colour:	Gray
.5	Tensile Strength:	400 x 330 lb. (W x F)
.6	Tarp Tear strength:	60 x 40 lb. (W x F)
.7	Mullen Burst Pressure:	650 psi
.8	Insulation thickness:	Match connecting piping
.9	Temperature Range:	-67°F to 500°F
.10	Lacing Hooks:	Stainless Steel
.11	Tie Wire:	16-ga stainless steel

2.4 ACCESSORIES

.1 Adhesives and finishes shall be as recommended by the insulation manufacturer and shall comply with Section 15100.2.2. Accessories such as adhesives, mastics and cements shall have the same properties as listed above and shall not detract from any of the system ratings specified.

.2 Vapor retarder lap adhesive shall be water based, fire retardant

.3 Tapes shall be of cloth reinforced aluminum, soft adhesive with minimum 2" (50 mm) width.

.4 Tie wire shall be of 1/16" (1.5 mm) ø stainless steel.

.5 Fasteners shall be of 1/8" (4 mm) Ø pins, with 35 mm square clips. Clip length to suit insulation thickness.

.6 Bands shall be 1/2" (12 mm) wide 1/4" (6mm) thick galvanized steel.

.7 Facing shall be of 1" (25 mm) galvanized steel hexagonal wire mesh attached on both faces of insulation.

3 EXECUTION

3.1 EXAMINATION

.1 Verify that piping has been tested before applying insulation materials.

.2 Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

.1 Install piping insulations to TIAC National Installation Standards.

.2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturer' written instructions and as specified.

.3 On exposed piping locate insulation and cover seams in least visible locations.

.4 Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:

.1 Provide vapour barrier jackets, factory applied or field applied.

.2 Insulate fittings, joints, and valves with moulded insulation of like material and thickness as adjacent pipe.
.3 Finish with glass cloth and vapour barrier adhesive.
.4 PVC fitting covers may be used.
.5 Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
.6 Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

.5 For insulated pipes conveying fluids above ambient temperature:
.1 Provide standard jackets, with or without vapour barrier, factory applied or field applied.
.2 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
.3 Finish with glass cloth and adhesive.
.4 PVC fitting covers may be used.
.5 For hot piping conveying fluids 140°F (60°C) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
.6 For hot piping conveying fluids over 140°F (60°C), insulate flanges and unions at equipment.

.6 Inserts and Shields:
.1 Application: Piping 1-1/2" (40 mm) diameter or larger.
.2 Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
.3 Insert Location: Between support shield and piping and under the finish jacket.
.4 Insert Configuration: Minimum 6" (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
.5 Insert Material: hydrous calcium silicate insulation.

.7 Finish insulation at supports, protrusions, and interruptions.

.8 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapour barrier cement.

.9 Provide integral vapour barrier jacket on insulation on pipe and fittings for exterior applications.

.10 Provide PVC jacket and fitting covers for pipe in mechanical equipment rooms and where exposed in finished spaces.

.11 Provide aluminum jacket and fitting covers with seams located on bottom side of horizontal piping for exterior applications, in boiler rooms and where subject to temperatures > 200°F (93°C).

.12 For buried piping, provide factory fabricated assembly with inner all-purpose service jacket with self sealing lap, and asphalt impregnated open mesh glass fabric, with one mil (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

.13 For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe

and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.3 PIPE INSULATION

.1 Insulate new or altered piping with rigid pipe insulation and re-insulate existing piping where insulation has been removed or damaged as follows:

RIGID PIPE INSULATION (I-P)			
Service	**Operating Temperature Range °F**	**Pipe Diameter in.**	**Insulation Thickness in.**
Chilled water	40 to 55	All sizes	1-1/2
	< 40	1 and smaller	1-1/2
		1-1/4 and larger	1-1/2
Cold water make-up (outside building)	0 to 850	All sizes	2
Condensate (cold)	0 to 850	All sizes	1/2
Domestic cold water	0 to 850	All sizes	1
Domestic hot water & hot water recirculation	105 and higher	2 and smaller	1
		2-1/2 and larger	1-1/2
High Pressure Steam and Condensate	251 to 350	1 and smaller	2
		1-1/4 to 4	2-1/2
		5 and larger	3
	>350	2 and smaller	'2-1/2
		2-1/2 to 4	3
		5 and larger	3-1/2
Hydronic heating (hot water & glycol/water)	105 to 140	4 and smaller	1
		5 and larger	1-1/2
	141 to 200	All sizes	1-1/2
Low Pressure Steam and Condensate	141 to 200	All sizes	1-1/2
	201 to 250	2 and smaller	1-1/2
		2-1/2 to 6	2

		8 and larger	3-1/2
Sanitary drainage	40 to 55	All sizes	1
Steam humidifier	201 to 250	2 and smaller	1-1/2
		2-1/2 to 6	2
Storm drainage	40 to 55	All sizes	1

FLEXIBLE INSULATION	
Service	**Insulation Thickness**
Horizontal storm and sanitary drainage	1"
Radiant ceiling panels	2"

RIGID PIPE INSULATION (SI)			
Service	**Operating Temperature Range °C**	**Pipe Diameter (mm)**	**Insulation Thickness (mm)**
Chilled water	4 to 13	All sizes	40
	< 4.4	25 and smaller	40
		38 and larger	40
Cold water make-up (outside building)	-18 to 454	All sizes	50
Condensate (cold)	-18 to 454	All sizes	13
Domestic cold water	-18 to 454	All sizes	25
Domestic hot water & hot water recirculation	41 and higher	50 and smaller	25
		65 and larger	40
High Pressure Steam and Condensate	122 to 177	25 and smaller	50
		32 to 100	65
		125 and larger	75
	>177	50 and smaller	65
		65 to 100	75
		125 and larger	90
Hydronic heating (hot water & glycol/water)	41 to 60	100 and smaller	25
		125 and larger	40

	61 to 93	All sizes	40
Low Pressure Steam and Condensate	61 to 93	All sizes	40
	94 to 121	50 and smaller	40
		65 to 150	50
		200 and larger	90
Sanitary drainage	4 to 13	All sizes	25
Steam humidifer	94 to 121	50 and smaller	40
		65 to 150	50
Storm drainage	4 to 13	All sizes	25

FLEXIBLE INSULATION	
Service	**Insulation Thickness**
Horizontal storm and sanitary drainage	25mm
Radiant ceiling panels	50mm

.2 Phenolic insulation may be used in place of rigid fibreglass pipe insulation, thickness to provide equivalent thermal resistance.

.3 Insulate valves, flanges and pipe connections with removable / reusable insulation covers.

.4 Wrap butt joints with a 4" (100 mm) strip of fire resistant vapour barrier jacket cemented with lagging adhesive.

.5 Where the pipe hanger is around the insulation, provide an insulation protection shield within the pipe saddle. Coordinate with installation of hangers.

.6 Insulate all fittings, flanges and valves on pipes to provide equivalent insulation to that on adjoining pipe.

.7 Continue insulation through sleeves including specified finish.

.8 Cut back covering on strainers and finish off to expose removable head insulation.

.9 Cover expansion joints first with 24 gauge (0.7 mm) galvanized metal sleeve and then insulate to provide equivalent thickness to that on adjoining pipe.

.10 Protect insulation with protection saddles where insulated pipe is supported by rollers.

.11 Insulate pipe hangers supporting new piping carrying water at 70°F (21°C) or less to prevent condensation. Extend insulating material along hanger rod to height 4 times thickness of insulation. Seal insulation with vapourproof sealant.

.12 Extend pipe insulation and covering through walls, floors, ceilings, and concrete beams, unless indicated otherwise on drawings. protect exposed insulation extending through floors with 4" (100 mm) wide strip of 18 gauge (1.3 mm) galvanized iron.

.13 Pack annular space between pipe sleeves and piping or pipe covering with glass

fibre insulation or rockwool insulation. In fire rated assemblies use Dow Silicon RTV or other ULC listed materials. Seal exposed insulation with mastic.

.14 Recover exposed surfaces of insulated piping installed in exposed areas, mechanical rooms, and equipment rooms with PVC jacketing and PVC fitting covers installed in accordance with manufacturers instructions.

.15 Insulate and cover exposed surfaces of waste connections, traps, hot and cold supply risers and valves at each lavatory and sink designated for "handicapped" or "barrier free" use with: PVC insulated fitting covers specifically designed for this application. Vinyl material is not to exceed flame spread rating of 150, and if intended to be used in high buildings, its smoke developed classification does not exceed 300. Zeston or other equivalant material. or foamed plastic type insulation finished with two coats of Armstrong Armflex or other equivalent material.

.16 Provide aluminum metal cladding over the insulation on the following services;

.1 All exposed piping located outdoors.

.17 Insulate sprinkler and standpipe main from take-off from domestic water to a point approximately 6 feet (1800 mm) after electrically supervised valve.

.18 Oversize insulation of Domestic hot water piping complete with heating cable for pipe sizes 1-1/4" (35 mm) dia. and smaller by 1/4" (6 mm) in inside diameter to allow for installation over heating cable.

3.4 HIGH TEMPERATURE PIPE INSULATION

.1 Applications: cut or mitre insulation where necessary to fit the shape and contour of the vessel. Impale insulation over welded pins on 12" (300 mm) centres. (When 2 layers are used the joints shall be stagger.) Apply Expanded Metal Lath using speed washers to hold insulation and mesh in place. Lace Metal Edges that butt together with 16 ga. (1.7 mm) galvanized annealed wire.

.2 Emergency Generator Exhaust

.1 Insulate the exhaust stack system including silencer (muffler) with 3" (75 mm) of high temperature pipe insulation.

.2 Tightly butt and stagger all joints. Secure blocks with galvanized steel bands. Provide welded studs, clips or angles as required to anchor wire and bands. Secure a 1" (25 mm) hexagonal wire mesh over the insulation.

.3 In exposed areas, cover insulation with 2 coats of Manson No. 375 finishing cement applied in 1/4" (7 mm) layers and trowel to a smooth hard finish.

.4 Cover with:

.1 6 oz./sq.yd. (200 g/m2) canvas neatly pasted in place.

.2 Aluminum jacketing installed to manufacturers instructions.

.5 Insulation shall be extended up through roof sleeve.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 21 01 01

1.2 COMMON WORK RESULTS

.1 Section 21 01 01 specifies items common to all Sections of Division 21 and applies to and governs all work of Division 21

1.3 SECTION INCLUDES

.1 System design, installation, and certification.
.2 Wet-pipe sprinkler assembly.

1.4 REFERENCES

.1 NFPA 13 - Installation of Sprinkler Systems
.2 NFPA 13A - Inspection, Testing and Maintenance of Sprinkler Systems
.3 NFPA 15 - Water Spray Fixed Systems
.4 NFPA 16 - Installation of Deluge Foam-Water Sprinkler System and Foam-Water Spray Systems
.5 NFPA 16A - Installation of Closed-Head Foam-Water Sprinkler Systems
.6 NFPA 25 - Water Based Fire Protection Systems
.7 NFPA 26 - Supervision of Valves Controlling Water Supplies
.8 NFPA 72 - Installation, Maintenance and Use of Protective Signalling Systems
.9 NFPA 72E - Automatic Fire Detectors
.10 NFPA 72G - Installation, Maintenance and Use of Notification Appliances for Protective Signalling Systems
.11 NFPA 72H - Testing Procedures for Local, Auxiliary, Remote Station and Proprietary Protective Signalling Systems
.12 NFPA 75 - Protection of Electronic Computer/Data Processing Equipment
.13 NFPA 231 - General Storage
.14 NFPA 231C - Rack Storage of Materials
.15 NFPA 291 - Fire Flow Testing and Marking of Hydrants
.16 FM - Factory Mutual Approval Guide.
.17 ULC/ORD C263.1 Sprinkler-Protected Windows Systems
.18 ULC - Fire Resistance Directory.
.19 UL 199 - Automatic Sprinklers for Fire-Protection Service.

1.5 SYSTEM DESCRIPTION

.1 System to provide coverage for entire building.
.2 Provide system to Owner's Insurer's occupancy requirements.
.3 Determine volume and pressure of incoming water supply from water flow test data.

.4 Interface system with building fire alarm system.
.5 Provide fire department connections where indicated.

1.6 SUBMITTALS FOR REVIEW

.1 Product Data: Provide data on following components including manufacturers catalogue information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
  .1 sprinkler alarm valves
  .2 flow switches
  .3 water motor alarm
  .4 excess pressure pump
  .5 low pressure alarm switch
  .6 ball drain valve
  .7 sprinkler heads
  .8 shut-off valves
.2 Preliminary layout: show finished ceiling areas indicating sprinkler locations coordinated with ceiling installation.
.3 Hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components and accessories, indicating:
  .1 Sheet number.
  .2 Sprinkler description and discharge constant K.
  .3 Hydraulic reference points.
  .4 Flow l/s.
  .5 Pipe size.
  .6 Pipe lengths, centre to centre of fittings.
  .7 Equivalent pipe lengths for fitting and devices.
  .8 Friction loss in kPa at each reference point.
  .9 Total friction loss between reference points.
  .10 Elevation head in kPa at each reference point.
  .11 Required pressure in kPa at each reference point.
  .12 Velocity pressure and normal pressure if included in calculations.
  .13 Notes to indicate starting points, reference to other sheets or to clarify data shown.
  .14 Semi-logarithmic graph paper indicating water supply curves and systems requirements plus inside and outside hose requirements so as to present a graphic summary of complete hydraulic calculations.
.4 Layout and Installation Drawings: Clearly indicate:
  .1 Name and department or agency
  .2 Location, including street address.
  .3 Point of compass
  .4 Ceiling construction.
  .5 Full height cross section.
  .6 Location of fire walls.

.7 Occupancy of each area or room.
.8 Location and size of blind spaces and closets.
.9 Any questionable small enclosures in which no sprinklers are to be installed.
.10 Size of city main in street, pressure and whether dead-end or circulating and if dead-end, direction and distance to nearest circulating main, with city main test results.
.11 Other sources of water supply, with pressure or elevation.
.12 Make, type and orifice size of sprinklers.
.13 Temperature rating and location of high temperature sprinklers.
.14 Number of sprinklers on each riser and on each zone by floors, and total area protected by each zone on each floor.
.15 Number of sprinklers on each riser and total per floor.
.16 Make, type, model and size of alarm valves.
.17 Arrangement and operation of system controls.
.18 Kind and location of alarm bells.
.19 Cutting lengths of pipe or centre to centre dimensions.
.20 Crosses, riser nipples and sizes.
.21 Type of hangers, inserts and sleeves.
.22 All control valves, checks, drain pipes and test pipes.
.23 Small hand hose and hose equipment.
.24 When plans include underground pipe indicate: weight or class and size of pipe pits; depth of top of pipe below grade.
.25 Provisions for flushing.
.26 Name and address of contractor
.27 A summary sheet, clearly indicating:
    .1 Date.
    .2 Location.
    .3 Name of department of agency.
    .4 Building number or other identification.
    .5 Description of hazard.
    .6 Name and address of contractor or designer.
    .7 Name of approving agency.
    .8 System design requirements, including design area of water application, minimum rate of application and area per sprinkler.
    .9 Total water requirements as calculated including allowance for inside hose and outside hydrants.
    .10 Water supply information.

.5 Submit shop drawings to Owner's insurance underwriter and authorities having jurisdiction for approval. Submit proof of approval to Consultant.
.6 Samples: Submit two of each style of sprinkler specified.

1.7 SUBMITTALS AT PROJECT CLOSEOUT

.1 Project Record Documents: Record actual locations of sprinklers and deviations of

piping from drawings. Indicate drain and test locations.

.2 Contractor's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.

.3 Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

.4 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.8 QUALITY ASSURANCE

.1 Perform Work to OBC, NFPA 13 and Owner's Insurer's requirements. Maintain one copy on site.

.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

.3 Installer Qualifications: Company specializing in performing the work of this section with minimum five (5) years documented experience.

.4 Design system under direct supervision of a Professional Engineer experienced in design of this Work and licensed at the place where the Project is located.

1.9 REGULATORY REQUIREMENTS

.1 Conform to OBC, OFC, ULC.

.2 Sprinkler Systems: Conform to NFPA 13.

.3 Valves: Bear FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

.4 Equipment and Components: Bear ULC and FM label or marking.

.5 Products Requiring Electrical Connection: CSA Listed and classified by Underwriters Laboratories of Canada Inc., as suitable for the purpose specified and indicated.

1.10 DELIVERY, STORAGE, AND PROTECTION

.1 Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.11 EXTRA MATERIALS

.1 Provide extra sprinklers to NFPA 13.

.2 Provide suitable wrenches for each sprinkler type.

.3 Provide metal storage cabinet located adjacent to alarm valve.

.4 Provide two of valve stem packings for each size and type of valve installed.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Viking.
.2 Reliable.
.3 Tyco - Central.
.4 Tyco - Grinnel (GEM).
.5 Substitutions: Refer to Section 01 62 00.

2.2 SPRINKLERS

.1 Suspended Ceiling:
  .1 Type: Semi-recessed pendant type with matching push on escutcheon plate.
  .2 Finish: Chrome plated.
  .3 Escutcheon Plate Finish: Chrome plated.
  .4 Fusible Link: Glass bulb type temperature rated for specific area hazard.
.2 Exposed Area Type:
  .1 Type: Standard upright type with guard.
  .2 Finish: Brass.
  .3 Fusible Link: Glass bulb type temperature rated for specific area hazard.
.3 Sidewall Type:
  .1 Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate and guard.
  .2 Finish: Chrome plated.
  .3 Escutcheon Plate Finish: Chrome plated.
  .4 Fusible Link: Glass bulb type temperature rated for specific area hazard.
.4 Dry Sprinklers:
  .1 Type: Standard pendant type with matching push on escutcheon plate.
  .2 Finish: Brass.
  .3 Escutcheon Plate Finish: Brass.
  .4 Fusible Link: Glass bulb type temperature rated for specific area hazard.
.5 Concealed Pendant:
  .1 Cover plate attachment with 1/2" (13mm) assembly adjustment.
  .2 Smooth aesthetic ceiling profile.
  .3 Factory installed protective cap.
  .4 Factory painted (confirm colour with architect prior to ordering)
.6 Guards: Finish to match sprinkler finish.

2.3 PIPING SPECIALTIES

.1 Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm and electric alarm, with pressure retard chamber and variable pressure trim ; with test and drain valve.
.2 Dry Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm and electric alarm, with pressure retard chamber and variable pressure trim ; with test and drain valve
.3 Preaction Sprinkler Sytem: factory assembled and tested Viking "Total Pac" or equivalent, double interlocked, supervised preaction system using a deluge valve

controlled by an electric release system including the following components:

.1 Deluge valve
.2 Check valve with rubber seat
.3 Main water supply control valve with tamper switch
.4 Sprinkler system piping network
.5 Strainer orifice check valve (S.O.C.V.)
.6 Test drain valve
.7 Drip check valve
.8 Check valve
.9 Strainer
.10 Alarm test valve
.11 Manual emergency release
.12 Gauge valve
.13 Water inlet pressure gauge (0-300 PSI)
.14 Priming chamber pressure gauge (0-300 PSI)
.15 System air pressure gauge (air, 0-80 PSI) (delay 80-250 PSI)
.16 Priming valve
.17 Solenoid valve (N.C.)
.18 Pressure operated relief valve (P.O.R.V.)
.19 Low air pressure supervisory switch
.20 Alarm pressure switch
.21 Main drain valve
.22 Electric junction with terminals
.23 Release control panel
.24 Air supply - air compressor with air maintenance device
.25 Steel enclosure cabinet
.26 Water inlet header including couplings
.27 Water drain header including couplings
.28 90 Degree grooved elbow including couplings
.29 Grooved end system riser stub including couplings

.4 Water Motor Alarm: Hydraulically operated impeller type alarm with aluminum alloy chrome plated gong and motor housing, nylon bearings, and inlet strainer.

.5 Electric Alarm: Electrically operated chrome plated gong with pressure alarm switch.

.6 Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.

.7 Fire Department Connections:

.1 Type: Flush mounted wall type with chrome plated finish.
.2 Outlets: Two way with thread size to suit fire department hardware; threaded dust cap and chain of matching material and finish.
.3 Drain: 3/4" (19 mm) automatic drip, outside.
.4 Label: "Sprinkler - Fire Department Connection".

.8 Supervisory Switches: As manufactured by Potter.

2.4 PRESSURE MAINTENANCE PUMP

.1 Manufacturer: Albany Pump Co.
.2 Type: Close coupled motor and positive displacement pump unit.
.3 Construction: Bronze with stainless steel shafts, carbon bearings.
.4 Motor: Open drip proof, permanently lubricated.
.5 Electrical Characteristics: CSA listed, ULC and FM approved.
  .1 0.38 kW.
  .2 115 volts,
  .3 single phase,
  .4 60 Hz.
.6 Accessories: Include flexible hose connections.
.7 Operation: Manual.

2.5 ELECTRIC DETECTION SYSTEM

2.6 ABOVE GROUND PIPING

.1 Steel Pipe: ASTM A53; Schedule 10.
  .1 joined by welding or by roll grooved pipe and fittings:
    .1 schedule 10 for sizes 5" (125mm) and smaller,
    .2 0.134" (3.40mm) for 6" (150mm) diameter,
    .3 0.188" (4.78mm) for 8" and 10" (200mm and 250mm) diameter.
  .2 joined with threaded fittings or cut groove pipe and fittings:
    .1 schedule 40 for sizes 6" (150mm) diameter and smaller,
    .2 schedule 30 for sizes 8" (200mm) diameter and larger.
.2 Pipe Fittings:
  .1 Steel Fittings: ASME B16.9, wrought steel, buttwelded;.
  .2 Cast Iron Fittings: ASME B16.1, flanges and flanged fittings;.
  .3 Malleable Iron Fittings: ASME B16.3, threaded fittings.
  .4 Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
  .5 Mechanical Formed Fittings: Carbon steel housing with integral pipe stop and O-ring pocket and O-ring uniformly compressed into permanent mechanical engagement onto pipe.

2.7 PIPE HANGERS AND SUPPORTS

.1 Conform to NFPA 13.
.2 Hangers for Pipe Sizes 1/2" to 1-1/2" (15 to 40 mm): Carbon steel, adjustable swivel, split ring.
.3 Hangers for Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
.5 Wall Support for Pipe Sizes to 3-1/4" (80 mm): Cast iron hook.

.6 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
.7 Vertical Support: Steel riser clamp.
.8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2.8 VALVES - GENERAL

.1 cUL or ULC and FM approved, listed and labelled.
.2 All valves controlling connections to water supplies shall be listed indicating valves.
.3 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
.4 Provide valves of the same manufacturer where possible.
.5 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
.6 All valves supplied for this project shall have a current and valid Canadian Registration Number for the Province of Ontario with TSSA. Suppliers shall provide a copy of the Statutory Declaration for valves, stamped, signed and dated by TSSA as validation of the CRN registration. This shall be included with the shop drawing submittal package.
.7 Materials:
  .1 Bronze: ASTM B62 or B61 as applicable
  .2 Brass: ASTM B283 C3770
  .3 Cast Iron: ASTM A126 Class B
.8 End Connections:
  .1 Threaded ends: ANSI B1.20.1
  .2 Flanged ends: ANSI B16.1 (Class 125), ANSI B16.5
  .3 Face-to-face dimensions: ANSI B16.10
.9 Design and Testing:
  .1 Bronze Gate & Check valves: MSS-SP-80
  .2 Cast Iron Gate Valves: MSS-SP-70
  .3 Cast Iron Globe Valves: MSS-SP-85
  .4 Cast Iron Check: MSS-SP-71
  .5 Butterfly Valves: MSS-SP-67
.10 Acceptable manufacturers:
  .1 Kitz
  .2 Crane, Jenkins.
  .3 Conbraco.
  .4 Nibco

2.9 ISOLATION VALVES

.1 Electrically Supervised: ULC listed, FM approved, NO/NC SPDT dry contact switch suitable for electrical supervision on trouble circuit of facility fire alarm system. Valve monitoring switches shall be Potter Electric Signal and Manufacturing Limited or equivalent.
.2 Up to 2" (50 mm):

.1 Construction: ULC listed, FM approved, 300 psig non-shock WOG, ASTM B62 bronze body, solid wedge disc, rising stem, bronze trim, threaded ends, Kitz #25

.3 2-1/2" (65 mm) and Larger:

.1 Construction: ULC listed, FM approved, 175 psi 1210 kPa CWP, outside screw and yoke, cast iron body, stem with ACME double threads, tapered solid wedge disc, flanged ends, renewable bronze seat rings.

2.10 CHECK VALVES

.1 2-1/2 " (65 mm) and Larger:

.1 Construction: ULC listed, FM approved, 175psi (1210 kPa)CWP, iron body and bolted cap, bronze trim, bronze swing disc with replaceable bronze seat rings, flanged ends.

OR

.2 Construction: ULC listed, FM approved, 175 psi (1210 kPa), Cast Iron body, 316 stainless steel shaft, Double Door Bronze Disc to B-62, Buna seat, 316 stainless steel spring, wafer style.

2.11 DRAIN VALVES

.1 Construction: ULC listed and FM approved, brass ball valve with cap and chain, 3/4" (20 mm) hose thread.

3 EXECUTION

3.1 PREPARATION

.1 Ream pipe and tube ends. Remove burrs.

.2 Remove scale and foreign material, from inside and outside, before assembly.

.3 Prepare piping connections to equipment with flanges or unions.

3.2 PIPING INSTALLATION

.1 Install piping to NFPA 13 for sprinkler systems,

.2 Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

.3 Install piping to conserve building space, to not interfere with use of space and other work.

.4 Group piping whenever practical at common elevations.

.5 Sleeve pipes passing through partitions, walls, and floors.

.6 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

.7 Inserts:

.1 Provide inserts for placement in concrete formwork.

.2 Provide inserts for suspending hangers from reinforced concrete slabs and

sides of reinforced concrete beams.

.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100 mm.

.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

.8 Pipe Hangers and Supports:

.1 Install to NFPA 13.

.2 Install hangers to provide minimum 1/2" (15 mm) space between finished covering and adjacent work.

.3 Place hangers within 12" (300 mm) of each horizontal elbow.

.4 Use hangers with 1-1/2" (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

.5 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

.6 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.7 Provide copper plated hangers and supports for copper piping.

.9 Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

.10 Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding, maximum VOC content of 250 g/L..

.11 Do not penetrate building structural members unless indicated.

.12 Provide sleeves when penetrating footings. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.

.13 When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

.14 Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

.15 Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.

.16 Provide ball valves for shut-off or isolating service.

.17 Provide drain valves at main shut-off valves, low points of piping and apparatus.

.18 All control, drain and test connection valves shall be provided with permanently engraved and marked weatherproof metal or rigid plastic identification signs, secured with weather resistant chain or other approved method.

3.3 SPRINKLER EQUIPMENT INSTALLATION

.1 Install to NFPA 13.

.2 Install equipment to manufacturers instructions.
.3 Install buried shut-off valves in valve box. Provide post indicator.
.4 Provide approved reduced pressure principle backflow preventer assembly at sprinkler system water source connection.
.5 Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle.
.6 Locate outside alarm gong on building wall as indicated.
.7 Place pipe runs to minimize obstruction to other work.
.8 Place piping in concealed spaces above finished ceilings.
.9 Centre sprinklers in two directions in ceiling tile and provide piping offsets as required.
.10 Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.
.11 Install and connect to fire pump system to Section 21 11 00.
.12 Install air compressor on vibration isolators. Refer to Section 23 05 48.
.13 Flush entire piping system of foreign matter.
.14 Install guards on sprinklers where indicated.
.15 Hydrostatically test entire system.
.16 Require test be witnessed by Fire Marshall.

3.4 INTERFACE WITH OTHER PRODUCTS

.1 Ensure required devices are installed and connected as required to fire alarm system.

3.5 OPERATING SEQUENCE FOR WET SPRINKLERS

.1 In Normal Set Condition: The system piping is filled with water.
  .1 All water supply control valves open and secured.
  .2 Alarm test shut-off valve in "ALARM" position.
  .3 Water gauge valves open.
  .4 The water supply pressure gauge (lower gauge) equals that of the known service-line pressure. The system pressure gauge (upper gauge) reading is equal to or greater than the water supply pressure gauge reading.
  .5 Incoming power to all alarm switches on.
  .6 Main-drain valve, auxiliary drain valves and inspectors test valves tightly closed.
  .7 The sprinkler head cabinet contains appropriate replacement sprinklers and wrenches.
  .8 Temperature maintained above freezing for entire system.
  .9 If Fire Department connection is used, make sure the automatic drip valve is free allowing accumulated water to escape.
  .10 Sprinklers in good condition and unobstructed.
.2 In Fire Condition:

.1 The heat produced operates a sprinkler allowing the water to flow.
.2 The alarm valve clapper is opened by the flow of water allowing pressurized water to enter the alarm port to activate the connected alarm devices.
.3 When using variable pressure trim the water flowing through the alarm port overcomes the retarding chamber's drain restriction, filling the retarding chamber then activating the connected alarm devices.
.4 The alarms will continue to sound until the flow of water is manually turned off.

.3 In Service condition:
.1 The system should be placed out of service only for repairs.
.2 The work to be done must be completed in a manner to minimize the time that the system must be out of service.
.3 All hazardous activities in the effected area shall be terminated until the system is placed back in service.
.4 Any system impairment shall be coordinated with the Owner, local authority having jurisdiction and other related parties.
.5 Provide a roving fire patrol in the area covered by the system until the system is back in service.
.6 Prior to turning off any valves or activating any alarms, notify local security guards and/or central alarm station so that a false alarm will not be signalled and result in a local fire department response.

3.6 OPERATING SEQUENCE FOR DRY SPRINKLERS

.1 In Normal condition:
.1 The system up to dry valve is filled with water, upstream from dry valve with media.
.2 All control valves open, locked and sealed with tamper proof seals.
.3 ALARM TEST SHUT-OFF VALVE IN "ALARM" POSITION.
.4 Water and air pressure gauge valves open.
.5 Accelerator shut-off valves open.
.6 System air-pressure and accelerator gauges indicating equal pressure.
.7 The water-pressure-gauge reading equals that of the known service-line pressure.
.8 Incoming power to all alarm switches on.
.9 Test drain valve, auxilliary-drain valves and inspector's test valves should be tightly closed.
.10 If an automatic air supply is used: the compressor should be on the air-maintenance-device; the by-pass valve should be closed; and, the system air should be maintained at a constant pressure.
.11 The sprinkler head cabinet contains appropriate replacement sprinklers.
.12 Dry valve house temperatre should be maintained above freezing.
.13 Drum drips and low points should be free of water.
.14 The water level in the riser must be below the air supply drain.

.2 In Fire condition:

.1 The heat produced will operate a sprinkler causing the air pressure in the piping system to escape.
.2 When the pressure trip-point is reached, the dry pipe valve opens allowing water to flow through the system piping and to the water motor alarm or electric pressure switch to sound an electric alarm.
.3 The alarms will continue to sound until the system is manually shut-off.

.3 In Service condition:
.1 The system should be placed out of service only for repairs.
.2 The work to be done must be completed in a manner to minimize the time that the system must be out of service.
.3 All hazardous activities in the effected area shall be terminated until the system is placed back in service.
.4 Any system impairment shall be coordinated with the owner, local authority having jurisdiction and other related parties.
.5 Provide a roving fire patrol in the area covered by the system until the system is back in service.
.6 Prior to turning off any valves or activating any alarms, notify local security guards and/or central alarm station (if used) so that a false alarm will not be signalled and result in a local fire department response.

3.7 TESTING AND INSPECTION

.1 Test automatic sprinkler in accordance with requirements of NFPA 13 and NFPA 25.
.1 hydrostatically tested at 50 psi (3.5 bar) in excess of system working pressure and minimum test pressure of 200 psi (13.8 bar) for 2-hr.
.2 when cold weather prevents testing with water, an interim test may be conducted with air. The hydrostatic test with water must be conducted subsequently when conditions permit.
.3 modifications affecting fewer than 20 sprinklers and modifications that can not be isolated shall not require testing in excess of system working pressure. Modifications affecting more than 20 sprinklers shall be isolated and tested at not less than 200 psi (13.8 bar) for 2-hr.
.4 loss shall be determined by a drop in gauge pressure or by visible leakage.
.5 Full Flow Trip Test: Conduct this test prior to final acceptance and pior to occupancy of the protected space.
<u>Caution</u>! Performance of this test will cause the deluge valve to open and the sprinkler system to fill with water.
.1 Follow manufacturer's instructions to take the system out-of-service.
.2 To trip the electrically controlled single interlocked preaction system:
.1 Notify the authorities having jurisdiction and those in the area affected by the test.
.2 Trip the deluge valve:
.1 Operate a detector or dectors according to the

manufacturers instructions.

.2 Open the sprinkler system inspectors test connection.

.3 The deluge valve should open filling the sprinkler system with water.

.4 Verify adequate flow from the sprinkler system inspector test valve within an acceptable time period.

.3 When trip testing is complete drain the system and follow manufacturer's instructions to return the system to service.

.4 Notify the authorities having jurisdiction and those in the affected area affected that testing is complete.

.3 Performance of a trip test is recommended annually during warm weather. Consider coordinating this test with operation testing of the detectors.

.2 Arrange and pay for all reviews and inspections required by:

.1 Local Inspection Authority.

.2 Owner's Insurance Authority.

.3 Coordinate testing of automatic sprinkler systems with fire alarm system verification to ensure that all devices are fully tested.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 Division 1 requirements and documents refered to therein.

.2 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work..

.3 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.

.4 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the most costly arrangement.

.5 Ensure Sub-contractors undertaking the work of Division 22 provide a 50% performance bond and a 50% labour and materials payment bond. In addition, ensure Sub-contractors employed to undertake any part of the work of Division 22 that is $50,000.00 or greater in contract value provide a 50% performance bond and a 50% labour and materials bond to the party they are in contract with.

1.2 DEFINITIONS

.1 The following are definitions of words found in this specification and on associated drawings under this Division:

.1	"Concealed"	locations hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
.2	"Exposed"	mechanical work normally visible to building occupants.
.3	"Furnish"	(and its derivatives) has the same meaning as the term "Supply".
.4	"Install"	(and its derivatives) - receive, store and handle at the site, mount and support and connect all required services. Includes adjustment and calibration, testing, commissioning, inspection by authorities having jurisdiction and documentation.
.5	"Provide"	(and its derivatives) - supply, install in place, connect the associated required services ready for operation, adjust and calibrate, test, commission, warrant, and document. Includes inspection by authorities having jurisdiction.
.6	"Supply"	(and its derivatives) purchase and deliver to the site for installation. Includes submittals, manufacturer's field inspection and warranty.
.7	"Wet"	locations exposed to moisture, requiring special materials and arrangement.

1.3 WORK INCLUDED

.1 Products and methods mentioned or shown in the Contract Documents complete with incidentals necessary for a complete operating installation. Provide all tools, equipment and services required to do the work.
.2 Cutting and patching of new or existing work.
.3 Identification of equipment, piping, valves and controllers.
.4 Take such measures and include in Bid Price for the proper protection of the existing building and its finishes at all times during alterations and construction of the new addition. Coordinate this protective work with all trades.
.5 Verify the correct operation of each equipment item provided and/or altered and each system in total and obtain the Owner's approval prior to starting and/or returning to operation.

1.4 SUBMITTALS

.1 Shop Drawings:Prepare and submit two (2) copies of shop drawings of major equipment items (including those items specifically indicated under Part 1: General of each Section), to the Consultant for review. The Consultant will return one copy, marked with comments and his review stamp as he deems appropriate. Prepare the necessary number of copies of the returned set and distribute to the Owner, the Prime Consultant, the General Contractor, the site, and to subcontractors and suppliers.
  .1 Clearly indicate manufacturer's and supplier's names, catalogue model numbers, details of construction, accurate dimensions, capacities and performance. Prior to submission check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of the shop drawings, reviewed by Consultant, has been returned to Contractor.
  .2 Clearly indicate the weight, location, method of support and anchor point forces and locations for each piece of equipment on shop drawings.
  .3 The Consultant will not review shop drawings that fail to bear the Contractor's stamp of approval or certification.
  .4 Read the following in conjunction with the wording on the shop drawing review stamp applied to each and every drawing submitted:
  "This review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review shall not mean that the Consultant approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub trades."
.2 As-Built Records: Prepare and submit complete as-built records prior to Substantial

Performance of the Contract. Refer to paragraph 3.2.5 and to Division 1 for requirements.

.3 Requests for Shut-Down: Obtain permission for systems shut-down and/or service interruption from the Owner prior to disruption of any system or service in use by the Owner. Employ the Owner's standard form of request where available. Refer to Division 1 for additional requirements.

.4 Requests for Start-up: Obtain permission from the Owner to start-up or to return to service any item of equipment, system or service installed new or previously shut-down. Refer to Division 1 for additional requirements.

1.5 QUALITY ASSURANCE

.1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.

.2 Ensure materials supplied under this Division conform to minimum requirements and recommendations or better of applicable standards of the following:

.1 ASTM American Society of Testing and Materials
.2 AWWA American Water Works Association
.3 CAN2 National Standard of Canada (Published by CGSB)
.4 CAN3 National Standard of Canada (Published by CSA)
.5 CGSB Canadian General Standards Board
.6 CSA Canadian Standards Association
.7 NBC National Building Code of Canada
.8 OBC Ontario Building Code
.9 TIAC Thermal Insulation Asociation of Canada
.10 ULC Underwriter's Laboratories of Canada Ltd
.11 UL Underwriter's Laboratories (including cUL)

.3 Use latest editions and amendments in effect on date of Bid call subject to requirements of OBC.

.4 Arrange and pay for permits and inspections by authorities having jurisdiction, required in the undertaking of this Division. Make modifications required by authorities.

.5 All tradesmen employed on the project shall hold valid trade certificates/licenses and shall make a copy available for review by the Consultant and/or Owner when requested.

1.6 PRODUCT DELIVERY, HANDLING AND STORAGE

.1 Immediately after letting of contract, review material and equipment requirements for this work, determine supply and delivery dates for all items, and notify Consultant of any potential delays in completion of this project in order that remedial action may be taken.

.2 Store neatly out of the way and protected from damage and theft, materials and equipment supplied under this Division that are received at the site by this Division.

1.7 JOB CONDITIONS

.1 Visit site and examine existing conditions which may affect work of this Division.
.2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
.3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
.4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.8 INTERRUPTIONS

.1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.
.2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.
.3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.
.4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.
.5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

1.9 WARRANTY

.1 Refer to Division 01 and to Section 22 00 01 General Requirements.
.2 Arrange with each manufacturer/supplier to extend warranties as necessary to coincide with warranty period or those periods specified.

1.10 EXTRAS AND CREDITS

.1 Accompany all price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:
    .1 Materials, quantities and unit costs including any applicable contractor's trade discount clearly identified.
    .2 Labour hours and unit costs.
    .3 Total materials and labour costs.
    .4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

.1 Ensure materials and equipment provided under this Division are new and free from defects and bear labels of approval as required by codes referred to in this Division and/or by inspection authorities.

.2 Ensure apparatus and equipment provided under this Division bears manufacturer's nameplate indicating name of manufacturer, model number or type, size, capacity, CRN, and other pertinent information. Ensure nameplates are easily read and clearly visible, with openings provided where equipment is insulated.

.3 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products are suitably labeled and supplied with Material Safety Data sheets. Obtain the Owner's approval in writing to bring hazardous materials onto the site prior to doing so.

.4 When utilizing any products that are hazardous, keep Material Safety Data sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide Workplace Labels on such containers.

2.2 ACCEPTABLE PRODUCTS

.1 First item named or specified by catalogue number meets specifications regarding performance, quality of material and workmanship, and is acceptable to the Consultant.

.2 Items, other than first named, meeting specifications regarding quality of materials and workmanship are acceptable to the Consultant, only, if they also meet performance and/or capacities specified and can be accommodated within the space allotted.

.3 General approval indicated by inclusion of other manufacturers named is subject to final review of shop drawings, performance data and test reports.

2.3 EQUIVALENTS AND ALTERNATIVES

.1 Suppliers wishing approval for additional equipment items as equivalent to those specified must submit complete description, technical and performance data to Consultant at least ten (10) working days prior to Bid closing date. Such equivalent equipment, if accepted, to conform to specifications with regard to all details, accessories, modifications, features and performance. Deviations from specifications must be stated in writing at time of submission for approval.

.2 Bid Prices shall include only products specified or approved equivalents. Contractors may propose unsolicited alternatives to the products specified. Alternative proposals shall be submitted in sealed envelope at time of general contract Bid submission and shall include full description and technical data, and a statement of the related increase or decrease in Bid Price should alternatives be accepted. All additional costs associated with unsolicited alternative proposals such as larger

motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in alternative price. Prior approval by Consultant is not required for unsolicited alternative proposals.

.3 Where the Contractor uses equipment other than that first named, on which the design is based, he shall be responsible for all details of installation including equipment size, arrangement, fit, and maintenance of all required clearances. Contractor shall prepare and submit revised layouts to iindicate arrangement of all affected piping, ductwork, conduit, lighting, equipment, etc. Failure by Contractor to provide such drawings will be considered indication that original arrangements and space allocations are adequate. All additional costs associated with equivalent equipment such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in Bid Price.

2.4 SUBSTITUTIONS DURING PROGRESS OF WORK

.1 If during the progress of work, specified products are not obtainable, equivalent or similar products by other manufacturers may be permitted by Consultant.

.2 Apply, in writing, to Consultant for substitution of any products, indicating the following:

.1 Manufacturer's name, model number, details of construction, accurate dimensions, capacities and performance of proposed products.

.2 Reason for substitution.

.3 Any revisions to the contract price made necessary by substitution.

.4 Any revisions to the contract time made necessary by substitution.

.5 Any revisions to layout, arrangement or services made necessary by substitution.

.3 No substitutions will be permitted without written authorization from the Consultant.

2.5 CONSULTANT'S REVIEW

.1 The consultants will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor. Such review and evaluation work will be undertaken by the Consultant on an additional fee basis. The Contractor shall reimburse the Owner for all costs associated with such reviews and evaluations.

.2 The Contractor shall also reimburse the Owner for any and all costs incurred in updating Contract Documents to reflect such changes.

3 EXECUTION

3.1 RELATIONSHIP WITH OTHER TRADES

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.

.2 Provide materials to be built-in, such as sleeves, anchors, and inserts, together with templates and/or measurements, promptly when required by other trades.

.3 Provide structural supports for equipment to be mounted on or in walls, supported above floors and/or suspended from the structure.

3.2 INSTALLATION REQUIREMENTS

.1 The Consultant's drawings and instructions govern the location of all items. Prepare fully coordinated installation drawings prior to installation.
.2 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.
.3 Confirm the exact location of outlets, fixtures and connections. Confirm location of outlets for equipment supplied under other Divisions.
.4 Install equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.
.5 Provide suitable shielding and physical protection for devices.
.6 Install products and services in accordance with the manufacturer's requirements and/or recommendations.
.7 Provide bases, supports, hangers and fasteners. Secure products and services so as not to impose undue stresses on the structure and systems.
.8 Do not use power activated tools without written permission of the Consultant. Use them in accordance with the Owner's health and safety policies.
.9 Ensure that the load onto structures does not exceed the maximum loading per square metre indicated on the structural drawings or as directed by the Consultant.

3.3 CONTRACT DRAWINGS

.1 The drawings of this Division are performance drawings and indicate general arrangement of the work. They are diagrammatic except where specific details are given.
.2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement. Location and elevation of services are approximate. Verify them before construction is undertaken.
.3 Make changes where required to accommodate structural conditions, (beams, columns, etc.). Obtain Consultant's approval before proceeding.
.4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. Note that outlets and/or equipment may be relocated up to 10 feet (3 m) in any direction without a change to the contract price.
.5 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the mechanical documents. If there is a difference in quantity between the architectural and drawings of this Division, base the contract price on the greater quantity.

3.4 RECORD DRAWINGS

.1 Maintain project "as-built" record drawings. Obtain white prints from the Consultant for this purpose and pay printing costs. Identify each set as "Project Record Copy".
.2 Record deviations from contract documents caused by site conditions or by changes ordered by the Consultant. Record deviations in red ink clearly and accurately, using industry standard drafting procedures consistent with quality and standards of Consultants documents.
.3 Record deviations as work progresses throughout the execution of this contract. Maintain record drawings on site in clean, dry, legible condition, making them available for periodic review by the Consultant.
.4 Record location of concealed services, particularly underground services. Before commencing any backfilling, obtain accurate measurements and information concerning correct location and depth of services.
.5 Transfer records from the "Project Record Copy" to a DVD in Autocad format matching the Consultant's documents. Arrange computer file in layers to exactly match the layering system of the Consultant.
.6 Submit the "Project Record Copy" on one or more DVD with white prints of each drawing to the Consultant at the time of Substantial Performance.

3.5 COMMISSIONING

.1 Refer to Section 01 80 50 Commissioning.
.2 The Contractor shall start-up and completely commission all equipment and systems installed and/or modified under this contract. Commissioning work shall be completed to the satisfaction of the Consultant prior to acceptance of the Work or any part thereof.
.3 Commissioning shall conform to CAN/CSA Z318.0 Commissioning of Health Care Facilities
.4 The Commissioning Team shall be comprised of;
    .1 Representatives of the Commissioning Coordinator (Commissioning Agent)
    .2 The individual, company or agency undertaking the work of each Section,
    .3 Representatives of the Contractor and his sub-contractors as required,
    .4 Representatives of equipment manufacturers,
    .5 Representatives of the Consultants,
    .6 Representatives of the Owner.
.5 The Contractor and his sub-contractors shall each assign an individual representing each of the relevant trades to the commissioning team and shall ensure that representatives of the equipment manufacturers are present during the relevant commissioning tasks.
.6 The Contractor shall provide all necessary labour, materials, equipment, testing apparatus and incidentals necessary to completely start-up, verify, test and commission each system provided as part of the Work.
.7 Each Section shall prepare Check Sheets in accordance with the standards listed above and shall issue them to the commissioning team for use during the commissioning process.

.8 Three (3) copies of commissioning manuals shall be provided, bound in hard cover D-ring binders with transparent cover on front and spine personalized to indicate;
  .1 name and logo of Health Care Facility,
  .2 name of the project,
  .3 the Owner's project number,
  .4 identification of the system commissioned,
  .5 the date that the system was commissioned.

.9 Commissioning manuals shall include machine printable index dividers to organize each manual by system and by commissioning stage.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 WORK INCLUDED

.1 Identification of existing services and utility connections.
.2 Installation, protection and maintenance of temporary services as required to support continuing operation of the facility.
.3 Disconnection and removal of various mechanical equipment in areas to be turned over to the Owner.
.4 Disconnection and making safe of various mechanical systems and equipment in areas to be demolished and/or renovated.
.5 Disposal of waste materials in accordance with waste management requirements.
.6 Re-certification and inspection of changes made to any equipment, machine or apparatus by authorities having jurisdiction including requirements for marking of equipment.

1.3 REGULATORY REQUIREMENTS

.1 Notify all authorities of intent to demolish and schedule for the work. Obtain required permits from authorities.
.2 Conform to all codes for demolition work, dust control, products requiring disconnection and re-connection.
.3 Do not close or obstruct egress width to any building or site exit.
.4 Do not disable or disrupt building fire or life safety systems without 3 days prior written notice to Owner.
.5 Conform to procedures applicable when hazardous or contaminated materials are discovered.
.6 Arrange for re-certification and inspection of changes made to any equipment, machine or apparatus by authorities having jurisdiction. This includes requirements for marking of equipment under rules 2-100 and 2-102 of the Ontario Electrical Safety Code.

1.4 JOB CONDITIONS

.1 Visit site and examine existing conditions which may affect work of this Division.
.2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
.3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
.4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.5 INTERRUPTIONS

.1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.

.2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.

.3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.

.4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.

.5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

1.6 PHASING AND SCHEDULING

.1 Refer to Division 1 PHASING AND SCHEDULING OF THE WORK.

.2 Coordinate with the work of all Sections of Division 22 with other trades and assist in the development of the Phasing Strategy.

3 EXECUTION

3.1 PREPARATION

.1 Prior to start of work under this Section, ensure that the General Trades;

- .1 Provide, erect, and maintain temporary barriers at locations indicated.
- .2 Erect and maintain weatherproof closures for exterior openings.
- .3 Erect and maintain temporary partitions to prevent spread of dust, odours, and noise to permit continued Owner occupancy.
- .4 Prevent movement of structure; provide bracing and shoring.

.2 Install, protect and maintain temporary services as required to support continuing operation of the facility.

.3 Protect services and equipment which are not to be demolished.

.4 Coordinate all service shut downs with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.

.5 Notify affected utility companies before starting work and comply with their requirements.

.6 Mark location and termination of utilities.

.7 Provide appropriate temporary signage including signage for exit or building egress.

3.2 RELATIONSHIP WITH OTHER TRADES

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.

.2 Remove and dispose of built-in items such as sleeves, anchors, and inserts.
.3 Remove and dispose of bases, supports and anchors for piping, equipment and ductwork mounted on or in walls, supported above floors and/or suspended from the structure.

3.3 PROTECTION

.1 Protect existing and new work to remain free from damage due to execution of work under this Division with tarpaulins and other protective coverings as necessary .
.2 Repair any and all damage to the building and components resulting from failure to provide suffcient protection, to the satisfaction of the Consultant.
.3 All existing air intake and exhaust openings that may be affected by dust and/or debris from the construction work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from construction work with new filters.
.4 In the event that dust and debris from construction work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.
.5 Temporary filters shall be removed on completion of the construction works.

3.4 DEMOLITION

.1 Notify all authorities of intent to demolish and schedule for the work.
.2 All demolition work shall conform to all codes, regulations, standards and by-laws applicable to the work.
.3 Isolate and drain systems as required to effect demolition. Disconnect, cap and make safe all mechanical services to the building including, but not limited to; sanitary sewer(s), storm sewer(s), water service, natural gas service, steam service, condensate return, water supply to standpipe and sprinkler systems, fire suppression systems hot water heating systems, steam and condenstae systems.
.4 Protect existing equipment and services to remain from debris and unwanted materials. Clean as necessary to maintain service during demolition period and on completion of the work.
.5 Coordinate all service shut downs with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.
.6 Remove and dispose of all redundant mechanical services and equipment within the limits of the demolition site and where demolished systems extend beyond these limits.
.7 Turn over items identified for recovery by the Owner.
.8 All demolition work shall conform to Occupational Health & Safety and Environmental regulations. Ensure that all parties are familiar with requirements and experienced in the work to be undertaken.
.9 Waste disposal shall conform to the requirements of Division 1, municipal By-Laws

and Ministry of the Environment regulations and standards.

.10 All existing air intake and exhaust openings that may be affected by dust and/or debris from the demolition work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from demolition work with new filters.

.11 In the event that dust and debris from demolition work does penetrate the building and/or its air distribution systems, this Section shall be responsible for cleaning the affected areas and/or systems.

.12 Disconnect remove, cap and identify all utilities within demolition areas.

.13 Demolish in an orderly and careful manner. Protect existing supporting structural members.

.14 Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.

.15 Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

.16 Remove temporary Work.

3.5 RENOVATIONS

.1 Isolate and drain systems as required to effect renovations, modifications and/or repairs. On completion of renovations, modifications and/or repairs, test entire system as if new. Report repairs or replacements required of existing equipment, piping, fittings or devices that are not included in contract to Consultant and Owner for instruction. Flush, clean and refill renovated systems as specified for new.

.2 Relocate or remove existing items so designated unless specifically indicated to be relocated or removed under other Sections.

.3 Existing items to be relocated shall be cleaned and repaired or altered as required to suit new location. All damaged or ineffective parts shall be replaced and the item made "as new".

.4 Existing items to be removed remain the property of the owner and shall be delivered to a location on site designated by the owner. If the owner declares no interest in the removed items, assume ownership and remove the items from the site.

.5 Make good all surfaces and finishes in areas from which items have been removed and in which items are relocated. Cap all existing services required to be severed to effect alterations and do all other work necessary to make good such areas to satisfaction of consultant.

.6 Openings in existing floor assemblies and vertical fire separations necessitated by installation of equipment and systems or construction in general must be temporarily sealed with fire barrier materials such as mineral wool or other noncombustible insulation.

.7 If during alteration work existing asbestos material, other than known asbestos, is discovered (e.g. fireproofing, acoustic or thermal insulation, tank covering), stop

work in the affected area and immediately notify consultant.

3.6 INSPECTION AND RE-CERTIFICATION

.1 Where any equipment, machine or apparatus is modified, rebuilt or rewound with any change resulting in its performance or capacity rating and characteristics it shall be inspected and re-certified as required by authorities having jurisdiction.

.2 A nameplate giving the name of the person or firm making the change and the resulting changes in performance or capacity shall be provided and afixed to the equipment, machine or apparatus adjacent to the original nameplate. Where the original nameplate is removed, the original manufacturer's name and original identifying data, such as serial numbers, shall be added to the nameplate.

.3 Refer to rules 2-100 and 2-102 of the Ontario Electrical Safety Code.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 COMMON WORK RESULTS

.1 Section 22 05 00 applies to and governs all work of Division 22.

1.3 REFERENCE STANDARDS

.1 Provide all work in accordance with requirements of Regulatory Agencies and conform to:
- .1 Local and district by-laws, regulations and published engineering standards.
- .2 the Ontario Building Code as amended,
- .3 the Ontario Gas Utilization Code as amended
- .4 Regulations for Construction Projects under The Occupational Health and Safety Act.

.2 Conform to following CSA Standards:
- .1 CAN/CSA-Z317.1: Special Requirements for Plumbing Installations in Health Care Facilities.
- .2 CAN/CSA-Z7396.1: Medical Gas Pipeline Systems - Part 1: Pipelines for Medical gases and Vacuum.
- .3 CAN/CSA-Z7396.2: Medical gas Pipeline Systems - Part 2: Anaesthetic Gas Scavenging Disposal Systems.
- .4 CSA B242 Groove and Shoulder Type: Mechanical Pipe Couplings.
- .5 CAN1-B149.1 Natural gas and propane installation code.
- .6 CSA B64.1 Manual for the Selection and Installation of Backflow Prevention Devices
- .7 CSA B64.1 Manual for the Maintenance and Field Testing of Backflow Prevention Devices.

.3 Conform to following National Research Council Canada publications:
- .1 National Building Code of Canada and Supplements to National Building Code of Canada
- .2 National Fire Code of Canada.
- .3 Canadian Plumbing Code.

.4 Provide work where indicated in conformance with guide Specification of the Victaulic System for Building Services, G-100.

.5 The above documents or portions thereof are referenced within the work of Division 22 and shall be considered part of the requirements of this document as though fully repeated herein.

1.4 QUALIFICATIONS

.1 Motor manufacturer: Company specializing in manufacture of electric motors for

HVAC use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.

.2 Firestop Sealant Manufacturer: Company specializing in manufacture of sealants with minimum three years documented product development, testing, and manufacturing experience.

.3 Firestop components and assemblies shall be ULC listed and tested in accordance with ULC S115 Standard Method of Fire Test for Firestop Sustems.

1.5 SUBMITTALS

.1 Submit shop drawings in accordance with Section 22 01 01 & 01 22 00.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Transport, handle, store, and protect products. Refer to Division 1 requirements as well.

.2 Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.7 WASTE MANAGEMENT & DISPOSAL

.1 Separate and recycle waste materials in accordance with Division 1 Waste Management and Disposal, and with the Contractor's Waste Reduction Workplan.

.2 Place materials defined as hazardous or toxic waste in designated containers.

.3 Ensure emptied containers are sealed and stored safely for disposal away from children.

1.8 WARRANTY

.1 Provide extended coverage five year warranty for motors larger than 20 HP (15 kW).

2 PRODUCTS

2.1 PIPING SPECIALTIES

.1 Cast brass, pressure, copper to copper unions shall be used with seamless copper tubing smaller than 3" (75 mm).

.2 Cast brass flanges shall be used with seamless copper tubing, type L for tubing 3" (75 mm) and larger.

.3 Dart type, 125 lb. (860 kPa) black malleable iron unions shall be used with all steel pipe for piping 2-1/2" (65 mm) and smaller.

.4 Slip-on, 150 lb. (1000 kPa) carbon steel flanges with 1/16" (4 mm) raised face shall be used with all steel pipe for piping larger than 2-1/2" (65 mm).

.5 Gaskets for joining flanged steel pipe shall be 1/16" (4 mm) Cranite ring type gaskets.

.6 Piping specialties including backflow preventers, strainers, valves etc. shall be line

size unless indicated otherwise on drawings.

.7 Strainers

.1 Manufacturers:

.1 Sarco SB
.2 S. A. Armstrong
.3 Crane
.4 Conbraco
.5 Colton

.2 In copper tubing: Class 250, wye type, bronze, screwed connection, with blind caps, and 1/32" (0.8 mm) perforated stainless steel screen.

.3 In Steel Piping: 2" (50mm) and smaller

.1 Body and cover: screwed, line size Y type strainer, semi-steel conforming to ASTM A278-85, Class 30, complete with screwed blind cap. Primary service rating of 125 psi @ 350 F (860 kPa @ 178 C). Body shall have side drain connection.

.2 Screen: perforated type 304 stainless steel service:

.1	Steam	1/16" (0.4 mm)
.2	Water	1/32" (0.8 mm)
.3	Glycol	1/32" (0.8 mm)
.4	Water @ Pump Suction	1/8" (3.2 mm)
.5	Light Oil	1/16" (1.6 mm)
.6	Compressed Air	1/64" (0.4 mm)

.4 In Steel Piping: 2-1/2" (65mm) and larger

.1 Body and cover: flanged, line size Y type strainer, cast steel, class 150, complete with flanged blow down cover. Primary service rating of 150 psi @ 500 F (1 MPa @ 260 C).

.2 Screen: performated type 304 stainless steel service:

.1	Steam	1/32" (0.8 mm)
.2	Water	1/16" (1.6 mm)
.3	Glycol	1/16" (1.6 mm)
.4	Water @ Pump Suction	1/4" (6.4 mm)
.5	Light Oil	1/16" (1.6 mm)
.6	Compressed Air	1/32" (0.8 mm)

.5 In grooved piping:

.1 Victaulic Style 730 grooved end tee-type strainer for piping 2 1/2" (65 mm) and larger or approved equivalent.

.2 Victaulic Style 731 suction diffuser, or approved equivalent

2.2 ADHESIVES, SEALANTS, PAINTS AND COATINGS

.1 Adhesives, Sealants, Paints and Coatings: Use only low VOC emitting materials meeting following criteria;

.1 Paint for Mechanical Identification: maximum VOC emission of 250g/L

.2 Touch-Up Paint: maximum VOC emission of 250g/L

.3 Zinc-Rich Primer: maximum VOC emission of 250g/L
.4 Adhesives for Mechanical Identification: maximum VOC emission of 70g/L
.5 Sealants for service penetrations: maximum VOC emission of 650g/L clear and 350 g/L pigmented
.6 Sealants for Firestopping: max. VOC emission of 650g/L clear and 350 g/L pigmented
.7 Acrylic Sealant for supports and anchors: maximum VOC emission of 250g/L
.8 Insulation Vapour Barrier Lap Adhesive: maximum VOC emission of 80g/L
.9 Insulation Joint Sealer: maximum VOC emission of 250g/L
.10 Insulation Vapour Barrier Mastic: maximum VOC emission of 400g/L
.11 Flame Retardent Adhesive: maximum VOC emission of 650g/L clear and 350 g/L pigmented

2.3 FIRESTOPPING COMPOUNDS

.1 Manufacturer: 3M products indicated.
.2 Other acceptable manufacturers offering equivalent products.
.1 Dow Corning
.2 John Manville
.3 Hilti Firestop Systems
.3 Fire Rated Sealants: intumescent material, synthetic elasomers, capable of expanding up to 8 to 10 times when exposed to temperatures of 250°F (121°C) or higher. ULC listed and labelled.

2.4 NAMEPLATES

.1 Provide laminated plastic plates with black face and white centre of minimum size 3-1/2" x 1-1/2" x 3/32" (90 x 40 x 2 mm) nominal thickness, engraved with 1/4" (6 mm) high lettering. Use 1" (25 mm) lettering for major equipment.
.2 Fasten nameplates securely in conspicuous place. Where nameplates cannot be mounted on cool surface, provide standoffs.
.3 Identify equipment type and number and service of areas or zone of building served.
.4 For each item of equipment which may be started automatically or remotely, add a red lamacoid plate, 2-1/2" x 9" (65 x 230 mm), reading: "WARNING. THIS EQUIPMENT IS AUTOMATICALLY CONTROLLED AND MAY START AT ANY TIME."

2.5 TAGS

.1 Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background colour. Tag size minimum 1-1/2" (40 mm) diameter. OR
.2 Metal Tags: Brass, aluminum or stainless steel with stamped letters; tag size minimum 1-1/2" (40 mm) diameter with smooth edges.
.3 Chart: Typewritten letter size list in anodized aluminum frame.

2.6 STENCILS

.1 Stencils: With clean cut symbols and letters of following size:
  .1 3/4"-1-1/4" (20-30 mm) Outside Diameter of Insulation or Pipe: 8" (200 mm) long colour field, 1/2" (15 mm) high letters.
  .2 1-1/2"-2" (40-50 mm) Outside Diameter of Insulation or Pipe: 8" (200 mm) long colour field, 3/4" (20 mm) high letters.
  .3 2-1/2"-6" (65-150 mm) Outside Diameter of Insulation or Pipe: 12" (300 mm) long colour field, 1-1/4" (30 mm) high letters.
  .4 8" - 10" (200-250 mm) Outside Diameter of Insulation or Pipe: 24" (600 mm) long colour field, 2-1/2" (65 mm) high letters.
  .5 Over 10" (250 mm) Outside Diameter of Insulation or Pipe: 32" (800 mm) long colour field, 3-1/2" (90 mm) high letters.
  .6 Ductwork and Equipment: 2-1/2" (65 mm) high letters.

2.7 PRESSURE GAUGES

.1 Manufacturer: Trerrice Model 600C.
.2 Other acceptable manufacturers offering equivalent products.
  .1 Weiss
  .2 Winter
  .3 Morrisson
  .4 Taylor
.3 Gauge: 4-1/2" (115mm) diameter black cast aluminum, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background, mid-scale accuracy: 1%, scale: psi and kPa.
.4 Gauge Cock: Tee or lever handle, brass for maximum 150 psi (1034 kPa0.
.5 Needle Valve: Brass, 1/4" (6 mm) NPT for minimum 150 psi (1034 kPa).
.6 Pulsation Damper: Pressure snubber, brass with 1/4" (6 mm) connections.
.7 Syphon: Steel, Schedule 40, 1/4" (6 mm) angle or straight pattern.

2.8 STEM TYPE THERMOMETERS

.1 Manufacturer: Trerrice Model BX91403-1/2.
.2 Other acceptable manufacturers offering equivalent products.
  .1 Weiss Model 9VS3-1/2.
  .2 Winter
  .3 Morrison
  .4 Taylor
.3 Thermometer: 9" (230mm) scale, red appearing thermal fluid with black figures on white scale, calibrated in both degrees F and degrees C, accuracy to ASTM E77 of 2%, clear glass lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device, 3/4" (20mm) NPT brass stem.
.4 All thermometers to include a separable well.
.5 Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
.6 Flange: 3" (75 mm) outside diameter reversible flange, designed to fasten to sheet

metal air ducts, with brass perforated stem.

2.9 DIAL THERMOMETERS

.1 Manufacturer: Trerrice
.2 Other acceptable manufacturers offering equivalent products.
  .1 Weiss
  .2 Winter
  .3 Morrisson
  .4 Taylor
.3 Thermometer: ASTM E1, stainless steel case, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
  .1 Size: 2" (50 mm) diameter dial.
  .2 Lens: Clear glass.
  .3 Accuracy: 1 percent.
  .4 Calibration:Degrees C Both degrees F and degrees C.
  OR
.4 Thermometer: ASTM E1, stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
  .1 Size: 3" (75 mm) diameter dial.
  .2 Lens: Clear glass.
  .3 Accuracy: 1 percent.
  .4 Calibration: Degrees F.
  OR
.5 Thermometer: ASTM E1, stainless steel case, vapour or liquid actuated with brass or copper bulb, copper or bronze braided capillary, white with black markings and black pointer glass lens.
  .1 Size: 2-3/8" (60 mm) diameter dial.
  .2 Lens: Clear glass.
  .3 Length of Capillary: Minimum 60" (1500 mm).
  .4 Accuracy: 2 percent.
  .5 Calibration:Degrees C Both degrees F and degrees C.
.6 Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
.7 Flange: 3" (75 mm) outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.10 TEST PLUGS

.1 Manufacturer: Pete's Plug.
.2 Other acceptable manufacturers offering equivalent products.
  .1 WATTS TP
.3 Test Plug: 1/4" or 1/2" (6 mm or 15 mm) brass fitting and cap for receiving 1/8" (3 mm)

outside diameter pressure or temperature probe with neoprene core for temperatures up to 93°C (200°F).

.4 Test Kit: Carrying case, internally padded and fitted containing one diameter pressure gauges, one gauge adapters with 1/8" (3 mm) probes, two 1" (25 mm) dial thermometers.

2.11 STATIC PRESSURE GAUGES

.1 Manufacturer: Trerrice

.2 Other acceptable manufacturers offering equivalent products.
- .1 Weiss
- .2 Winter
- .3 Taylor

.3 3-1/2" (90 mm) diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.

.4 Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.

.5 Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4" (6 mm) diameter tubing.

2.12 ACCESS DOORS

.1 Standard:
- .1 Minimum 12ga
- .2 steel, prime coat painted
- .3 heavy duty fully concealed hinges
- .4 screwdriver operated, cam latch

.2 Concealed (Recessed):
- .1 Minimum 12ga
- .2 steel, prime coat painted
- .3 heavy duty fully concealed hinges
- .4 screwdriver operated, cam latch

.3 Fire Rated:
- .1 Access doors in fire separations or fire rated assemblies: ULC labelled.
- .2 Refer to architectural drawings for ratings of fire separations and assemblies.
- .3 Minimum 12ga
- .4 steel, prime coat painted
- .5 heavy duty fully concealed [frame and] hinges
- .6 screwdriver operated, cam latch

.4 Air Seal Flush Mount:
- .1 Minimum 16ga.
- .2 304 stainles steel, #7 satin finish
- .3 1/2" (13 mm) wide, heavy duty, fully concealed frame and concealed hinges
- .4 1/8" x 3/8" (3.2 x 9.6 mm) closed-cell neoprene gasket
- .5 screwdriver operated, stainless steel cam latch

2.13 MOTOR CONSTRUCTION AND GENERAL REQUIREMENTS

.1 Motors less than 0.33 HP (250 W), for intermittent service may be equipment manufacturer's standard and need not conform to these specifications.

.2 Electrical Service:
- .1 Motors 0.35 HP (0.38 kW) and Smaller: 115 volts, single phase, 60 Hz.
- .2 Motors Larger than 0.35 HP (0.38 kW): 575 volts, three phase, 60 Hz.

.3 Type:
- .1 Open drip-proof except where noted otherwise.
- .2 Design for continuous operation in 104°F (40°C) environment.
- .3 Design for temperature rise to NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- .4 Motors with frame sizes 254T and larger: NEMA premium efficiency.

.4 Motors smaller than 0.5 HP (372 W): Provide continuously rated squirrel cage induction type with capacitor start, EEMAC `N' starting characteristics and a minimum of Class `A' insulation.

.5 Motors 0.5 HP (372 W) and over: Provide continuously rated squirrel cage induction type with EMAC `B' starting characteristics and a minimum of Class `B' insulation.

.6 Provide drip-proof type motors with a 1.15 service factor, unless specified or required otherwise by the motor location.

.7 Provide fan cooled totally enclosed motors having a 1.0 service factor.

.8 Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.

.9 Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

.10 Wiring Terminations:
- .1 Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code, threaded for conduit.
- .2 For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

.11 Provide motors within the 1-500 horsepower range of the "high efficiency" or "premium efficiency" as required under provincial regulations. Ensure this is indicated on the motor nameplate. Provide "T" frame (NEMA Specifications) motors approved under the Ontario Electrical Safety Code. If delivery of specified motor will delay delivery of any equipment, install an acceptable motor for temporary use. Final acceptance of equipment will not occur until the specified motor is installed.

.12 Coordinate with Division 26 the sizing of electrical protective devices supplying new and relocated mechanical equipment that contain integral motor starters and contactors.

.13 Motor ratings rated in watts refer to output watts.

.14 Provide constant speed motors with reduced voltage starters where specified.

.15 Motors for use with variable frequency drives shall be rated for invertor duty. Motors

for pumps and fans shall be rated for inverter duty whether or not VFD are included at this time.

.16 Design BHP shall not exceed 80% of nominal motor HP.

2.14 SINGLE PHASE POWER - SPLIT PHASE MOTORS

.1 Starting Torque: Less than 150 percent of full load torque.
.2 Starting Current: Up to seven times full load current.
.3 Breakdown Torque: Approximately 200 percent of full load torque.
.4 Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
.5 Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.15 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

.1 Starting Torque: Exceeding one fourth of full load torque.
.2 Starting Current: Up to six times full load current.
.3 Multiple Speed: Through tapped windings.
.4 Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

2.16 SINGLE PHASE POWER - CAPACITOR START MOTORS

.1 Starting Torque: Three times full load torque.
.2 Starting Current: Less than five times full load current.
.3 Pull-up Torque: Up to 350 percent of full load torque.
.4 Breakdown Torque: Approximately 250 percent of full load torque.
.5 Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
.6 Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
.7 Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

2.17 THREE PHASE POWER - SQUIRREL CAGE MOTORS

.1 Starting Torque: Between 1 and 1-1/2 times full load torque.
.2 Starting Current: Six times full load current.
.3 Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
.4 Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
.5 Insulation System: NEMA Class B or better.

.6 Testing Procedure: To IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

.7 Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

.8 Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 26 29 23 - Variable Frequency Controllers.

.9 Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt centre line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

.10 Sound Power Levels: To NEMA MG 1.

.11 Part Winding Start Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

.12 Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

.13 Nominal Efficiency: As scheduled at full load and rated voltage when tested to IEEE 112.

.14 Nominal Power Factor: As scheduled at full load and rated voltage when tested to IEEE 112.

2.18 SLEEVES

.1 Materials: minimum schedule 20 galvanized steel or cast iron.

2.19 ESCUTCHEONS

.1 Finish: Polished chrome

2.20 FLASHINGS AND COUNTER FLASHINGS

.1 Thaler or equivalent mechanical/electrical flashings as recommended for specific purpose.

.2 Stainless steel flashing sleeve, integral deck flange and EPDM seal.

2.21 PENETRATION SEALS

.1 Manufacturer: Link-Seal

.2 Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut.

3 EXECUTION

3.1 INSPECTION

.1 Inspect installed work of other trades and verify that such work is complete to point where work under this Division may properly commence.
.2 Verify that work of this Division may be executed in accordance with pertinent codes and regulations, specifications, drawings, and referenced standards.
.3 Review drawings and verify dimensions at the site. Report discrepancies immediately to Consultant before proceeding with any construction work or shop drawings.

3.2 PREPARATION

.1 Existing services and equipment shall be relocated or removed to suit new construction and renovation work.
.2 Services that are no longer required shall be removed or cut back and capped to the satisfaction of Consultant.
.3 Obtain written authorization from Consultant for renovation work that is not specifically indicated.
.4 Where modifications or connections to existing systems require shutdown of the system the Contractor shall submit a request for system shutdown describing the system or part to be shutdown, the duration of the shutdown, the work planned and steps to be taken to reinstate the system to full operation. The request shall be submitted in the format stipulated by the Owner.
.5 All work required to prepare systems for shutdown and/or re-instatement, such as draining, chemical treatments, and re-filling shall be included in this Bid Price.

3.3 PIPING INSTALLATION - ABOVE GROUND

.1 Cooperate with other trades whose work affects or is affected by work of this Section, to ensure satisfactory installation and to avoid delays. Provide all materials to be built-in such as sleeves, anchors, etc., together with accurate dimensions or templates, promptly.
.2 Layout all work accurately, installing piping parallel to lines of building.
.3 Install piping, wherever possible, in partitions and above ceiling. Do not install piping in outside walls unless so shown on drawings. Wrap un-insulated piping in masonry walls with building paper.
.4 Install concealed piping close to building structure to minimize furring dimensions.
.5 Provide adequate space around piping to facilitate application of insulation.
.6 Use dielectric couplings where piping of dissimilar metals connect.
.7 Where piping passes through concrete floors, or walls, sleeves shall be sized to permit the pipe to expand freely without binding or crushing pipe insulation.
.8 Install automatic control valves and wells supplied under other Sections.

3.4 PIPING JOINTS

.1 Make joints in piping installed under this Division using persons familiar with the

particular materials being used and in accordance with Canadian Plumbing Code, manufacturer's instructions, and as specified herein.

.2 Use only welder and/or brazer operators, with a valid identification card, as issued under The Boiler and Pressure Vessels Act, to make joints in Registered Piping Systems, as indicated under Section 22 01 01, paragraph 1.11.

.3 Use 95/5 Sb.Sn (tin-antimony) solder for joining copper drainage tubing smaller than 4" (100 mm), and for joining copper water tubing installed above grade, and smaller than 4" (100 mm).

.4 Use silver solder or Silfos for joining copper water tubing installed below grade, and all copper tubing 4 " (100 mm) and larger in size.

.5 Carefully ream joints in threaded pipe and paint with approved graphite type joint sealer on male connections only. Make connections with proper wrench to suit pipe size. Where leaks occur, the joint shall be disassembled and corrected if possible, or replaced. Over-tightening, caulking or peening will not be acceptable.

.6 Make joints in cast iron pipe with standard M-J joints in accordance with manufacturer's recommendations and CSA B70.

.7 When using Victaulic Grooved Piping Method:

.1 Make joints in grooved piping with couplings and gaskets in accordance with Victaulic Company of Canada Ltd, General Catalogue G-100, latest edition. Cut or roll grooves using tools specifically designed for that purpose.

.2 Use Zero-flex or rigidlok couplings in locations where rigidity is required, in particular in mechanical rooms on coils, headers and pumps.

.3 Vic-Boltless couplings may be used.

.8 Install unions or welding flanges at connections to valves, etc. to facilitate removal.

.9 Use butt welding and/or schedule 40 carbon steel welding fittings to join sections of steel piping with welding ends.

3.5 FLUSHING AND CLEANING

.1 Flush and sterilize domestic water mains in accordance with procedures established by AWWA Specification C601.

.2 Flush new domestic water piping in accordance with Local and Provincial Codes.

.3 Thoroughly flush all other piping installed by this Division.

.4 Remove, clean and replace all strainers in systems after flushing.

.5 Thoroughly clean all equipment and fixtures, lubricate mechanical equipment, and leave all items in perfect order ready for operation.

3.6 ELECTRICAL COMPONENTS AND WIRING

.1 Conform to requirements of Division 26 for all wiring included in Division 22. Includes pre-wired equipment provided by Sections under Division 22.

.2 Ensure that all pre-wired electrical equipment is CSA approved. Arrange and pay for special approval where this is not possible.

.3 Coordinate all wiring requirements with other Divisions. Line voltage wiring from power distribution panels to starters and from starters to motors will be provided

under Division 26. All ther field wiring for equipment shall be included under Division 22, unless specifically called for under Division 25.

3.7 EQUIPMENT TESTING AND INSPECTION

.1 Test operation of equipment installed under this Division according to instructions in appropriate articles of this Division. Make any required adjustments or replacements to ensure equipment is operating as intended. Retest equipment requiring adjustment or replacement.

.2 Pay all fuel consumption charges for equipment under testing and during commissioning.

.3 Conduct tests before application of external insulation and before concealment of piping or ductwork.

.4 Arrange and pay for inspections by authorities as required by code and complete any changes or alterations required by such inspections.

.5 Conduct tests in the presence of:

.1 Authorized inspector(s) for authorities having jurisdiction.

.2 The Commissioning Agent.

.3 The Consultant.

.4 The Owner's Representative.

.6 Notification must be given at least 48 hours in advance of tests being conducted, to all persons required to be present.

3.8 PIPING SYSTEMS TESTING AND INSPECTION

.1 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures.

.2 Test all piping at the completion of roughing-in, before connecting to existing systems, and prior to concealment, insulation or covering of piping.

.3 Make tests, that are required by any authority having jurisdiction, in the presence of the authority's authorized inspector and shall be certified by him.

.4 Conduct tests in the presence of:

.1 Authorized inspector(s) for authorities having jurisdiction.

.2 The Commissioning Agent.

.3 The Owner's Representative

.4 The Consultant

.5 Notification must be given at least 48 hours in advance of tests being conducted, to all persons required to be present.

.6 Repair all leaks exposed during testing and retest. If defects in pipe or fittings are discovered in the system, they shall be removed and replaced.

.7 Certify tests not required by authorities having jurisdiction.

3.9 TESTING AND BALANCING

.1 Allow sufficient time for testing and verification prior to substantial completion. Notify

Testing and Balancing Agency on completion of adjusting and balancing of systems.

.2 Adjust systems and components (drives, sheaves, belts, etc.) as required by Testing and Balancing Agency.

.3 Maintain systems in full operation during testing and verification.

.4 Make adjustments to control systems as required to facilitate verification. Maintain all safety controls in operation.

.5 Check and correct alignment of drive shaft coupling, drives, etc. as required by Testing and Balancing Agency.

.6 Provide pitot tube test fittings at all main branches of sheet metal work and at intake and discharge locations of air handling systems as required by Testing and Balancing Agency.

3.10 PROTECTION

.1 Protect finished and unfinished work by tarpaulins, or other covering, from damage due to execution of work under this Division.

.2 Repair to satisfaction of Consultant, damage to building resulting from failure to provide such protection.

.3 All existing air intake and exhaust openings that may be affected by dust and/or debris from the construction work of this Division shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from construction work with new filters.

.4 In the event that dust and debris from construction work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.

.5 Temporary filters shall be removed on completion of the construction works.

3.11 CUTTING AND PATCHING

.1 Include cutting and patching as required in execution of work under respective Sections of this Division.

.2 Holes through the structure will not be permitted without written approval of the Consultant. Any and all openings required through the completed structure must be clearly and accurately shown on a copy of the relevant structural drawing(s). Exact locations, elevations and size of the proposed opening must be identified well in advance of the need for the work.

.3 All sleeved or formed openings through the structure must be shown on sleeving drawings and must be approved by the Structural Consultant prior to construction.

.4 The Contractor shall conduct exploratory work including x-ray of the existing structure, shall mark the location of embedded reinforcements, anchors, conduits and piping on exposed surfaces of adjacent floors and/or walls and shall pay all associated costs.

.5 Reinforcing shall not be cut or modified without prior approval of the Structural

Consultant. Should reinforcement be cut without such prior approval, the cost of any additional reinforcement deemed necessary by the Structural Consultant shall be the responsibility of this Contractor.

.6 Alternative imaging techniques are subject to the approval of the Structural Consultant.

.7 Ensure that cutting and patching of roofs and reinforced concrete structures is executed by specialists familiar with the materials affected, and is performed in a manner to neither damage nor endanger the work. Coordinate and supervise such cutting and patching.

.8 Maintain the integrity of fire rated assemblies where they are pierced by ducts and pipes.

.9 Make good surfaces affected by this work and repair finish to satisfaction of Consultant. Finish painting, where required, will be provided under Division 9.

.10 Stop work immediately upon discovery of any hazardous material and report discovery to the Owner and Consultant. Obtain instruction prior to proceeding with the work.

3.12 SEALANTS & CAULKING

.1 Fill voids around pipes:

- .1 Seal between sleeve and pipe in foundation walls and below grade floors with penetration seals (link-seal)). Install as per manufacturer's installation instructions.
- .2 Where sleeves pass through non-fire rated walls or floors, caulk space between pipe and sleeve with fibreglass. Seal space at each end with waterproof, fire retardant, non-hardening mastic.
- .3 Ensure no contact between copper tube or pipe and ferrous sleeve.
- .4 Fill future-use sleeves with easily removable filler.
- .5 Coat exposed exterior surfaces or ferrous sleeves with heavy application of zinc rich paint (VOC content not to exceed 250 g/L).

.2 Temporarily plug all openings during construction.

3.13 FIRESTOPPING

.1 All openings in fire separations and fire rated assemblies for service penetrations shall be protected with ULC listed service penetration firestop systems (SP).

.2 The service penetration firestop system shall have F and FT ratings equal to or greater than ratings specified by the Architect for the fire separation (F) and firewall (FT) joint firestop systems (JF).

.3 All components employed in the service penetration firestop system shall conform to the ULC listing.

.4 Contractor shall prepare and submit a schedule of service penetration firestop systems to be employed indicating the ULC listing designation, services involved, location of opening through fire separation and the components of the fire separation assembly.

.5 Refer to architectural drawings for ratings of fire separations and assemblies.

3.14 SLEEVES AND CURBS

.1 Provide pipe sleeves at points where pipes pass through masonry or concrete.
.2 Provide sleeves of minimum schedule 20 galvanized steel or cast iron.
.3 Use cast iron or steel pipe sleeves with annular fin continuously welded at midpoint:
  .1 through foundation walls, with penetration seals.
  .2 through floors of mechanical rooms and equipment rooms.
.4 Provide 1/4" (6 mm) clearance all around, between sleeve and pipes or between sleeve and insulation.
.5 Where piping passes below footings, provide minimum clearance of 2" (50 mm) between sleeve and pipe. Backfill up to underside of footing with concrete of same strength as footing with concrete of same strength as footing.
.6 Terminate sleeves flush with surface of concrete and masonry and 2" (50 mm) above floors. Not applicable to concrete floors on grade.
.7 Provide watertight concrete curb 4" (100 mm) high around mechanical services (pipes, ducts, conduits) which rise through mechanical (service) room floors. Provide minimum 4" (100 mm) clearance between openings for services within curbs.
.8 For pipes passing through roofs, use cast iron sleeves with caulking recess and flashing clamp device. Anchor sleeves in roof construction, caulk between sleeve recess and pipe, fasten roof flashing to clamp device, make water-tight durable joint. Co-ordinate with roofing Section.

3.15 FLASHINGS

.1 Provide all flashing at each point where piping passes through the roof.
.2 Coordinate this work with the roofing Trades to ensure a satisfactory installation and to avoid delays.

3.16 ESCUTCHEONS AND PLATES

.1 Provide on pipes passing through finished walls, partitions, floors and ceilings.
.2 Use chrome or nickel plated brass, solid type with set screws for ceiling or wall mounting.
.3 Inside diameter shall fit around finished pipe. Outside diameter shall cover opening or sleeve.
.4 Where sleeve extends above finished floor, escutcheon or plates shall clear sleeve extension.
.5 Secure to pipe or finished surface, but not insulation.

3.17 PAINTING

.1 Repair minor damage to finish of equipment with standard factory applied baked enamel finish under the appropriate Sections of this division. Replace entirely, items suffering major damage to finish if too extensive to be repaired in the opinion of the

Consultant.

.2 Apply at least one coat of corrosion resistant primer paint to supports, and equipment fabricated from ferrous metals.

3.18 SUPPORT AND ATTACHEMENT

.1 Support and attach piping, ductwork fixtures and equipment from load bearing structures such as beams, joists, reinforced concrete slabs and concrete block walls, and do not support from or attach to steel roof deck and/or wall or ceiling finishes.

3.19 DISSIMILAR METALS

.1 Separate dissimilar metals in order to prevent galvanic corrosion.
.2 Provide gaskets or shims of approved materials to avoid electrolytic action.
.3 Use dielectric unions and/or flanges where piping of dissimilar metals are connected.

3.20 EQUIPMENT BASES AND CURBS

.1 Supply and erect structural work required for installation of mechanical equipment.
.2 Build concrete bases 6" (150 mm) high, providing all necessary inserts, anchor bolts and other fasteners required, for floor mounted tanks, heaters, pumps, air handlers, boilers, etc. Make concrete bases 2" (50 mm) larger all around than the base of the supported equipment and trowel finish to a neat smooth finish. Anchor equipment to pads using 8" (200 mm) cast-in-place anchor bolts. Ensure concrete supplied under this Division is 2500 psi (17 MPa) compressive strength after 28 days.
.3 Build 4" (100 mm) high concrete curbs around all openings through floors. Ensure joint between curb and floor is watertight and maintains integrity of floor membrane where applicable.

3.21 SERVICE CONNECTIONS

.1 Include in Bid Price all amounts required by municipality and/or utilities for service connections and /or modifications to service connections for water services. Ensure amounts include fees, assessments, charges, etc., required in relation to service connection. Do not include acreage or frontage charges.

3.22 BELT DRIVES AND SHEAVES

.1 Provide belt driven equipment with V-belt drive, designed for at least 130 percent of motor nameplate horsepower rating and in accordance with manufacturer's recommendations for type of service intended. Ensure belt drives are at least 95 percent efficient. Balance and properly align drives. Provide matched sets of belts for multiple belt assemblies. Select belts to suit starting torque of driver. Do not use single belt drives only for motors larger than two horsepower.
.2 Provide motor sheaves for one and two belt drives of variable pitch type, with Dodge key adjustments. Supply two sets of fixed drive sheaves for drives with three

or more belts. Install first set of fixed motor sheaves to obtain the originally specified rpm. After initial test and preliminary adjustment, supply and install the second set of fixed sheaves if necessary, to provide the design flow quantities as established on the job. Obtain correct total flow rate for fans through speed changes and not by throttling.

.3 Provide adjustable sheaves on motor sizes up to 2 HP (1492 w) and fixed sheaves on larger motors.

3.23 FIELD QUALITY CONTROL

.1 Temporary and Trial Usage
  .1 Allow the Owner the privilege of temporary and trial usage of installed equipment, as soon as work is complete, for a period of time required to conduct a thorough test.
  .2 Do not construe such usage as evidence of acceptance of work by Owner.
  .3 Repair damage to work tested, resulting from such trial usage, by this Contractor at no cost to Owner.

.2 Systems Verification:
  .1 Verify the correct installation and proper operation of equipment and systems installed. Adjust and balance each system as necessary to achieve optimum operation of each system.
  .2 Co-operate with the TAB agency as follows:
    .1 provide assistance when and as requested,
    .2 co-ordinate completion of work systematically to permit orderly verification and adherence to schedules,
    .3 provide additional necessary flow balancing devices as directed by agency,
    .4 notify TAB Agency of tests being conducted.

3.24 ADJUST AND CLEAN

.1 Clean equipment and fixtures, lubricate mechanical equipment installed under this Division and leave items in perfect order ready for operation.

.2 Test and adjust control devices, instrumentation, relief valves, dampers, etc., installed in this Division after cleaning of systems and leave in perfect order ready for operation.

.3 Remove from the premises upon completion of work of this division, debris, surplus, and waste materials resulting from operations.

3.25 MECHANICAL IDENTIFICATION INSTALLATION

.1 Degrease and clean surfaces to receive adhesive for identification materials.

.2 Prepare surfaces for stencil painting.

.3 Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear

lacquer (VOC content not to exceed 680 g/L).

.4 Install tags with corrosion resistant chain.

.5 Comply with standard detail drawing plate, "Detail of Piping Identification".

.6 Apply stencil markings on all covered piping.

.7 Install plastic tape pipe markers complete around bare pipe to manufacturer's instructions.

.8 Identify medical gas piping in accordance with CSA Z305.1 and CSA Z7396-1

.9 Identify anaesthetic gas scavenging piping in accordance with CSA Z7396-1.

.10 Label piping that is heat traced or equipped with heating cable "HEAT TRACED" in addition to other identification. Locate such labels adjacent to other identifications.

.11 Clearly identify abandoned services left in place as "ABANDONED".

.12 Mark drain from hot lab sink with radiation warning symbols at 10 ft. (3 m) intervals.

.13 Install underground plastic pipe markers 6"-8" (150-200 mm) below finished grade, directly above buried pipe.

.14 Identify pumps, water heating equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

.15 Identify control panels and major control components outside panels with plastic nameplates.

.16 Identify valves in main and branch piping with tags. Consecutively number valves in each system.

.17 Identify piping, concealed or exposed, with stencilled painting and plastic tape pipe markers . Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 6 m on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

.18 For each item of equipment which may be started automatically or remotely, add a red lamacoid plate, 2-3/8" x 9" (60 x 230 mm), reading:

"WARNING. THIS EQUIPMENT IS AUTOMATICALLY
CONTROLLED. IT MAY START AT ANY TIME."

.19 Provide colour coded self-adhesive dots to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

3.26 MECHANICAL IDENTIFICATION SCHEDULES

.1 Consult the Owner and identify piping, ductwork and equipment as directed;

.1 conforming to the Owner's existing identification practices, or

.2 conforming to the following Pipe and Valve Identification Table:

Pipe Marker Legend	Valve Tag Legend	Primary Colour	Secondary Colour
Cold Water	CW	Green	None
Compressed Air	CA [psi]	Green	None

Dom. Hot Water Supply	DHWS	Green	None
Dom. Hot Water Recirc.	DHWR	Green	None
Sanitary Sewer	SAN	Green	None
Storm Sewer		Green	None
Vent		Green	None

.2 Where coloured PVC jacketing is specified, conform to the following schedule;

Service	Legend	Colour
Cold Water	CW	Dark Green
Dom. Hot Water Supply	DHWS	Yellow
Dom. Hot Water Recirc.	DHWR	Yellow
Sanitary Sewer	SAN	Dark Grey
Storm Sewer	STRM	Light Grey

3.27 MANUFACTURER'S NAMEPLATES

.1 Provide metal nameplates on each piece of equipment, mechanically fastened with raised or recessed letters.

.2 Include registration plates, Underwriters' Laboratories and CSA approval, as required by respective agency and as specified. Indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors, all factory supplied.

.3 Locate nameplates so that they are easily read. Do not insulate or paint over plates.

3.28 FLOW DIAGRAMS AND DIRECTORIES

.1 Provide Consultant with six identification flow diagrams of approved size for each system. Include tag schedule, designating number, service, function, and location of each tagged item and normal operating position of valves.

.2 Install where agreed with the Owner one copy of each flow diagram and valve schedule mounted in glazed frame. Provide one copy of each in Operation and Maintenance Manual.

3.29 INSTALLATION OF GAUGES AND THERMOMETERS

.1 Install to manufacturer's instructions.

.2 Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.
.3 Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
.4 Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide syphon on gauges in steam systems. Extend nipples and syphons to allow clearance from insulation.
.5 Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-3/8" (60 mm) for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
.6 Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
.7 Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
.8 Locate test plugs adjacent thermometers and thermometer sockets.

3.30 INSTALLATION OF ACCESS DOORS

.1 Supply access doors for access to equipment requiring service, lubrication or adjustment and all concealed valves, cleanouts, trap primers, control and volume dampers, and other such equipment.
.2 Turn over access doors to the appropriate general trade for installation under other Sections.
.3 Refer to architectural drawings for ratings of fire separations and assemblies. install fire rated access doors in fire rated partitions, walls, and ceilings.
.4 Access doors in ceilings shall be minimum 24" x 24" (600mm x 600mm), unless otherwise approved by the Consultant.
.5 Provide concealed access doors in GWB ceilings and coordinate in-fill with general trades.
.6 Provide Air Seal Flush Mount access doors in all Clean Rooms, Laboratories and Health Care Facility Class 1 rooms [e.g. operating rooms, procedure rooms, ICU, CCU, PACU, and all sterile environments].

3.31 MOTOR APPLICATIONS

.1 Single phase motors for shaft mounted fans: Split phase type.
.2 Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.
.3 Single phase motors for fans: Capacitor start type.
.4 Single phase motors for fans: Capacitor start, capacitor run type.
.5 Motors located in exterior locations: Totally enclosed type.
.6 Motors located in outdoors: Totally enclosed weatherproof epoxy-treated type.
.7 Motors located in outdoors: Totally enclosed weatherproof epoxy-sealed type.

3.32 INSTALLATION OF MOTORS

.1 Install motors to manufacturer's instructions.
.2 Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
.3 Check line voltage and phase and ensure agreement with nameplate.

3.33 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

HP	kW	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6 - 1/3	0.12-0.25	1.35	1.35	1.35	1.35
1/2	0.38	1.25	1.25	1.25	1.15
3/4	0.5	1.25	1.25	1.15	1.15
1	0.75	1.25	1.15	1.15	1.15
1/6 - 150	0.1-111	1.15	1.15	1.15	1.15

3.34 PERFORMANCE SCHEDULE: THREE PHASE - ENERGY EFFICIENT, OPEN DRIP-PROOF

3 PHASE, ODP					
HP	**KW**	**RPM(Syn)**	**NEMA Frame**	**Minimum Efficiency %**	**Minimum Power Factor %**
1	0.75	1200	145T	81	72
1-1/2	1.1	1200	182T	83	73
2	1.5	1200	184T	85	75
3	2.25	1200	213T	86	60
5	3.7	1200	215T	87	65
7-1/2	5.6	1200	254T	89	73
10	7.5	1200	256T	89	74

3 PHASE, ODP					
HP	**KW**	**RPM(Syn)**	**NEMA Frame**	**Minimum Efficiency %**	**Minimum Power Factor %**
1	0.75	1800	143T	82	84
1-1/2	1.1	1800	145T	84	85

2	1.5	1800	145T	84	85
3	2.25	1800	182T	86	86
5	3.7	1800	184T	87	87
7-1/2	5.6	1800	213T	88	86
10	7.5	1800	215T	89	85

3 PHASE, ODP					
HP	**KW**	**RPM(Syn)**	**NEMA Frame**	**Minimum Efficiency %**	**Minimum Power Factor %**
1-1/2	1.1	3600	143T	82	85
2	1.5	3600	145T	82	87
3	2.25	3600	145T	84	85
5	3.7	3600	182T	85	86
7-1/2	5.6	3600	184T	86	88
10	7.5	3600	213T	87	86

3.35 PERFORMANCE SCHEDULE: THREE PHASE-ENERGY EFFICIENT, TOTALLY ENCLOSED, FAN COOLED

3 PHASE, TEFC					
HP	**KW**	**RPM(Syn)**	**NEMA Frame**	**Minimum Efficiency %**	**Minimum Power Factor %**
1	0.75	1200	145T	81	72
1-1/2	1.1	1200	182T	83	73
2	1.5	1200	184T	85	75
3	2.25	1200	213T	86	60
5	3.7	1200	215T	87	65
7-1/2	5.6	1200	254T	89	73
10	7.5	1200	256T	89	74

3 PHASE, TEFC					
HP	**KW**	**RPM(Syn)**	**NEMA Frame**	**Minimum Efficiency %**	**Minimum Power Factor %**
1	0.75	1800	143T	82	84
1-1/2	1.1	1800	145T	84	85
2	1.5	1800	145T	84	85
3	2.25	1800	182T	86	86
5	3.7	1800	184T	87	87
7-1/2	5.6	1800	213T	88	86
10	7.5	1800	215T	89	85

3 PHASE, TEFC					
HP	**KW**	**RPM(Syn)**	**NEMA Frame**	**Minimum Efficiency %**	**Minimum Power Factor %**
1-1/2	1.1	3600	143T	82	85
2	1.5	3600	145T	82	87
3	2.25	3600	145T	84	85
5	3.7	3600	182T	85	86
7-1/2	5.6	3600	184T	86	88
10	7.5	3600	213T	87	86

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

.1 Flexible pipe connectors.
.2 Expansion joints and compensators.
.3 Pipe loops, offsets, and swing joints.
.4 Anchors and guides

1.3 REFERENCES

.1 CSA B51 Boiler, Pressure Vessel and Pressure Piping Code
.2 ASME B31.1 Code for Power Piping
.3 ASME B31.3 Process piping
.4 MIL-E-17814E - Expansion Joints, Pipe, Slip-Type, Packed.

1.4 PERFORMANCE REQUIREMENTS

.1 Provide structural work and equipment required to control expansion and contraction of piping.
.2 Verify that anchors, guides, and expansion joints provided, adequately protect system.
.3 Arrange all piping so that expansion and contraction of any piping may take place without placing undue strain on the piping or connections to the equipment. Use swing joints and suitable expansion joints wherever necessary due to field conditions and where indicated on the drawings.
.4 This Section shall analyze each section of pipe installed between constraints and shall determine the potential for expansion of the pipe based on pipe temperature at installation and pipe temperatures throughout the pipe's operating range. Where potential expansion exceeds 1" (25 mm) over the length of the pipe section, expansion compensators shall be installed. Pipe sections are constrained where they penetrate walls, partitions, floors, ceilings, roofs and movement of the pipe is restricted and where the pipe is anchored to the building structure.
.5 Expansion Calculations:
  .1 Safety Factory: 30 percent.
  .2 Installation Temperature: 50°F (10°C).
  .3 Hot Water Heating: 210°F (99°C).
  .4 Domestic Hot Water: 140°F (60°C).
  .5 Steam (100psig WP): 350°F (177°C).
  .6 Steam (15psig WP): 300°F (150°C).
  .7 Condensate (to 125 psig): 350°F (177°C).

.8 Condensate & feedwater (to 300 psig): 500°F (260°C)

1.5 SUBMITTALS

.1 Refer to section 01 33 00 & 22 01 01
.2 Product Data:
.1 Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per metre and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
.2 Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
.3 Design Data: Submit detailed construction drawings for expansion compensation and piping anchors, signed and sealed by a professional engineer licenced in Ontario. Provide selection criteria used.
.4 Manufacturer's Installation Instructions: Indicate special procedures, and external controls.

1.6 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.
.2 Design expansion compensating system under direct supervision of a Professional Engineer experienced in design of this work and licenced in the Province of Ontario.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Transport, handle, store, and protect products.
.2 Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.
.3 Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.8 WARRANTY

.1 Warranty: 5-year replacement warranty.

1.9 EXTRA MATERIALS

.1 Section 22 01 01: Submittals for project closeout.
.2 Provide two 340 gm containers of packing lubricant and cartridge style grease gun.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Manufacturers must be certified by the Expansion Joint Manufacturers Association

(EJMA)

.2 Flexible Pipe Connectors
- .1 Flex-Pression Ltd.
- .2 Sr. Flexonics
- .3 Ontario Hose
- .4 Colton Industries

.3 Expansion Joints
- .1 Flex-Pression Ltd.
- .2 Hyspan Precision Products, Inc.
- .3 Sr. Flexonics

.4 Pipe Alignment Guides
- .1 Flex-Pression Ltd.
- .2 Hyspan Precision Products, Inc.
- .3 Sr. Flexonics

2.2 PIPE ALIGNMENT GUIDES

.1 Steel Pipe:
- .1 radial "spider" type, minimizing piping motions in non-axial planes.
- .2 constructed of carbon steel with a 360-degree two-piece bolted housing, and 360-degree two-piece bolted clamps with spider type legs.
- .3 provide an insulation clearance of 1.5" on sizes 6" IPS and under, and 2.0" on sizes 8" IPS and over.
- .4 axial travel shall be 3" for sizes 2" IPS and under, and 6" for sizes 2-1/2" IPS and over.
- .5 refer to piping and expansion joint schedules for specific insulation and motion requirements.
- .6 Basis of design: Hyspan Series 9500.

.2 Copper Pipe:
- .1 radial "spider" type, minimizing piping motions in non-axial planes.
- .2 constructed of carbon steel with non-metallic coating on the tube clamps, and a 360-degree two-piece bolted housing, and 360-degree two-piece bolted clamps with spider type legs.
- .3 provide an insulation clearance of 1.5".
- .4 axial travel shall be 3" for sizes 2-1/2" and under, or 6" for sizes 3" and 4".
- .5 refer to piping and expansion joint schedules for specific insulation and motion requirements.
- .6 Basis of design: Hyspan Series 9500.

2.3 FLEXIBLE PIPE CONNECTORS

.1 Copper Piping:
- .1 Inner Hose: Bronze
- .2 Exterior Sleeve: Braided bronze.
- .3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).

.4 Joint: As specified for pipe joints.
.5 Size: Use pipe sized units
.6 Maximum offset: 3/4" (20 mm) on each side of installed centre line.

.2 Steel Piping, 2" (50 mm) diameter and smaller:
.1 Inner Hose: braided bronze.
.2 Exterior Sleeve: None.
.3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).
.4 Joint: Threaded.
.5 Size: Use pipe sized units.
.6 Maximum offset: 3/4" (20 mm) on each side of installed centre line.

.3 Steel Piping, 2-1/2" to 3-1/2" (65mm to 90mm) diameter :
.1 Inner Hose: braided bronze.
.2 Exterior Sleeve: None.
.3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).
.4 Joint: Flanged.
.5 Size: Use pipe sized units.
.6 Maximum offset: 3/4" (20 mm) on each side of installed centre line.

.4 Steel Piping, 4" (100mm) diameter and larger:
.1 Inner Hose: braided 321 stainless steel.
.2 Exterior Sleeve: None.
.3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).
.4 Joint: Flanged.
.5 Size: Use pipe sized units.
.6 Maximum offset: 3/4" (20 mm) on each side of installed centre line.

2.4 EXPANSION JOINTS - COPPER PIPING

.1 Bronze Bellows Type:
.1 Construction: 2-ply bronze with anti-torque device, limit stops, internal guides.
.2 Pressure Rating: 125 psi (862 kPa) WSP and 400°F (204°C).
.3 Maximum Compression: 1-3/4" (45 mm).
.4 Maximum Extension: 1/4" (6 mm).
.5 Joint: Soldered.
.6 Size: Use pipe line sized units
.7 Application: Copper piping.

2.5 EXPANSION JOINTS - DESIGN 150 PSIG / 500°F

.1 Ratings
.1 Design Pressure: 150 psig (1035 kPa)
.2 Test Pressure: 225 psig (1552 kPa)
.3 Design Temperature: 500 °F (260°C)

.2 Stainless Steel Bellows Type:
.1 Construction multi-ply ASTM A240 type 321 stainless steel bellows, ASME A53, Gr. B carbon steel housing,

.2 Pressure Rating: 150 psi (1035 kPa) WSP and 500°F (260°C).
.3 Maximum Compression: 1-3/4" (45 mm).
.4 Maximum Extension: 1/4" (6 mm).
.5 Joint: Flanged.
.6 Size: Use pipe line sized units
.7 Application: Steel piping 2-1/2" (65 mm) and smaller.

.3 Externally Pressurized:
.1 Construction: Self-equalizing type with three or four ply ASTM A240 type 321 stainless steel bellows; ASME A53, Grade B carbon steel housing and pipe nipples; ASME-A36 steel plate guide rings and flanges; ASME A105, 3000-lb thread-o-let drain port & plug.
.2 Pressure Rating: 300 psi (2070 kPa) WOG and 500°F (260°C).
.3 Maximum Compression: 8" (200 mm).
.4 Maximum Extension: 2" (50 mm).
.5 Joints: Flanged.
.6 Size: Use pipe line sized units
.7 Application: Steel piping 3" (75 mm) and larger.

2.6 EXPANSION JOINTS - DESIGN 300 PSIG / 500°F

.1 Ratings
.1 Design Pressure: 300 psig (2070 kPa)
.2 Test Pressure: 450 psig (3105 kPa)
.3 Design Temperature: 500 °F (260°C)

.2 Externally Pressurized:
.1 Construction: Self-equalizing type with three or four ply ASTM A240 type 321 stainless steel bellows; ASME A53, Grade B carbon steel housing and pipe nipples; ASME-A36 steel plate guide rings and flanges; ASME A105, 3000-lb thread-o-let drain port & plug.
.2 Pressure Rating: 300 psi (2070 kPa) WOG and 5000°F (260°C).
.3 Maximum Compression: 8" (200 mm).
.4 Maximum Extension: 2" (50 mm).
.5 Joints: Flanged.
.6 Size: Use pipe line sized units
.7 Application: Steel piping 3" (75 mm) and larger.

2.7 LAMINATED, ULTRA-LOW PRESSURE FORCE SERIES 1501-1506

.1 Ratings:
.1 Design Pressure: 150 PSIG
.2 Test Pressure: 225 PSIG
.3 Maximum Temperature: 500 F.

.2 Basis of design: Hyspan series 1501-1506.

.3 Expansion joints shall be low area, three-ply, internally pressurized designs, single or dual configurations as scheduled.

.4 Integral pipe attachments must have a radius where the bellows neck is received.
.5 Expansion joints with larger effective area, welded to the pipe OD, not of three plies, or attached to a pipe without a radius will not be accepted.
.6 Bellows shall be three ply, type 304 or 321 stainless steel, with the effective areas listed below, and attached to the pipe ID. Alloy 625 bellows shall be provided when chloride-ion, stress-corrosion cracking is a concern.

Pipe Size	Effective Area (in^2)	Pipe Size	Effective Area (in^2)
1-1/2"	2.3	6"	33.3
2"	4.1	8"	56.8
2-1/2"	5.8	10"	87.2
3"	8.8	12"	122.0
4"	15.4	14"	152.0

.7 Internal liners of stainless steel shall remain within the joint over all dimensions under design motions.
.8 Bellows receivers of A53 Gr. B (or A106 Gr. B) standard weight pipe, with internal radii.
.9 Flanges shall be A36 carbon steel plate, or A105 forged, with ANSI B16.5 drilling and outside diameter. Flanges may be fixed or lap joint stub end as specified.
.10 Butt weld ends of schedule standard A53 Gr. B (or A106 Gr. B).
.11 Dual joints must include an intermediate anchor base.

2.8 LAMINATED, ULTRA-LOW PRESSURE FORCE, SERIES 1501-1502 HYRISER

.1 Ratings:
  .1 Design Pressure: 150 PSIG
  .2 Test Pressure: 225 PSIG
  .3 Maximum Temperature: 500 F.
.2 Basis of design: Hyspan series 1501/1502 HYRISER.
.3 Expansion joints shall be low area, three-ply, internally pressurized designs, single configuration incorporating an internal guide liner.
.4 Integral pipe attachments must have a radius where the bellows neck is received.
.5 Expansion joints with larger effective area or axial spring rate welded to the pipe OD, not of three plies, or attached to a pipe without a radius will not be accepted.
.6 Bellows shall be three ply, type 304 or 321 stainless steel, with the effective areas listed below, and attached to the pipe ID. Alloy 625 bellows shall be provided when chloride-ion, stress-corrosion cracking is a concern.

Pipe Size	Effective Area (in^2)	Axial Spring Rate (lbs/in)

4"	15.4	155
5"	23.5	190
6"	33.3	348
8"	56.8	325
10"	87.2	411
12"	122.0	614

.7 Internal liners of stainless steel shall remain within the joint over all dimensions under design motions and self-drain.
.8 Bellows receivers of A53 Gr. B (or A106 Gr. B) standard weight pipe, with internal radii.
.9 Flanges shall be A36 carbon steel plate, or A105 forged, with ANSI B16.5 drilling and outside diameter. Flanges may be fixed or lap joint stub end.
.10 Butt weld ends of schedule standard A53 Gr. B (or A106 Gr. B).
.11 Dual joints must include an intermediate anchor base.
.12 Warranty required: 5-Year limited.

2.9 TIED UNIVERSAL EXPANSION JOINTS, SERIES 1511R-1512R

.1 Ratings:
  .1 Design Pressure: 50, 150, or 300 PSIG
  .2 Test Pressure: 75, 225, or 450 PSIG
  .3 Lateral Motions: 2", 3", 4"
  .4 Maximum Temperature 500 F.
.2 Expansion Joints shall be the tied universal configuration incorporating two independent bellows. The expansion joint shall be installed perpendicular to the piping run inducing lateral motion. The expansion joint induces only spring forces to the piping when only lateral motions are absorbed.
.3 Bellows shall be one-to-four plies as required of austenitic stainless steel.
.4 Flanges shall be A36 carbon steel plate, with ANSI B16.5 drilling and outside diameter. Flanges may be fixed, or vanstoned as indicated on the schedule. Carbon steel vanstone flanges allow slight rotation for misalignment and/or to allow *stainless steel wetted surfaces for corrosion resistance.
.5 Butt weld-ends, shall be schedule standard A53 Gr. B, or the schedule and material grade otherwise indicated.
.6 Tie/Limit rods are required to absorb pressure thrust forces and provide safety limits for design motions.
.7 Internal liners shall be provided for;
  .1 liquid flows at 10 feet per second or higher in pipes 6" IPS and over,
  .2 flows exceeding 2 feet per second per inch of diameter in pipes under 6" diameter,
  .3 flow rates exceeding 100 feet per second
  .4 steam service,

.5 abrasive flows.

.8 Tied Universal expansion joints shall be Hyspan series 1511R flanged or 1512R weld end.

2.10 EXTERNALLY-PRESSURIZED & LAMINATED EXPANSION JOINT SERIES 3501-3506

.1 Ratings:
- .1 Design Pressure 150 PSIG
- .2 Test Pressure 225 PSIG
- .3 Maximum Temperature 500 F.

.2 Expansion joints shall be externally pressurized, with internal and external guides.

.3 Bellows must be three plies with the specified effective areas and attached via independent collars.

.4 Materials of construction are A-53 Gr.B (or A-106 Gr.B) standard weight liner and housing, carbon steel guide rings, and type 304 stainless steel bellows with the effective areas listed below. Attach the bellows to internal and external guide rings via 304 S.S. collars. Use Alloy 625 bellows when chloride-ion, stress-corrosion cracking is a concern.

.5 Bellows welded to guide rings at the root or crest radii are not acceptable.

.6 Vent internal guide rings to reduce the effects of sudden pressure changes.

.7 Include a lifting lug and drain port.

.8 Flanges shall be A36 carbon steel plate, or A105 forged, with ANSI B16.5 drilling and outside diameter. Flanges may be fixed or lap joint stub end.

.9 Butt weld ends of schedule standard A53 Gr. B (or A106 Gr. B).

.10 Dual joints must include an intermediate anchor base.

.11 Design basis: Hyspan series 3500.

.12

Pipe Size	Effective Area (in^2)	Pipe Size	Effective Area (in^2)
1-1/2"	8.2	6"	50.3
2"	8.2	8"	80.5
2-1/2"	10.6	10"	115
3"	13.7	12"	164
4"	22.7	14"	206
5"	35.3	16"	258
		18"	318

2.11 EXTERNALLY-PRESSURIZED & LAMINATED SERIES 8500

.1 Ratings:
- .1 Design Pressure: 200 PSIG

.2 Test Pressure: 300 PSIG
.3 Maximum Temperature: 500 F.
.4 Axial Compression: 2" or 3"

.2 Expansion compensators will be externally pressurized, with internal and external guides. The Expansion Joint Manufacturers Association (EJMA) must certify the manufacturer. Bellows must be two plies minimum with the specified effective areas.

.3 Materials of construction for steel piping compensators are: Butt weld, male pipe thread and steel groove ends with integral liner are schedule standard A53 Grade B, carbon steel housing and guide rings, and *304 s/s or 321 s/s bellows with the effective areas listed below. Flanges, if specified, are provided fixed with ANSI B16.5 drilling and outside diameter. Attach bellows necks to internal and external guide rings. Bellows welded to guide rings at the convolution root or crest radii are not acceptable.

.4 Materials of construction for copper tube compensators are: Type L copper tube ends male or female sweat, 304 s/s housing and guide rings, *304 or 321 s/s bellows with the effective areas listed below. Attach the bellows necks to internal and external guide rings. Bellows welded to guide rings at the convolution root or crest radii are not acceptable.

.5 Expansion compensators will be Hyspan series 8500, or other engineer approved equal.

Steel Pipe Size	Effective Area (in^2)	Copper Tub Size	Effective Area (in^2)
3/4"	1.5	3/4"	1.1
1"	2.1	1"	1.7
1-1/4"	3.3	1-1/4"	2.4
1-1/2"	4.3	1-1/2"	3.2
2"	6.3	2"	5.1
2-1/2"	8.8	2-1/2"	7.6
3"	13.1	3"	10.6
4"	20.8	4"	17.9

2.12 PRESSURE BALANCED, EXTERNALLY-PRESSURIZED, LAMINATED SERIES 3500PB

.1 Ratings:
.1 Design Pressure 150 PSIG
.2 Test Pressure 225 PSIG
.3 Maximum Temperature 500 F.

.2 Expansion joints pressure balanced, externally pressurized, laminated bellows type, with internal and external guides

.3 Bellows shall be three plies with specified spring rates per Hyspan catalog 574H and

attached via independent collars.

.4 Materials of construction are A-53 Gr.B (or A-106 Gr.B) standard weight liner and housing, carbon steel guide rings, and type 304 stainless steel bellows with three plies. Attach the bellows to internal and external guide rings via 304 S.S. collars. Use Alloy 625 bellows when chloride-ion, stress-corrosion cracking is a concern.

.5 Bellows welded to guide rings at the root or crest radii are not acceptable.

.6 Vent internal guide rings to reduce the effects of sudden pressure changes.

.7 Include a lifting lug and drain port.

.8 Flanges shall be A36 carbon steel plate, or A105 forged, with ANSI B16.5 drilling and outside diameter. Flanges may be fixed or lap joint stub end.

.9 Butt weld ends of schedule standard A53 Gr. B (or A106 Gr. B).

.10 Dual joints must include an intermediate anchor base.

.11 Design basis: Hyspan series 3500PB.

2.13 SLIP EXPANSION JOINT, SERIES 6500 PERMA-PAX

.1 Expansion joints shall be packed-slip type containing injectable flaked graphite packing and graphite seals. Packing ports allowing packing under full line pressure are required. Non-injectable packing designs are not acceptable. Non-graphite packing and seals are not acceptable.

.2 Internal and external line-bore machined guides of ASTM SB169-C614. Non-ASME rated bearing materials are not acceptable. Joint Seal Force is 850 pounds per inch of diameter or less in published catalog.

.3 A stainless steel extension limit stop ring covering approximately 360 degrees will be included on each slip tube. Limit-stop pins are not acceptable.

.4 The slip tube will be made from A53-Gr.B pipe, schedule 80 from 1-1/4" through 16" IPS and schedule 60 from 18" through 24" IPS sizes. The slip tube will be hard-chromed-plated .002" thick according to ASTM B650.

.5 One-piece body required.

.6 Include a drain port on each joint.

.7 See the expansion joint schedule for required weld end fittings of schedule standard, schedule 40 or schedule 80, or flanges.

.8 Joint design and manufacturing in compliance with ASTM F1007 and MIL-E-17814F.

.9 Expansion joints will be Hyspan Series 6500 Perma-Pax .

Nominal Size (NPS)	Effective Area (square inches)	Joint Seal Force (lbs)
2	4	1700
2-1/2	5.9	2125
3	8.9	2550
4	15	3400

5	23.2	4250
6	32.5	5100
8	55.9	6800
10	86.6	8500
12	123	10,200
14	148	11,900
16	195	13,600
18	247	15,300
20	306	17,000
24	443	20,400

2.14 BALL JOINTS, TYPE N, SERIES 6500

.1 Hyspan-Barco Type N Series I Ball Joints
- .1 Angular motion of plus and minus 7.5 degrees and torsional motion of 360 degrees
- .2 Ball, Case and Bolting Retainer of carbon steel - stronger than schedule standard pipe of equivalent size
- .3 Bolted Retainer Ball Joints allowing field tightening/adjustment of bearing/seals and unbolting replacement of bearing/seals via bolt removal. Cutting and rewelding of ball joint case for bearing/seal removal and replacement will not be accepted
- .4 Ball hard-chromed-plated .002" thick according to ASTM B650.
- .5 Bearing seals of composite phenolic material not requiring field lubrication
- .6 Design basis: Hyspan series 6500

.2 Hyspan-Barco Type N Series II Ball Joints
- .1 Angular motion of plus and minus 7.5 degrees and torsional motion of 360 degrees
- .2 Ball, Case and Bolting Retainer of carbon steel - stronger than schedule standard pipe of equivalent size.
- .3 Bolted Retainer Ball Joints allowing field tightening/adjustment of bearing/seals and unbolting replacement of bearing/seals via bolt removal. Cutting and rewelding of ball joint case for bearing/seal removal and replacement will not be accepted. Injectable graphite secondary seal shall be included.
- .4 Flake graphite packing injected, plugged and tested at the factory.
- .5 Ball hard-chromed-plated .002" thick according to ASTM B650.
- .6 Bearing seals of ductile iron, composite phenolic, Inconel or other factory clarified material
- .7 Design basis: Hyspan series 6500

3 EXECUTION

3.1 INSTALLATION

.1 Install flexible pipe connectors and expansion joints to manufacturer's instructions.
.2 Ratings and bolt patterns for flanges shall suit design pressure and design temperature of piping system and match those of installed components.
.3 Construct spool pieces to exact size of flexible connection for future insertion.
.4 Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.
.5 Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
.6 Pipe anchors shall be installed securing the piping system to the building structure in order to control the direction and the amount of pipe movement. In addition, pipe anchors shall be installed to prevent separation of pipe due to hydraulic pressures. Pipe anchors shall be designed by the Contractor to accommodate all forces experienced. Prepare calculations for each anchor and submit to Consultant for review and approval. Provide pipe guides so movement is directed along axis of pipe only. Not less than two guides shall be provided on each side of an expansion joint. Erect piping such that strain and weight is not on cast connections or apparatus.
.7 Provide support and equipment required to control expansion and contraction of piping. Provide pipe offsets, and swing joints, or expansion joints where required. The Contractor may elect to install expansion loops in place of expansion compensators where there is adequate space to do so; subject to the approval of the Consultant. The Contractor shall prepare and submit detailed design calculations for each expansion loop proposed to the Consultant for review and approval prior to installation.

3.2 MANUFACTURER'S FIELD SERVICES

.1 Prepare and start systems to Section 22 01 01.
.2 Provide inspection services by manufacturer's representative for final installing and certify installation is to manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

.1 Pipe and equipment hangers and supports.
.2 Equipment bases and supports.
.3 Sleeves and seals.
.4 Flashing and sealing equipment and pipe stacks.

1.3 REFERENCES

.1 ASME B31.1 - Power Piping.
.2 ASME B31.2 - Fuel Gas Piping.
.3 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
.4 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
.5 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
.6 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
.7 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
.8 NFPA 13 - Installation of Sprinkler Systems.
.9 NFPA 14 - Installation of Standpipe, Private Hydrants, and Hose Systems.
.10 UL 203 - Pipe Hanger Equipment for Fire protection Service.

1.4 SUBMITTALS

.1 Section 22 01 01: Procedures for submittals.
.2 Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
.3 Product Data: Provide manufacturers catalogue data including load capacity.
.4 Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
.5 Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 REGULATORY REQUIREMENTS

.1 Conform to CSA B-51 for support of piping.

2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

.1 Manufacturers:
  .1 Anvil
  .2 Myat
  .3 Hunt
.2 Hydronic Piping:
  .1 Conform to CSA B-51 and ASME B31.9.

.2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
.3 Hangers for Cold Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
.4 Hangers for Hot Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.
.5 Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.
.6 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
.7 Multiple or Trapeze Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
.8 Wall Support for Pipe Sizes to 3" (76 mm): Cast iron hook.
.9 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
.10 Wall Support for Hot Pipe Sizes 6" (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
.11 Vertical Support: Steel riser clamp.
.12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
.13 Floor Support for Hot Pipe Sizes to 4" (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
.14 Floor Support for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
.15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.3 Steam and Steam Condensate Piping:
.1 Conform to CSA B-51 and ASME B31.1.
.2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
.3 Hangers for Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.
.4 Hangers for Pipe Sizes 6" (150 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.
.5 Multiple or Trapeze Hangers for Pipe Sizes to 4" (100 mm): Steel channels with welded spacers and hanger rods.
.6 Multiple or Trapeze Hangers for Pipe Sizes 6" (150 mm) and Over: Steel channels with welded spacers and hanger rods; cast iron roll and stand.
.7 Wall Support for Pipe Sizes to 2-3/4" (70 mm): Cast iron hook.
.8 Wall Support for Pipe Sizes 4" to 5" (100 to 125 mm): Welded steel bracket and wrought steel clamp.
.9 Wall Support for Pipe Sizes 6" (150 mm) and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll.
.10 Vertical Support: Steel riser clamp.
.11 Floor Support for Pipe Sizes to 4" (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
.12 Floor Support for Pipe Sizes 6" (150 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
.13 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.2 ACCESSORIES

.1 Hanger Rods: galvanized, carbon steel continuous threaded.
.2 Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded

connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.3 EQUIPMENT ROOF CURBS

.1 Fabrication: Welded 0.05" (1.2 mm) galvanized steel shell and base, mitred 3" (75 mm) cant, variable step to match roof insulation, factory installed wood nailer.

2.4 ROOFTOP PIPE/DUCT SUPPORTS

.1 Acceptable manufacturers;
  .1 Portable Pipe Hangers, Inc.
  .2 Unistrut
.2 Pre-enginnered pipe/duct support system including;
  .1 Bases: weather resistant and UV radiation resistant with seismic attachments
  .2 Framing: 1-5/8" (41.3mm) strut or 1-7/8" (47.6mm) strut, fabricated of steel to ASTM A570, Grade 33., roll formed of 12-gauge (2.7mm thick) steel into 3-sided or tubular shape.
  .3 Pipe Supports and Hangers: Conform to MSS SP-58 and MSS SP-69, fabricated of carbon steel. Single roller supports for piping subject to expansion and contraction.
  .4 Finishes:
    .1 Plastics as moulded with UV radiation protection.
    .2 Metal surfaces hot dip galvanized free of roughness, whiskers, unsightly spangles, icicles, runs, barbs, sags, droplets and other surface blemishes. Galvanizing shall conform to ASTM A123 for tubing and to ASTM A153 for hardware and accessories.
  .5 Shop Drawings: Manufacturer to provide detailed shop drawings to indicate layout and supporting capacities of system components with installation and assembly instructions for each application. Shop drawings shall bear the signature and seal of a professional engineer licenced in Ontario.

3 EXECUTION

3.1 INSTALLATION

.1 Install to manufacturer's instructions and best trade practises.

3.2 INSERTS

.1 Provide inserts for placement in concrete formwork.
.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.3 PIPE HANGERS AND SUPPORTS

.1 Support horizontal piping as scheduled.
.2 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.
.3 Place hangers within 12" (300 mm) of each horizontal elbow.
.4 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment.
.5 Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.
.6 Support vertical piping at every other floor. Support vertical cast iron pipe at each floor at hub.
.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
.8 Support riser piping independently of connected horizontal piping.
.9 Provide copper plated hangers and supports for copper piping.
.10 Design hangers for pipe movement without disengagement of supported pipe.
.11 Prime coat exposed steel hangers and supports. Refer to Section 09 91 10. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.4 EQUIPMENT BASES AND SUPPORTS

.1 Provide housekeeping pads of concrete, minimum 4" (100 mm) thick and extending 6" (150 mm) beyond supported equipment.
.2 Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
.3 Construct supports of steel members. Steel pipe and fittings. Brace and fasten with flanges bolted to structure.
.4 Provide rigid anchors for pipes after vibration isolation components are installed.

3.5 ROOFTOP PIPE/DUCT SUPPORT

.1 Coordinate installation of supports and bases with roofing work. Ensure that roofing surfaces are smooth and flat and are ready to receive work.
.2 Use care in installation of support systems not to damage roofing, flashing, equipment or related materials.
.3 Install and secure support systems in strict accordance with manufacturer's written instruction.
.4 Consult manufacturers of roofing system to determine if walk pads are required. Provide and fully adhere walk pads to roof system where required.
.5 Bases and support framing shall be located as indicated on shop drawings provided by support system manufacturer and as specified herein. The support of all piping shall be complete and adequate, whether or not all required devices are shown.
.6 The use of wood or wire for supporting piping will not be permitted.
.7 Deflection of pipes shall not exceed 1/240th of the span.
.8 Accurately locate and align bases. Where applicable, replace gravel around bases. Set framing posts into bases and assemble framing structure as indicated.
.9 Use galvanized fasteners for galvanized framing, and use stainless steel fasteners for stainless steel framing.

3.6 FLASHING

.1 Provide flexible flashing and metal counterflashing where piping and ductwork penetrate

weather or waterproofed walls, floors, and roofs.

.2 Flash vent and soil pipes projecting 3" (75 mm) minimum above finished roof surface with lead worked 1" (25 mm) minimum into hub, 8" (200 mm) minimum clear on sides with 24" x 24" (600 x 600 mm) sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.

.3 Flash floor drains in floors with topping over finished areas with lead, 10" (250 mm) clear on sides with minimum 36" x 36" (910 x 910 mm) sheet size. Fasten flashing to drain clamp device.

.4 Seal roof, floor, shower and mop sink drains watertight to adjacent materials.

.5 Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed to manufacturer's instructions for sound control.

.6 Provide curbs for mechanical roof installations 14" (350 mm) minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

.7 Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 SLEEVES

.1 Set sleeves in position in formwork. Provide reinforcing around sleeves.

.2 Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

.3 Extend sleeves through floors 1" (25 mm) above finished floor level. Caulk sleeves.

.4 Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing insulation and caulk. air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

.5 Install chrome plated steel escutcheons at finished surfaces.

3.8 SCHEDULES

.1 Imperial Measure (IP)

Pipe Size (in)	Rod Diameter (in)	Support Spacing (Ft)	
		Steel Pipe	Copper Tube
1/2	3/8	7	6
3/4	3/8	7	6
1	3/8	7	6
1-1/4	3/8	7	6
1-1/2	3/8	9	8
2	3/8	10	9
2-1/2	3/8	12	10
3	3/8	12	10
4	5/8	14	12
6	7/8	17	

8	7/8	19	
10	7/8	21	
12	7/8	23	
14	1	25	
16	1	27	
18	1	28	

.2 Metric Measure (SI)

Pipe Size (mm)	Rod Diameter (mm)	Support Spacing (m)	
		Steel Pipe	Copper Tube
13	10	2.1	1.8
20	10	2.1	1.8
25	10	2.1	1.8
32	10	2.1	1.8
38	10	2.7	2.4
50	10	3	2.7
65	10	3.6	3
75	10	3.6	3
100	16	4.2	3.6
150	22	17	
200	22	5.7	
250	22	6.4	
300	22	7	

END OF SECTION

1 GENERAL

1.1 SYSTEM DESCRIPTION

.1 This Section includes a heat tracing system for freeze protection of aboveground water lines with Proportional Ambient Sensing Control (PASC), monitoring, integrated ground-fault circuit protection and Building Management System (BMS) communication capabilities.

.2 The freeze protection system shall have a design, installation and operating manual specific to aboveground water lines.

1.2 REFERENCES

.1 CSA C22.2 No.130-03 Requirements for Electrical Resistance Heating Cables and Heating Device Sets

1.3 SUBMITTALS

.1 Heating cable data sheet
.2 ULC, CSA, FM approval certificates for freeze protection for aboveground water lines
.3 Pipe freeze protection design guide
.4 Manufacturer's installation and operation manual
.5 Manufacturer's installation details
.6 Manufacturer's maintenance instructions.
.7 Connection kits and accessories data sheet
.8 Controller data sheet
.9 Controller wiring diagram

1.4 QUALIFICATIONS

.1 Manufacturers Qualifications
  .1 Minimum of ten (10) years experience in manufacturing electric self-regulating heating cables.
  .2 ISO-9001 registered.
  .3 Manufacturer to provide products consistent with UL 515, CSA 22.2 No 130-03 and IEEE 515.1 requirements.

.2 Installer Qualifications
  .1 System installer shall have complete understanding of product and product literature from manufacturer or authorized representative prior to installation.
  .2 Electrical connections shall be executed by a licensed electrician.

1.5 DELIVERY, STORAGE AND HANDLING

.1 General Requirements: Deliver, store and handle products to prevent their deterioration or damage due to moisture, temperature changes, contaminates or other causes.

.2 Delivery and Acceptance Requirements: Deliver products to site in original, unopened containers or packages with intact and legible manufacturers' labels identifying the following:
  .1 Product and Manufacturer
  .2 Length/Quantity
  .3 Lot Number
  .4 Installation and Operation Manual
  .5 MSDS (if applicable)
.3 Storage and Handling Requirements
  .1 Store the heating cable in a clean, dry location with a temperature range 0°F (-18°C) to 140°F (60°C).
  .2 Protect the heating cable from mechanical damage.

1.6 WARRANTY

.1 Extended Warranty
  .1 Manufacturer shall provide ten (10) year warranty for all heating cables and components. Provide one (1) year warranty for all heat trace controllers.
  .2 Contractor shall submit to owner results of installation tests required by the manufacturer.

2 PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

.1 Manufacturer shall be Tyco Thermal Controls, LLC, located at, 307 Constitution Drive, Menlo Park, CA 94025 Tel: (800) 545-6258 www.tycothermal.com
.2 Pipe Freeze Protection System
  .1 Raychem® XL-Trace® self-regulating heating cable with polyolefin (-CR) or fluoropolymer (-CT) outer jacket
  .2 Raychem RayClic® or FTC connection kits and accessories
  .3 DigiTrace® C910-485 or ACCS-30 digital controller
  .4 DigiTrace ProtoNode multi-protocol device server
.3 Furnish heat tracing system for the freeze protection of aboveground water lines from a single manufacturer to ensure a single source responsibility.
.4 The system (heating cable, connection kits, and controller) shall be ULC Listed, CSA Certified and FM Approved for freeze protection of aboveground water lines. No parts of the system may be substituted or exchanged.

2.2 SELF-REGULATING HEATING CABLE

.1 Heating cable shall be Raychem XL-Trace self-regulating heating cable manufactured by Tyco Thermal Controls.
  .1 The heating cable shall consist of a continuous core of conductive polymer that is radiation cross-linked, extruded between two (2) 16 AWG nickel-plated

copper bus wires that varies its power output in response to pipe temperature changes.

.2 The heating cable shall have a modified polyolefin inner jacket and a tinned-copper braid to provide a ground path and enhance the cables ruggedness.

.3 The heating cable shall have a polyolefin (-CR) or fluoropolymer (-CT) outer jacket

.4 The heating cable shall have a self-regulating factor of at least 90 percent for 5/8XL or at least 70 percent for 12XL. The self-regulating factor is defined as the percent reduction of the heating cable power output going from a 40°F pipe temperature to 150°F pipe temperature.

.5 The heating cable shall operate on line voltages of 120,or 208 volts without the use of transformers.

.6 The heating cable shall be part of a ULC Listed, CSA Certified and FM Approved system.

.7 The outer jacket of the heating cable shall have the following markings:

.1 Heating cable model number

.2 Agency listings

.3 Meter mark

.4 Lot/Batch ID

2.3 HEATING CABLE CONNECTION KITS

.1 Heating cable connection kits shall be Raychem RayClic or FTC connection kits.

.2 Manufacturer shall provide power connection, splice/tee and end seal kits compatible with selected heating cable.

.3 Installation shall not require the installing contractor to cut into the heating-cable core to expose the bus wires.

.4 Connection kits shall be rated NEMA 4X to prevent water ingress and corrosion. All components shall be UV stabilized.

.5 Connection kits shall be UL Listed, CSA Certified and FM Approved.

2.4 HEATING CABLE INSTALLATION ACCESSORIES

.1 High temperature, glass filament tape for attachment of heating cable to water lines. Cable ties are not permitted. (TTC Catalog Number: GT-66)

.2 Plastic Piping - provide an aluminium self-adhesive tape over the heating cable on all plastic piping if required. (TTC Catalog Number: AT-180)

.3 Labels - Provide warning labels every 10 feet on exterior of insulation, opposite sides of pipe. (TTC Catalog Number: ETL)

2.5 DIGITAL TEMPERATURE CONTROLLER

.1 Single Circuit Local Digital Controller with Built-in Ground Fault Protection Device (GFPD)

.1 Local digital controller shall be DigiTrace C910-485.

.2 Heating cable manufacturer shall provide a local digital controller with built-in GFPD compatible with selected heating cable.
.3 Digital controller shall be capable of supporting up to two (2) RTD temperature sensors per control point. Leads can be extended using 18 AWG, 3-wire, shielded cable.
.4 Enclosure type shall be NEMA 4X fiberglass reinforced plastic (FRP).
.5 Digital controller shall have an integrated adjustable GFPD (10 - 200 mA).
.6 Digital control system can be configured for line-sensing, ambient sensing and PASC modes. PASC control proportionally energizes the power to the heating cable to minimize energy based on ambient sensed conditions.
.7 Digital controller shall be capable of operating with supply voltages from 100 V to 277 V.
.8 Digital controller will have a built-in self-test feature to verify proper functionality of heating cable system.
.9 Digital controller will also be able to communicate with BMS by one of the following protocols using the DigiTrace ProtoNode multi-protocol gateway.
.1 BACnet® [
.10 Digital controller will also supply an isolated triac alarm relay and a dry contact relay for alarm annunciation back to the BMS.
.11 The following variables will be monitored by the digital controller and reported back to the BMS.
.1 Temperature
.2 Ground-fault
.3 Current draw
.4 Power consumption
.5 Associated alarms
.12 Digital controller shall have c-CSA-us approvals.

3 EXCECUTION

3.1 INSTALLATION

.1 Installers shall be familiar with installing heat-trace cable and equipment.
.2 The installer shall be responsible for providing a complete functional system, installed in accordance with applicable national and local requirements.
.3 Install heating cables in accordance with the contract documents and the manufacturer's recommendations.
.4 Apply the heating cable linearly on the pipe after piping has successfully completed any pressure tests. Secure the heating cable to piping with fiberglass tape at maximum spacing 0.5 m.
.5 On plastic piping, the heating cable shall be applied using aluminum tape (AT-180)
.6 Ensure that heating cables do not touch or cross each other at any point.
.7 Run only cold leads in conduit and ensure sensing bulb does not touch cable.
.8 Loop additional cable at fittings, valves, and flanges.
.9 Ground shield to building ground.

.10 Grounding of controller shall conform to requirements in Division 16.
.11 Make power and control connections. Connection of all electrical wiring shall conform to requirements in Division 16.
.12 Power connection, end seal, splice and tee kit components shall be applied in the field.
.13 Heating cable circuit shall be protected by a ground-fault device for equipment protection.
.14 Coordinate cable installation with insulation application.
.15 Apply "Electric Traced" labels to outside of thermal insulation.

3.2 THERMAL PIPE INSULATION

.1 Pipes must be thermally insulated in accordance with the XL-Trace design guide requirements.
.2 Thermal insulation must be a type that is flame retardant (closed-cell or fiberglass) with waterproof covering.

3.3 FIELD QUALITY CONTROL

.1 Start-up of system shall be performed by a factory technician or a qualified factory representative.
.2 Field Testing and Inspections
  .1 The system shall be commissioned in accordance the manufacturer's installation and operating instructions.
  .2 The heating cable circuit integrity shall be tested using a 2500 Vdc megohmmeter at the following intervals below. Minimum acceptable insulation resistance shall be 1000 megohms or greater.
    .1 Before installing the heating cable
    .2 After heating cable has been installed onto the pipe
    .3 After installing connection kits
    .4 After the thermal insulation is installed onto the pipe
    .5 Prior to initial start-up (commissioning)
    .6 As part of the regular system maintenance
  .3 The technician shall verify that the C910-485 or ACCS-30 [Select one] control parameters are set to the application requirements.
  .4 The technician shall verify that the C910-485 or ACCS-30 [Select one] alarm contacts are corrected connected to the BMS.
  .5 The technician shall verify that the C910-485 or ACCS-30 [Select one] and ProtoNode-RER/-LER [Select one] are configured correctly with the BMS.
  .6 All commissioning results will be recorded and presented to the owner.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

.1 Vibration control of piping, ductwork and equipment.
.2 Inertia bases.
.3 Coordination with Supports and Anchors
.4 Coordination with Seismic Restraint of Piping & Equipment

1.3 REFERENCES

.1 Ontario Building Code.
.2 SMACNA "HVAC Duct Construction Standards"

1.4 PERFORMANCE REQUIREMENTS

.1 Provide vibration isolation on motor driven equipment over 1/2 HP (0.35 kW), plus connected piping and ductwork.
.2 Provide minimum static deflection of isolators for equipment as indicated.
    .1 Basement, Under 20 HP (15 kW)
        .1 Under 400 rpm: RIS
        .2 400 - 600 rpm: 1" (25 mm)
        .3 600 - 800 rpm: 1/2" (12 mm)
        .4 800 - 900 rpm: 1/4" (5 mm)
        .5 1100 - 1500 rpm: 1/8" (4 mm)
        .6 Over 1500 rpm: 1/8" (3 mm)
    .2 Basement, Over 20 HP (15 kW)
        .1 Under 400 rpm: RIS
        .2 400 - 600 rpm: 2" (50 mm)
        .3 600 - 800 rpm: 1" (25 mm)
        .4 800 - 900 rpm: 1/2" (12 mm)
        .5 1100 - 1500 rpm: 1/4" (5 mm)
        .6 Over 1500 rpm: 1/8" (4 mm)
    .3 Upper Floors, Normal
        .1 Under 400 rpm: 1-1/2" (40 mm)
        .2 400 - 600 rpm: 3-1/2" (90 mm)
        .3 600 - 800 rpm: 2" (50 mm)
        .4 800 - 900 rpm: 1" (25 mm)
        .5 1100 - 1500 rpm: 1/2" (12 mm)
        .6 Over 1500 rpm: 1/4" (5 mm)
    .4 Upper Floors, Critical

.1 Under 400 rpm: 1-1/2" (40 mm)
.2 400 - 600 rpm: 2" (50 mm)
.3 600 - 800 rpm: 3-1/2" (90 mm)
.4 800 - 900 rpm: 2" (50 mm)
.5 1100 - 1500 rpm: 1" (25 mm)
.6 Over 1500 rpm: 1/2" (12 mm)

.5 Consider upper floor locations critical unless otherwise indicated.

.6 Use concrete inertia bases for fans having static pressure in excess of 3.4 IN. WG (0.85 kPa) or motors in excess of 40 HP (30 kW), and on base mounted pumps over 10 HP (7.5 kW).

.7 Provide seismic restraints in accordance with Ontario Building Code requirements for Post Disaster Buildings. Seismic restraints shall be designed, installed and reviewed under the direct supervision of a professional engineer licensed in the Province of Ontario.

1.5 SUBMITTALS

.1 Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.

.2 Product Data: Provide schedule of vibration isolator type with location and load on each.

.3 Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.

.4 Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Manufacturer shall be a member of VISCMA.

.2 Coordinate selection of Manufacturer with Section 15191.

.3 Acceptable manufacturers;
.1 Kinetics [Vibron]
.2 Vibroacoustics
.3 VAW Systems.
.4 Korfund
.5 Masdom

2.2 VIBRATION ISOLATORS

.1 Isolators and bases shall be as tabulated on the equipment schedule.

.2 Type 1 Isolators: Model KIP Precompressed Molded Fiberglass Noise and Vibration Isolation Pads, individually coated with a flexible moisture-impervious elastomeric membrane. Pads shall be fine (0.00027"/6.9 micron diameter) bonded annealed

glass fibers which have been stabilized during manufacture by compressing the material ten times. Pads shall have a constant natural frequency over the operating load range, and the stiffness shall increase proportionately with load applied. Pads shall be no taller than the shortest horizontal dimension. Where the equipment base does not provide a uniform load surface, steel plates shall be bonded to the top of the pads. Alternatively, Model RD Neoprene Mounts, incorporating completely enclosed metal inserts to permit bolting to the supported unit, may be used.

.3 Type 2 Floor Isolators: Model FDS Free-Standing, Unhoused, Laterally Stable Steel Springs incorporating levelling bolts and 1/4 in. (6 mm) thick ribbed noise isolation pads.To assure stability, the spring shall have a lateral spring stiffness greater than 1.0 times the rated vertical stiffness, and shall be designed to provide 50% overload capacity. In capacities up to 5,000 lbs. (2268 kg), springs shall be replaceable. In capacities over 5,000 lbs. (2268 kg), springs shall be welded to the top and bottom load plate assemblies.

.4 Type 2 Hangers: Model SFH Combination Spring and Fiberglass Hangers, incorporating pre-compressed moulded fiberglass noise and vibration isolation pads, coated with a moisture impervious elastomeric membrane in series with springs, all encased in welded steel brackets. Springs shall be as specified above. Isolators shall be designed to accommodate rod misalignment over a 30 degree arc. Brackets shall be designed to carry 500% overload without failure.

.5 Type 3 Isolators: Model FLS, Free-Standing, Laterally Stable, Spring Isolators, similar to Type FDS, but incorporating vertical limit stops to assure a constant operating height if the supported weight is removed, and to reduce movement due to wind loads. Limit stops shall be isolated from the housing to prevent short-circuiting.

.6 Type 4 Bases: No base required. Isolators may be attached directly to the supported equipment.

.7 Type 5 or 6 Bases: Model SFB or SBB Structural Steel Bases, designed and supplied by the isolator manufacturer. Bases shall be designed with isolator brackets to reduce the mounting height of the equipment. To assure adequate stiffness, the height of the members shall be a minimum of 8% of the longest span between isolators, or at least 6 inches (152 mm). Where thinner sections are necessary due to head room limitations, etc., the section modulus of the members selected shall equal or exceed the section modulus of wide flange steel members whose thickness is 8% of the longest span between isolators.

.8 Type 7 Bases: Model CIB Reinforced Concrete Inertia Bases, the steel members of which are designed and supplied by the isolator manufacturer. The concrete shall be poured into a welded steel frame, incorporating prelocated equipment anchor bolts, 1/2 in. (13 mm) diameter reinforcing bars on nominal 8 in. (203 mm) centers each way, and recessed isolator mounting brackets to reduce the mounting height of the equipment, but yet remain within the confines of the base. The thickness of the base shall be a minimum of 8% of the longest span between isolators, at least 6 inches (152 mm), or as indicated on the drawings. Where inertia bases are used to mount pumps, the bases shall be large enough to support piping elbows.

.9 Type 8 Bases: Model KSR, KSCR or ESR Isolation Rail System, consisting of two parallel

rail systems, incorporating steel spring isolators designed for the specified static deflection, all fabricated to be installed as a part of the roof curb system, and provide continuous support for the isolated equipment.

.10 Piping: All piping 1 in. (25 mm) diameter and over in the mechanical equipment room, and all piping three supports away from other mechanical equipment shall be isolated from the structure by means of vibration and noise control isolators. Suspended piping shall be isolated with Type 2 Hangers as described above. Floor-mounted piping shall be isolated with Type 2 Spring Isolators as described above.

.11 Flexible members shall be incorporated in the ductwork adjacent to all reciprocating equipment, and shall be approved construction.

.12 Flexible connections shall be incorporated in the ductwork adjacent to all air-moving units. The connections shall be neoprene or canvas of approved construction. High pressure ductwork, for a distance of 50 feet (1270 mm) from high pressure fans shall be isolated from the ductwork by means of Type 2 Hangers as described above.

3 EXECUTION

3.1 INSTALLATION

.1 Install to manufacturer's instructions.

.2 Install isolation for motor driven equipment.

.3 Bases:

- .1 Set steel bases for 1" (25 mm) clearance between housekeeping pad and base.
- .2 Set concrete inertia bases for 2" (50 mm) clearance between housekeeping pad and base.
- .3 Adjust equipment level.

.4 Install spring hangers without binding.

.5 On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

.6 Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

.7 Provide pairs of horizontal limit springs on fans with more than 1.5 kPa static pressure, and on hanger supported, horizontally mounted axial fans.

.8 Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.06" (1.5 mm) maximum clearance. Provide other snubbers with clearance between 1/8" and 1/4" (4 mm and 7 mm).

.9 Support piping connections to isolated equipment resiliently as follows:

- .1 Up to 4" (100 mm) Diameter: First three points of support.
- .2 5" to 8" (125 to 200 mm) Diameter: First four points of support.
- .3 10" (250 mm) Diameter and Over: First six points of support.

.4 Select three hangers closest to vibration source for minimum 1" (25 mm) static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1" (25 mm) static deflection or 1/2 static deflection of isolated equipment.

.10 Connect wiring to isolated equipment with flexible hanging loop.

3.2 MANUFACTURER'S FIELD SERVICES

.1 Inspect isolated equipment after installation and submit report. Include static deflections.

3.3 VIBRATION ISOLATOR SELECTIONS

.1 Based on Kinetics Selection Guide. Copied with permission.

.2 Notes to Selection Guide

.1 Provide Type 5 or 6 base if required to support equipment properly.

.2 Provide Type 5, 6 or 7 base if required to stabilize supported equipment.

.3 Isolator natural frequency to be 40% of the lowest equipment operating speed.

.4 Provide HSR thrust restraints for air-moving equipment operating at 2.1in. (501 Pa) static pressure and above..5 Provide 12 in. (305 mm) thick Type 7 inertia base for 75 HP (56 kW) and over pumps

.5 Provide Type 7 inertia base weighing a minimum of 10 times the maximum equipment unbalanced forces.

.6 Provide Type 7 inertia base large enough to provide elbow support.

.7 If RTU weight causes additional roof deflection >0.25" (6 mm), stiffen roof structure or relocate RTU so additional deflection is <=0.25" (6mm). RTUs over noise-sensitive areas may require additional acousticaltreatment too reduce airborne noise below.

.8 Extreme care must be taken for equipment located on spans of over 20ft, especially if construction is open web joints or thin, lightweight slabs. The recommended procedure is to determine the additional deflection caused by equipment in the roof. If additional roof deflection is 0.25 in. or less, the isolator should be selected for 10 times the additional roof deflection. If additional roof deflection is over 0.25 in., supplemental roof stiffening should be installed to bring the roof deflection down below 0.25 in., or the unit should be relocated to a stiffer roof position

* Reference notes do not apply.

\+ Reference note #1 does not apply.

.3 Kinetics Products Meeting Selection Guide .

.1 Type 1

Fiberglass Isolation Pad, Model KIP
Fiberglass Isolation Mount, Model AC
Elastomer Isolation Pad, Model NG
Machinery Mount, Model KLM
Vibration Isolation Mount, Model RD
Isolation Hanger, Model RH

.2 Type 2
Free-standing Steel Spring, Model FDS
Isolation Hanger, Model SH
Isolation Hanger, Model SFH
Isolation Hanger, Model SRH

.3 Type 3
Restrained Spring Isolator, Model FLS

.4 Type 4
No Base Required

.5 Type 5
Structural Rail Base, Model SBB

.6 Type 6
Integral Structural Beam Base, Model SFB

.7 Type 7
Concrete Inertia Base, Model CIB-L
Concrete Inertia Base, Model CIB-H
Concrete Inertia Base, Model CIB-SS

.8 Type 8
Roof Curb Rail, Model KSR, Model KSCR, Model ESR

Taken from Kinetics Selection Guide	EQUIPMENT ITEM	Horsepower and Other (Shaft Power, kW and Other)	RPM	GRADE SUPPORTED SLAB			UP TO 20 FT. (6 M) FLOOR SPAN			20-30 FT. (6-9 M) FLOOR SPAN			30-40 FT. (9-12 M) FL		
				BASE TYPE	ISOLATOR TYPE	MIN. DEFLECTION IN. (MM)	BASE TYPE	ISOLATOR TYPE	MIN. DEFLECTION IN. (MM)	BASE TYPE	ISOLATOR TYPE	MIN. DEFLECTION IN. (MM)	BASE TYPE	ISOLATOR TYPE	DI
AIR COMPRESSORS AND VACUUM PUMPS	Tank-Mounted	up to 10 (7.5)	All	4	2	0.75 (19)	4	2	0.75 (19)	4	2	1.75 (44)	4	2	
		15 (11) and over	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
	Base-Mounted	All	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
	Large Reciprocating	All	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
PUMPS	Close Coupled	up to 7.5 (5.6)	All	5/6*	1	0.25 (6)	7	2	0.75 (19)	7	2	0.75 (19)	7	2	
		10 (7.5) and over	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
	In Line	5 to 25 (3.7 to 19)	All	4	2	0.75 (19)	4	2	1.75 (44)	4	2	1.75 (44)	4	2	
		30 (22) and over	All	4	2	1.75 (44)	4	2	1.75 (44)	4	2	1.75 (44)	4	2	
	End Suction	up to 40 (30)	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
		50 to 125 (37 to93)	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
		150 (110) and over	All	7	2	0.75 (19)	7	2	1.75 (44)	7	2	1.75 (44)	7	2	
	Split Case	up to 40 (30)	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
		50 to 125 (37 to 93)	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
		150 (110) and over	All	7	2	0.75 (19)	7	2	1.75 (44)	7	2	1.75 (44)	7	2	
AH, AC AND H & V UNITS	All	up to 10 (7.5)	All	4	2	0.75 (19)	4	2	0.75 (19)	4	2	0.75 (19)	4	2	
		15 (11) and over, up to 4" (1 kPa) static pressure	up to 300	4	2	0.75 (19)	4	2	3.50 (89)	4	2	3.50 (89)	7+	2	
			301 to 500	4	2	0.75 (19)	4	2	2.50 (64)	4	2	2.50 (64)	4	2	
			501 and over	4	2	0.75 (19)	4	2	1.75 (44)	4	2	1.75 (44)	4	2	
		15 (11) and over, 4" (1 kPa) static pressure and over	up to 300	5/6	2	0.75 (19)	7	2	3.50 (89)	7	2	3.50 (89)	7	2	
			301 to 500	5/6	2	0.75 (19)	7	2	1.75 (44)	7	2	2.50 (64)	7	2	
			501 and over	5/6	2	0.75 (19)	7	2	1.75 (44)	7	2	1.75 (44)	7	2	
PACKAGED ROOFTOP EQUIPMENT	All	All	All	4/8	1	0.25 (6)	8	2	0.75 (19)	See note #9			See note #'		

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

.1 Engineering, design and calculations for seismic restraint
.2 Seismic restraints for equipment, piping and ductwork
.3 Coordination with Supports and Anchors
.4 Coordination with Vibration Isolation

1.3 REFERENCES

.1 Ontario Building Code
.2 National Building Code
.3 ASHRAE Standard "A Practical Guide to Seismic Restraint",
.4 SMACNA "HVAC Duct Construction Standards"
.5 Good engineering practice.

1.4 SUBMITTALS

.1 All vibration isolation and seismic restraint systems shall be by one manufacturer. Basis of this design is Vibro-Acoustics.
.2 Submit shop drawings for all devices specified herein and as indicated on the drawings. Submittals shall include dimensions, materials, attachment and anchorage requirements. Indicate compliance with each specification item herein.
.3 Provide calculations for selection of seismic restraints, certified by a qualified professional engineer licensed in the province where the project is located.
.4 Shop Drawings:
    .1 Provide detailed drawings of all seismic control measures for equipment, duct, and piping.
    .2 Provide separate shop drawings for each isolated system complete with performance and product data, indicating all calculations for loads and deflections.
    .3 Indicate inertia bases and locate vibration isolators, with static and dynamic loads on each.
    .4 Shop drawings shall include engineering calculations for all seismic restraints and attachment. A Professional Engineer registered in the province of the project shall sign, seal and date the calculations.
.5 Product Data: Provide schedule of vibration isolator type with location and load on each.
.6 Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
.7 Manufacturer's Certificate: Certify that isolators are properly installed and adjusted

to meet or exceed design requirements.

1.5 PROJECT RECORD DOCUMENTS

.1 Record actual locations of seismic restraints including attachment points.

1.6 SEISMIC DESIGN CRITERIA

.1 For post-disaster buildings;
  .1 Importance factor for wind load, IW, is 1.25
  .2 Importance factor for earthquake loads and effects, IE, is 1.5.
.2 Site classification for seismic site response is **unknown**
.3 Climatic and Seismic Data from the Ontario Building Code for specific location:

Location	**Sa(0.2)**	**Sa(1.0)**	**q (1/50)**
Hamilton	0.33	0.058	0.46

.4 Terms:
  .1 Sa(0.2): Spectral response acceleration for short periods.
  .2 Sa(1.0): Spectral response acceleration for 1-second periods.
  .3 q(1/50): The reference hourly wind velocity pressure in kPa.

1.7 SEISMIC ENGINEER

.1 Professional Engineer holding a Certificate of Authorization in the Province of Ontario with a minimum of 5 years experience in seismic design, and a minimum of $1 million Professional Liability Insurance including Errors and Omissions Insurance.
.2 At the completion of the project, the Seismic Engineer shall review the installations on site, and shall prepare a written report, with a letter signed, sealed and dated by the Seismic Engineer, certifying that the installations have been completed in accordance with their design and shop drawings.

1.8 SEISMIC CONTROL MEASURES

.1 A single Supplier shall provide seismic design, vibration isolation, and seismic restraint. Coordinate with Section 15190.
.2 Seismic restraints are to be provided for all operational and functional components of building services in accordance with current requirements of the Ontario Building Code.
.3 Cable restraint systems, rod stiffener clamps and seismic isolator capacities shall be verified by an independent test laboratory.
.4 Connection materials shall be selected by and site specific designs to be prepared by the Seismic Engineer. The Seismic Engineer may select and specify materials and anchors to be provided by the contractor where this is appropriate.
.5 Contractor shall ensure that the Seismic Engineers' requirements and specification are met.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Manufacturer shall be a member of VISCMA.
.2 Acceptable manufacturers;
  .1 Vibro Acoustics
  .2 Kinetic-Vibron
  .3 The VMC Group (Korfond-Masdom)

2.2 GENERAL

.1 All isolation and seismic restraint products supplied by common manufacturer / supplier.
.2 All isolators are to be seismic rated or to be used with a bracing or snubber system.
.3 Colour code springs for load carrying capacity.
.4 Outdoor springs and housings to be corrosion resistant.
.5 Units containing water that can be drained are to use a vertical limiting spring as F-2.

3 EXCECUTION

3.1 SEISMIC RESTRAINT

.1 Pipes and Ducts: the following pipe and duct sizes, and larger, must be restrained:
  .1 2.5" (64 mm) diameter pipe in general areas
  .2 1.25" (32 mm) diameter pipe in mechanical rooms
  .3 1" (25 mm) diameter pipe containing hazardous materials and medical piping (ie natural gas, oil, medical vacuum, etc)
  .4 6 square feet face area for duct
  .5 any trapeze with a component combined weight that exceeds the above items
.2 Pipes and ducts hung with hanger rods less than 12" (300 mm) in length do not require seismic restraint provided the following conditions are all satisfied:
  .1 All hanger rods in the "run" are attached to the structure with non-moment generating connections; and
  .2 At least 12" (300 mm) clearance on each side of the pipe or duct is provided for the entire "run" so that the pipe or duct can swing freely and will not contact anything; and
  .3 All hanger rods in a "run" of pipe or duct must be less than 12" (300 mm) in length. If one hanger rod exceeds 12" (300 mm) in a "run", this exception cannot be applied.
  .4 The 12" (300 mm) rule does not apply to suspended equipment.
.3 Base Mounted Equipment: all base mounted equipment requires attachments and seismic restraint as specified by the Seismic Engineer.
.4 Suspended Equipment: all suspended equipment requires seismic restraint.
.5 Roof mounted equipment shall be installed on a structural frame, seismic rated roof curb, or structural curb or frame mechanically connected to the structure. Items shall

not be mounted on sleepers or pads that are not mechanically attached to the structure.

.6 Roof mounted piping and ductwork is to be installed on curbs or frames mechanically connected to the building structure. Roof anchors and seismic cables or frames shall be used to resist seismic and wind loading. Wind loading forces shall be determined by the Seismic Engineer.

3.2 INSTALLATION - GENERAL

.1 Install to manufacturer's instructions and adjust mountings to level equipment.

.2 Ensure pipe, duct and electrical connections to isolated equipment do not reduce system flexibility. Ensure that pipe, conduit and duct passing through walls and floors do not transmit vibrations.

.3 Install isolation for motor driven equipment.

.4 Bases:

.1 Set steel bases for 1" (25 mm) clearance between housekeeping pad and base.

.2 Set concrete inertia bases for 2" (50 mm) clearance between housekeeping pad and base.

.3 Adjust equipment level.

.5 Install spring hangers without binding.

.6 On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

.7 Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

.8 Provide pairs of horizontal limit springs on fans with more than 1.5 kPa static pressure, and on hanger supported, horizontally mounted axial fans.

.9 Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.06" (1.5 mm) maximum clearance. Provide other snubbers with clearance between 1/8" and 1/4" (4 mm and 7 mm).

.10 Block and shim level bases so that ductwork and piping connections can be made to a rigid system at the operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

.11 Connect wiring to isolated equipment with flexible hanging loop.

3.3 INSTALLATION - EQUIPMENT

.1 Rigid Mounted Equipment:

.1 Anchor floor and wall mounted equipment to structure as per the seismic shop drawings.

.2 Suspended equipment shall be restrained using sway bracing, or struts, and hanger rods as per the seismic shop drawings.

.2 Vibration isolated equipment:
  .1 Seismic control measures shall not compromise the performance of noise control, vibration isolation or fire stopping systems.
  .2 Equipment supported by vibration-isolation hangers shall be detailed and installed with isolation hangers tight to the structure and upward limit stops located directly below the hangers.

3.4 INSTALLATION - PIPING AND DUCT SYSTEMS

.1 Provide seismic control measures with spacing and anchorage engineered for the specific project. Provide rod stiffeners where required.
.2 Maximum Restraint Spacing
  .1 Piping: transverse spacing 40 ft (12 m), longitudinal spacing 80 ft (24 m).
  .2 Duct: transverse spacing 40 ft (12 m), longitudinal spacing 80 ft (24 m).
  .3 Hazardous Material and Medical Piping: transverse spacing 20 ft (6 m), longitudinal spacing 40 ft (12 m).
.3 Support piping connections to isolated equipment resiliently as follows:
  .1 Up to 4" (100 mm) Diameter: First three points of support.
  .2 5" - 8" (125 to 200 mm) Diameter: First four points of support.
  .3 10" (250 mm) Diameter and Over: First six points of support.
  .4 Select three hangers closest to vibration source for minimum 1" (25 mm) static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1" (25 mm) static deflection or 1/2 static deflection of isolated equipment.
  .5 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 2" (50 mm).
  .6 Deflection shall be not less than that for the equipment to which the piping is connected.
.4 Seismic systems are to be compatible with requirements for anchoring and guiding of piping systems.
.5 Drilled or power driven anchors or fasteners not permitted for use with seismic control measures.
.6 Outdoor and roof mounted systems must be mechanically attached to structure. This attachment must account for seismic and wind loading.
.7 Friction due to gravity does not constitute a seismic attachment.
.8 Where equipment is mounted on concrete housekeeping pads the design of reinforcement and anchorage of the pad to the structure shall be performed by the Seismic Engineer. Alternatively, the equipment must be attached through the pad to the base structure, at the Seismic Engineer's discretion.
.9 Do not brace equipment to separate portions of the structure that may act differently in response to an earthquake. For example, do not connect a transverse brace to a wall and a longitudinal brace to a floor or roof at the same brace location.
.10 All duct over 6 square feet is to be hung with a double trapeze at restraint locations,

one angle on the top and one angle on the bottom of the duct.

.11 Unless noted otherwise on seismic shop drawings, all duct is to be screwed to the trapeze (top and bottom) with #10 screws at 12" (300 mm) spacing for every trapeze.

.12 All pipes must be attached to trapeze with pipe clamps.

.13 Where pipe or duct size reduces below required dimensions noted in Section 2.3.1, the final restraint shall be installed at the transition location.

.14 Items mounted into T-bar suspended ceiling grids require 4 wires to attach the unit to the structure. The wires and their attachment do not form part of the seismic restraint system. If the ceiling grid is seismically restrained, then the item does not require independent seismic restraint. This design in not in this scope of work, as the ceiling grid is an architectural component.

.15 Sleepers for roof mounted pipes, duct, and equipment require mechanical connection to the building. The forces imposed on this attachment are to be provided by the seismic engineer.

.16 Seismic restraint connections are not to be connected to the bottom chord of steel joists or the bottom flange of steel beams.

.17 Rod stiffeners are required where the hanger rod exceeds the maximum length as shown in the seismic calculation sheets. They are only required at restraint locations.

.18 Standard beam clamps can only be used on seismically restrained components; they cannot be used to connect the seismic restraint to the structure - only for the hanger rods.

.19 Horizontal penetrations through walls should be through a pre-fabricated metal sleeve with a compressible material between the pipe and the sleeve. Vertical penetrations through floors/roofs should use an oversize hole in the structure with compressible material between the hole and the pipe and the pipe should be supported by a clamp resting on two steel load-distributing plates.Block walls can be used for transverse restraints if the item penetrates the wall at 90 degrees and is a snug fit. If angles are attached to the item around its perimeter and attached to the wall, then the wall can act as a transverse and longitudinal restraint. Metal stud walls cannot be used for restraint unless specifically designed.

3.5 MANUFACTURER'S FIELD SERVICES

.1 Examine systems to Section 22 01 01.

.2 Inspect isolated equipment after installation and submit report. Include static deflections.

PIPE ISOLATION SCHEDULE

Pipe Size (mm)	Isolated Distance from Equipment
25	120 diameters (3.0 m)
50	90 diameters (4.5 m)

80	80 diameters (6.0 m)
100	75 diameters (7.5 m)
150	60 diameters (9.0 m)
200	60 diameters (9.0 m)
250	54 diameters (13.5 m)
300	50 diameters (15.0 m)
400	45 diameters (18.0 m)
600	38 diameters (23.0 m)
Over 600	To be determined by Seismic Engineer

END OF SECTION

1 ENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

.1 Piping insulation.
.2 Jackets and accessories.

1.3 REFERENCES

.1 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
.2 ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
.3 ASTM C195 - Mineral Fibre Thermal Insulating Cement.
.4 ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
.5 ASTM C449/C449M - Mineral Fibre Hydraulic-setting Thermal Insulating and Finishing Cement.
.6 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
.7 ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
.8 ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
.9 ASTM C547 - Mineral Fibre Pipe Insulation.
.10 ASTM C552 - Cellular Glass Thermal Insulation.
.11 ASTM C578 - Rigid, Cellular Polystyrene Thermal Insulation.
.12 ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
.13 ASTM C591 - Unfaced Preformed Cellular Polyisocyanurate Thermal Insulation.
.14 ASTM C610 - Moulded Expanded Perlite Block and Pipe Thermal Insulation.
.15 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
.16 ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
.17 ASTM D1667 - Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Foam).
.18 ASTM D2842 - Water Absorption of Rigid Cellular Plastics.
.19 ASTM E84 - Surface Burning Characteristics of Building Materials.
.20 ASTM E96 - Water Vapour Transmission of Materials.
.21 NFPA 255 - Surface Burning Characteristics of Building Materials.
.22 UL 723 - Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

.1 Product Data: Provide product description, list of materials and thickness for each service, and locations.

.2 Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

.1 Materials: Flame spread/smoke developed rating of 25/50 or less to ULC S102 and ASTM E84.

1.6 QUALIFICATIONS

.1 Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Transport, handle, store, and protect products.
.2 Deliver materials to site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
.3 Store insulation in original wrapping and protect from weather and construction traffic.
.4 Protect insulation against dirt, water, chemical, and mechanical damage.

1.8 ENVIRONMENTAL REQUIREMENTS

.1 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
.2 Maintain temperature during and after installation for minimum period of 24 hours.

2 PRODUCTS

2.1 GLASS FIBRE

.1 Manufacturers:
  .1 Manufacturer: Owens Corning Fiberglas
.2 Other acceptable manufacturers offering equivalent products:
  .1 Manson
  .2 Knauf Fiber Glass
  .3 Johns Manville
.3 Insulation: ASTM C547; rigid moulded, noncombustible.
  .1 'ksi' value : ASTM C335, 0.035 at 75°F (24°C).
  .2 Minimum Service Temperature: -20°F (-28.9°C).
  .3 Maximum Service Temperature: 302°F (150°C).
  .4 Maximum Moisture Absorption: 0.2 percent by volume.
.4 Vapour Barrier Jacket
  .1 ASTM C921, White kraft paper reinforced with glass fibre yarn and bonded to aluminized film.

.2 Moisture Vapour Transmission: ASTM E96; 0.02 perm.
.3 Secure with self sealing longitudinal laps and butt strips.
.4 Secure with outward clinch expanding staples and vapour barrier mastic.

.5 Tie Wire: 1.3 mm stainless steel with twisted ends on maximum 12" (300 mm) centres.

.6 Vapour Barrier Lap Adhesive
.1 Compatible with insulation.

.7 Insulating Cement/Mastic
.1 ASTM C195; hydraulic setting on mineral wool, VOC content not to exceed 80 g/L.

.8 Fibrous Glass Fabric
.1 Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
.2 Blanket: 1.0 lb/cu ft (16 kg/cu m) density.

.9 Indoor Vapour Barrier Finish
.1 Vinyl emulsion type acrylic, compatible with insulation, white colour, VOC content not to exceed 250 g/L.

.10 Outdoor Vapour Barrier Mastic
.1 Vinyl emulsion type acrylic, compatible with insulation, white colour.

.11 Insulating Cement
.1 ASTM C449, VOC content not to exceed 80 g/L.

2.2 JACKETS

.1 PVC Plastic
.1 Jacket: ASTM C921, One piece moulded type fitting covers and sheet material.
.1 Minimum Service Temperature: -31°F (-35°C).
.2 Maximum Service Temperature: 151°F (66°C).
.3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.
.4 Maximum Flame Spread: ASTM E84; 25 or less.
.5 Maximum Smoke Developed: ASTM E84; 50 or less.
.6 Thickness: 20 mil (0.4 mm) minimum.
.2 Colour: standard off-white
.3 Covering Adhesive Mastic
.1 Compatible with insulation, maximum VOC content of 50 g/L.
.4 Manufacturer;
.1 Ceel-Co 300 series
.2 Speedline *Smoke Safe*

.2 Aluminum Jacket: ASTM B209.
.1 Thickness: 0.02" (0.40 mm) sheet.
.2 Finish: Smooth.
.3 Joining: Longitudinal slip joints and 2" (50 mm) laps.
.4 Fittings: 0.02" (0.40 mm) thick die shaped fitting covers with factory attached protective liner.
.5 Metal Jacket Bands: 3/8" (10 mm) wide; 0.01" (0.38 mm) thick aluminum.

2.3 REMOVABLE / REUSABLE INSULATION COVERS

.1	Material:	Teflon coated, woven fibreglass fabric
.2	Weight:	16.5 oz/sq.yd. (± 10%)
.3	Thickness:	0.015" (± 10%)
.4	Colour:	Gray
.5	Tensile Strength:	400 x 330 lb. (W x F)
.6	Tarp Tear strength:	60 x 40 lb. (W x F)
.7	Mullen Burst Pressure:	650 psi
.8	Insulation thickness:	Match connecting piping
.9	Temperature Range:	-67°F to 500°F
.10	Lacing Hooks:	Stainless Steel
.11	Tie Wire:	16-ga stainless steel

2.4 ACCESSORIES

.1 Adhesives and finishes shall be as recommended by the insulation manufacturer and shall comply with Section 15100.2.2. Accessories such as adhesives, mastics and cements shall have the same properties as listed above and shall not detract from any of the system ratings specified.

.2 Vapor retarder lap adhesive shall be water based, fire retardant

.3 Tapes shall be of cloth reinforced aluminum, soft adhesive with minimum 2" (50 mm) width.

.4 Tie wire shall be of 1/16" (1.5 mm) ø stainless steel.

.5 Fasteners shall be of 1/8" (4 mm) Ø pins, with 35 mm square clips. Clip length to suit insulation thickness.

.6 Bands shall be 1/2" (12 mm) wide 1/4" (6mm) thick galvanized steel.

.7 Facing shall be of 1" (25 mm) galvanized steel hexagonal wire mesh attached on both faces of insulation.

3 EXECUTION

3.1 EXAMINATION

.1 Verify that piping has been tested before applying insulation materials.

.2 Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

.1 Install piping insulations to TIAC National Installation Standards.

.2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturer' written instructions and as specified.

.3 On exposed piping locate insulation and cover seams in least visible locations.

.4 Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:

.1 Provide vapour barrier jackets, factory applied or field applied.

.2 Insulate fittings, joints, and valves with moulded insulation of like material and thickness as adjacent pipe.
.3 Finish with glass cloth and vapour barrier adhesive.
.4 PVC fitting covers may be used.
.5 Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
.6 Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

.5 For insulated pipes conveying fluids above ambient temperature:
.1 Provide standard jackets, with or without vapour barrier, factory applied or field applied.
.2 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
.3 Finish with glass cloth and adhesive.
.4 PVC fitting covers may be used.
.5 For hot piping conveying fluids 140°F (60°C) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
.6 For hot piping conveying fluids over 140°F (60°C), insulate flanges and unions at equipment.

.6 Inserts and Shields:
.1 Application: Piping 1-1/2" (40 mm) diameter or larger.
.2 Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
.3 Insert Location: Between support shield and piping and under the finish jacket.
.4 Insert Configuration: Minimum 6" (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
.5 Insert Material: hydrous calcium silicate insulation.

.7 Finish insulation at supports, protrusions, and interruptions.

.8 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapour barrier cement.

.9 Provide integral vapour barrier jacket on insulation on pipe and fittings for exterior applications.

.10 Provide PVC jacket and fitting covers for pipe in mechanical equipment rooms and where exposed in finished spaces.

.11 Provide aluminum jacket and fitting covers with seams located on bottom side of horizontal piping for exterior applications, in boiler rooms and where subject to temperatures > 200°F (93°C).

.12 For buried piping, provide factory fabricated assembly with inner all-purpose service jacket with self sealing lap, and asphalt impregnated open mesh glass fabric, with one mil (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

.13 For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe

and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.3 PIPE INSULATION

.1 Insulate new or altered piping with rigid pipe insulation and re-insulate existing piping where insulation has been removed or damaged as follows:

RIGID PIPE INSULATION			
Service	**Operating Temperature Range °F**	**Pipe Diameter in.**	**Insulation Thickness in.**
Chilled water	40 to 55	All sizes	1-1/2
	< 40	1 and smaller	1-1/2
		1-1/4 and larger	1-1/2
Cold water make-up (outside building)	0 to 850	All sizes	2
Condensate (cold)	0 to 850	All sizes	1/2
Domestic cold water	0 to 850	All sizes	1
Domestic hot water & hot water recirculation	105 to higher	2 and smaller	1
		2-1/2 and larger	1-1/2
High Pressure Steam and Condensate	251 to 350	1 and smaller	2
		1-1/4 to 4	2-1/2
		5 and larger	3
	>350	2 and smaller	2-1/2
		2-1/2 to 4	3
		5 and larger	3-1/2
Hydronic heating (hot water & glycol/water)	105 to 140	4 and smaller	1
		5 and larger	1-1/2
	141 to 200	All sizes	1-1/2
Low Pressure Steam and Condensate	141 to 200	All sizes	1-1/2
	201 to 250	2 and smaller	1-1/2
		2-1/2 to 6	2

		8 and larger	3-1/2
Sanitary drainage	40 to 55	All sizes	1
Steam humidifier	201 to 250	2 and smaller	1-1/2
		2-1/2 to 6	2
Storm drainage	40 to 55	All sizes	1
FLEXIBLE INSULATION			
Service			**Insulation Thickness**
Horizontal storm and sanitary drainage			1"
Radiant ceiling panels			2"

RIGID PIPE INSULATION (SI)			
Service	**Operating Temperature Range °C**	**Pipe Diameter (mm)**	**Insulation Thickness (mm)**
Chilled water	4 to 13	All sizes	40
	< 4.4	25 and smaller	40
		38 and larger	40
Cold water make-up (outside building)	-18 to 454	All sizes	50
Condensate (cold)	-18 to 454	All sizes	13
Domestic cold water	-18 to 454	All sizes	25
Domestic hot water & hot water recirculation	41 and higher	50 and smaller	25
		65 and larger	40
High Pressure Steam and Condensate	122 to 177	25 and smaller	50
		32 to 100	65
		125 and larger	75
	>177	50 and smaller	65
		65 to 100	75
		125 and larger	90
Hydronic heating	41 to 60	100 and smaller	25

(hot water & glycol/water)		125 and larger	40
	61 to 93	All sizes	40
Low Pressure Steam and Condensate	61 to 93	All sizes	40
	94 to 121	50 and smaller	40
		65 to 150	50
		200 and larger	90
Sanitary drainage	4 to 13	All sizes	25
Steam humidifier	94 to 121	50 and smaller	40
		65 to 150	50
Storm drainage	4 to 13	All sizes	25

FLEXIBLE INSULATION	
Service	**Insulation Thickness**
Horizontal storm and sanitary drainage	25mm
Radiant ceiling panels	50mm

.2 Insulate valves, flanges and pipe connections with removable / reusable insulation covers.

.3 Wrap butt joints with a 4" (100 mm) strip of fire resistant vapour barrier jacket cemented with lagging adhesive.

.4 Where the pipe hanger is around the insulation, provide an insulation protection shield within the pipe saddle. Coordinate with installation of hangers.

.5 Insulate all fittings, flanges and valves on pipes to provide equivalent insulation to that on adjoining pipe.

.6 Continue insulation through sleeves including specified finish.

.7 Cut back covering on strainers and finish off to expose removable head insulation.

.8 Cover expansion joints first with 24 gauge (0.7 mm) galvanized metal sleeve and then insulate to provide equivalent thickness to that on adjoining pipe.

.9 Protect insulation with protection saddles where insulated pipe is supported by rollers.

.10 Insulate pipe hangers supporting new piping carrying water at 70°F (21°C) or less to prevent condensation. Extend insulating material along hanger rod to height 4 times thickness of insulation. Seal insulation with vapour-proof sealant.

.11 Extend pipe insulation and covering through walls, floors, ceilings, and concrete beams, unless indicated otherwise on drawings. protect exposed insulation extending through floors with 4" (100 mm) wide strip of 18 gauge (1.3 mm) galvanized iron.

.12 Pack annular space between pipe sleeves and piping or pipe covering with glass fibre insulation or rockwool insulation. In fire rated assemblies use Dow Silicon RTV or

other ULC listed materials. Seal exposed insulation with mastic.

.13 Recover exposed surfaces of insulated piping installed in exposed areas, mechanical rooms, and equipment rooms with PVC jacketing and PVC fitting covers installed in accordance with manufacturers instructions.

.14 Provide aluminum metal cladding over the insulation on the following services;

.1 All exposed piping located outdoors.

.15 Insulate sprinkler and standpipe main 6 feet (1800 mm) from take-off from domestic water.

.16 Oversize insulation of Domestic hot water piping complete with heating cable for pipe sizes 1-1/4" (35 mm) dia. and smaller by 1/4" (6 mm) in inside diameter to allow for installation over heating cable.

3.4 HIGH TEMPERATURE PIPE INSULATION

.1 Applications: cut or mitre insulation where necessary to fit the shape and contour of the vessel. Impale insulation over welded pins on 12" (300 mm) centres. (When 2 layers are used the joints shall be stagger.) Apply Expanded Metal Lath using speed washers to hold insulation and mesh in place. Lace Metal Edges that butt together with 16 ga. (1.7 mm) galvanized annealed wire.

.2 Emergency Generator Exhaust

.1 Insulate the exhaust stack system including silencer (muffler) with 3" (75 mm) of high temperature pipe insulation.

.2 Tightly butt and stagger all joints. Secure blocks with galvanized steel bands. Provide welded studs, clips or angles as required to anchor wire and bands. Secure a 1" (25 mm) hexagonal wire mesh over the insulation.

.3 In exposed areas, cover insulation with 2 coats of Manson No. 375 finishing cement applied in 1/4" (7 mm) layers and trowel to a smooth hard finish.

.4 Cover with:

.1 6 oz./sq.yd. (200 g/m2) canvas neatly pasted in place.

.2 Aluminum jacketing installed to manufacturers instructions.

.5 Insulation shall be extended up through roof sleeve.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

.1 Roof and floor drains.
.2 Cleanouts.
.3 Thermostatic mixing valves.
.4 Trap Seal Primers.

1.3 REFERENCES

.1 ASME A112.21.1 - Floor Drains.
.2 ASME A112.21.2 - Roof Drains.
.3 ASME A112.26.1 - Water Hammer Arrestors.
.4 ASSE 1011 - Hose Connection Vacuum Breakers.
.5 PDI WH-201 - Water Hammer Arrestors.

1.4 SUBMITTALS FOR REVIEW

.1 Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
.2 Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

1.5 SUBMITTALS FOR INFORMATION

.1 Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

.1 Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors
.2 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.7 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND PROTECTION

.1 Accept specialties on site in original factory packaging. Inspect for damage.

2 PRODUCTS

2.1 GENERAL

.1 Manufacturer: Watts Drainage model indicated or equivalent by;
- .1 Zurn
- .2 Jay R. Smith
- .3 Precision Plumbing Products.

2.2 ROOF DRAINS

.1 Built - Up Roofs
- .1 Manufacturer: Watts Drainage Model RD100-BED-W-1.
- .2 Assembly: ANSI A112.21.2.
- .3 Body: Lacquered cast iron with sump.
- .4 Strainer: Removable polyethylene dome with vandal proof screws.
- .5 Accessories: Coordinate with roofing type, refer to Division 7:
  - .1 Membrane flange and membrane clamp with integral gravel stop.
  - .2 Adjustable under deck clamp.
  - .3 Roof sump receiver.
  - .4 Adjustable extension sleeve for roof insulation

.2 Landscaped Roofs
- .1 Manufacturer: Watts Drainage Model RD200-GSS-BED
- .2 Assembly: ANSI A112.21.2.
- .3 Body: Lacquered cast iron with sump.
- .4 Strainer: Removable polyethylene dome with vandal proof screws.
- .5 Accessories: Coordinate with roofing type, refer to Division 7.
  - .1 Membrane flange and membrane clamp with integral gravel stop.
  - .2 Adjustable under deck clamp.
  - .3 Roof sump receiver.
  - .4 Adjustable extension sleeve for roof insulation.
  - .5 Perforated stainless steel ballast guard extension.

2.3 FLOOR DRAINS

.1 Floor Drain (FD):
- .1 Watts Drainage model FD-100-C-5
- .2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable round nickel-bronze strainer with removable perforated sediment bucket.

.2 Floor Drain (FFD):
- .1 Watts Drainage Model FD-100-C-EG
- .2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-

bronze strainer with polished bronze eleongated funnel.

.3 Floor Drain (HD):
  .1 Watts Drainage Model FD-100-C-AS-7-8
  .2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, adjustable nickel-bronze angle strainer, trap primer tapping, and backwater valve.

2.4 TRAP SEAL PRIMERS

.1 Individual Traps:
  .1 Watts Drainage model MS-810
  .2 Automatic cast brass body, renewable disc and seat rings, vacuum breaker and removable cover.
.2 Groups of Traps:
  .1 PPP Inc. Oregon #1 complete with suply tube and/or distribution units. Primer suitable for up to 8 drains.

2.5 CLEANOUTS

.1 Exterior Surfaced Areas:
  .1 Watts Drainage model CO-200-RFC
  .2 Round cast nickel bronze access frame and non-skid cover.
.2 Exterior Unsurfaced Areas:
  .1 Watts Drainage model CO-300-MF
  .2 Extra Heavy Duty type with epoxy coated cast iron body with two fixed anchor flanges and round heavy duty ductile iron gasketed cover.
.3 Interior Finished Floor Areas:
  .1 Watts Drainage model CO-200-R, CO-200-U
  .2 Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.
.4 Interior Finished Wall Areas:
  .1 Watts Drainage model WUCO
  .2 Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.
.5 Interior Unfinished Accessible Areas: Caulked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.
.6 Line Cleanouts: lacquered cast iron Malcom type with cleanout ferrule, 1/2" (13mm) thick epoxy coated gasketted cover.
.7 Caulking for cleanouts: VOC content not to exceed 250g/L.

3 EXECUTION

3.1 GENERAL

.1 Install all products in accordance with the plumbing code and with manufacturer's instructions.

3.2 CLEANOUTS

.1 Cleanouts shall be the same size as the pipe up to 4" (100mm) and not less than 4" (100mm) for larger pipes.
.2 Provide cleanouts at the end of mains and branches, at changes in direction, in long straight runs and at the base of all soil stacks and rainwater leaders and where required by code.
.3 Extend cleanouts to finished floor or wall surface.
.4 Encase exterior cleanouts in concrete flush with grade.
.5 Install floor cleanouts at elevation to accommodate finished floor.
.6 Cleanouts in floors with surface membranes shall be installed with a membrane clamp and anchoring flange.
.7 Lubricate threaded cleanout plugs with mixture of graphite and linseed oil.
.8 Ensure clearance at cleanout for rodding of drainage system.

3.3 FLOOR DRAINS

.1 Provide floor drains where indicated on architectural and plumbing floor plans.
.2 Inspect locations where floor drains are shown to determine that floor is sloped appropriately. Report concerns to Consultant prior to installation of drains.
.3 Coordinate installation with general trades.
.4 Trap and vent all floor drains in accordance with Plumbing Code.
.5 Provide trap seal priming for each floor drain trap.
.6 Floor drains in floors with surface membranes shall be installed with a membrane clamp and anchoring flange.
.7 Floor drains, traps and drain pipes installed in slabs on grade shall be embedded in concrete and made water-tight to prevent water seepage.

3.4 ROOF DRAINS

.1 Locate roof drains where indicated on roofing plans.
.2 Inspect locations where roof drains are shown to determine that roof is sloped appropriately. Report concerns to Consultant prior to installation of drains.
.3 Coordinate installation with roofing trade.

3.5 TRAP SEAL PRIMERS

.1 Traps may be primed from the flush tube of a flush valve or from the waste of a drinking fountain.
.2 No more than three (3) traps may be primed from one flush valve or one drinking fountain.
.3 Condensate drains from cooling units may not be used to prime traps.
.4 Trap seal primers shall be provided where flush valves and/or drinking fountains are

not available.

.5 Group trap primers shall be provided where specifically shown and where agreed with the Consultant.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

.1 Pipe, pipe fittings, valves, and connections for piping systems.
  .1 Sanitary Sewer
  .2 Sanitary Vent
  .3 Domestic (Potable) Water.
  .4 Non-Potable Water
.2 Disinfection of potable water distribution system.
.3 Testing and reporting results.

1.3 REFERENCES

.1 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
.2 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
.3 ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
.4 ASME B16.26 - Copper Alloy Bronze Fittings for Flared Copper Tubes.
.5 ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
.6 ASME B16.32 - Cast Copper Alloy Solder Joint Fittings for Sovent Drainage Systems.
.7 ASTM A74 - Cast Iron Soil Pipe and Fittings.
.8 ASTM B32 - Solder Metal.
.9 ASTM B42 - Seamless Copper Pipe, Standard Sizes.
.10 ASTM B68 - Seamless Copper Tube, Bright Annealed.
.11 ASTM B75 - Seamless Copper Tube.
.12 ASTM B88 - Seamless Copper Water Tube.
.13 ASTM B251 - General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
.14 ASTM B302 - Threadless Copper Pipe, Standard Sizes.
.15 ASTM B306 - Copper Drainage Tube (DWV).
.16 ASTM C1053 - Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications.
.17 ASTM D2235 - Solvent Cement for Acrylonitrile - Butadiene - Styrene (ABS) Plastic Pipe and Fittings.
.18 ASTM D2239 - Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
.19 ASTM D2241 - Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
.20 ASTM D2447 - Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
.21 ASTM D2466 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

.22 ASTM D2564 - Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
.23 ASTM D2661 - Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
.24 ASTM D2665 - Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
.25 ASTM D2729 - Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
.26 ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer, Pipe, and Fittings.
.27 ASTM D2846 - Chlorinated Polyvinyl Chloride (CPVC) Pipe, Fittings, Solvent Cements and Adhesives for Potable Hot Water Systems.
.28 ASTM D2855 - Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
.29 ASTM D3034 - Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
.30 ASTM E814 - Fire Tests of Through-Penetration Fire Stops.
.31 ASTM F679 - Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
.32 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
.33 AWWA C110 - Ductile - Iron and Gray - Iron Fittings, 3" - 48" (76 mm - 1219 mm), for Water.
.34 AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
.35 AWWA C651 - Disinfecting Water Mains.
.36 AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe (and Fabricated Fittings), 4" - 12" (100 mm - 300 mm), for Water Distribution.
.37 AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2" - 3" (13 mm - 76 mm) for Water Service.
.38 AWWA C902 - Polybutylene (PB) Pressure Pipe and Tubing, 1/2" - 3" (13 mm - 76 mm) for Water.
.39 AWWA C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14" - 48" (350 mm - 1200mm).
.40 CSA B181.2 – PVC Drain, Waste and Vent Pipe and Pipe Fittings
.41 CSA B602:20 – Mechanical Couplings for drains, waste and Vent Pipe and Sewer Pipe
.42 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
.43 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
.44 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.4 SUBMITTALS FOR REVIEW

.1 Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

.1 Project Record Documents: Record actual locations of valves.

1.6 QUALITY ASSURANCE

.1 Perform Work to Province of Ontario standards. Maintain one copy on site.
.2 Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.7 REGULATORY REQUIREMENTS

.1 Perform Work to Province of Ontario plumbing code.
.2 Conform to applicable code for installation of backflow prevention devices.
.3 Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

1.8 DELIVERY, STORAGE, AND PROTECTION

.1 Accept valves on site in shipping containers with labelling in place. Inspect for damage.
.2 Provide temporary protective coating on cast iron and steel valves.
.3 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
.4 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 ENVIRONMENTAL REQUIREMENTS

.1 Do not install underground piping when bedding is wet or frozen.

1.10 EXTRA MATERIALS

.1 Provide two repacking kits for each size valve.

2 PRODUCTS

2.1 SANITARY SEWER PIPING, BURIED WITHIN 1500 mm (5 FEET) OF BUILDING

.1 IPEX System XFR:
  .1 Pipe and fittings shall be certified to CSA B181.2. When combustible pipe and fittings are used in buildings required to be of non-combustible construction, they shall be listed under ULC standard CAN/ULC-S102.2 and clearly marked with the certification logo indicating a Flame Spread Rating not exceeding 25 and a Smoke Developed Classification not exceeding 50

2.2 SANITARY SEWER PIPING, ABOVE GRADE

.1 IPEX System XFR:
  .1 Pipe and fittings shall be certified to CSA B181.2. When combustible pipe and fittings are used in buildings required to be of non-combustible construction, they shall be listed under ULC standard CAN/ULC-S102.2 and clearly marked with the certification logo indicating a Flame Spread Rating not exceeding 25

and a Smoke Developed Classification not exceeding 50

2.3 WATER PIPING, BURIED WITHIN 1500 mm (5 FEET) OF BUILDING

.1 Copper Tubing: ASTM B42, hard drawn.
  .1 Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
  .2 Joints: AWS A5.8, BCuP silver braze.
.2 Copper Tubing: ASTM B42, annealed.
  .1 Fittings: ASME B16.26, cast bronze.
  .2 Joints: Flared.

2.4 WATER PIPING, ABOVE GRADE

.1 Copper Tubing: ASTM B88M, Type L, hard drawn.
  .1 Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
  .2 Joints: ASTM B32, solder, Grade 95TA.
.2 Copper Tubing: ASTM B88M, Type L, hard drawn.

2.5 STORM WATER PIPING, BURIED WITHIN 1500 mm (5 FEET) OF BUILDING

.1 XRF PVC Pipe: CSA B181.2
  .1 Fittings: XRF PVC. B602:20

2.6 STORM WATER PIPING, ABOVE GRADE

.1 XRF PVC Pipe: CSA B181.2
  .1 Fittings: XRF PVC. B602:20

2.7 FLANGES, UNIONS, AND COUPLINGS NEEDS TO BE FIXED

.1 Pipe Size 3-1/4" (80 mm) and Under:
  .1 Ferrous pipe: Class 150 malleable iron threaded unions.
  .2 Copper tube and pipe: Class 150 bronze unions with soldered joints.
.2 Pipe Size Over 1" (25 mm):
  .1 Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
  .2 Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
.3 Grooved and Shouldered Pipe End Couplings:
  .1 Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.
  .2 Sealing gasket: "C" shape composition sealing gasket.
.4 Dielectric Connections: Union with galvanized or plated steel threaded end, copper

solder end, water impervious isolation barrier.

2.8 PIPE HANGERS AND SUPPORTS

.1 Plumbing Piping - Drain, Waste, and Vent:
- .1 Conform to ASME B31.9.
- .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (15 to 40 mm): Malleable iron, adjustable swivel, split ring.
- .3 Hangers for Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
- .4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- .5 Wall Support for Pipe Sizes to 3-1/4" (80 mm): Cast iron hook.
- .6 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
- .7 Vertical Support: Steel riser clamp.
- .8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- .9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.2 Plumbing Piping - Water:
- .1 Conform to ASME B31.9.
- .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (15 to 40 mm): Malleable iron, adjustable swivel, split ring.
- .3 Hangers for Cold Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
- .4 Hangers for Hot Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.
- .5 Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable steel yoke, cast iron pipe roll, double hanger.
- .6 Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
- .7 Multiple or Trapeze Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.
- .8 Wall Support for Pipe Sizes to 3-1/4" (80 mm): Cast iron hook.
- .9 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
- .10 Wall Support for Hot Pipe Sizes 6" (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe roll.
- .11 Vertical Support: Steel riser clamp.
- .12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- .13 Floor Support for Hot Pipe Sizes to 4" (100 mm): Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
- .14 Floor Support for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable cast iron pipe roll and stand, steel screws, and concrete pier or steel support.

.15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.9 VALVES - GENERAL

.1 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
.2 Provide valves of the same manufacturer where possible.
.3 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
.4 Valid CRN (Canadian Registration Number) issued by Provine of Ontario required for each valve.
.5 Materials:
  .1 Bronze: ASTM B62 or B61 as applicable
  .2 Brass: ASTM B283 C3770
  .3 Cast Iron: ASTM A126 Class B
.6 End Connections:
  .1 Flanged ends: ANSI B16.1 (Class 125), ANSI B16.5
  .2 Face-to-face dimensions: ANSI B16.10
.7 Design and Testing:
  .1 Bronze Gate & Check valves: MSS-SP-80
  .2 Ball Valves: MSS-SP-110
  .3 Cast Iron Gate Valces: MSS-SP-70
  .4 Cast Iron Globe Valves: MSS-SP-85
  .5 Cast Iron Check: MSS-SP-71
  .6 Butterfly Valves: MSS-SP-67
.8 First named product as indicated in paragraphs below; other acceptable manufacturers, subject to equivalent products listed on spread sheet attached.

2.10 ISOLATION VALVES

.1 Up To and including 2" (50mm) - Ball type
  .1 Manufacturer: Kitz #69AMLL
  .2 Construction: MSS SP-110, Class 150, 600 psi (4140 kPa) CWP, forged brass, two piece body, stainless steel ball and stem, full port, virgin PTFE seats and stem packing, blow-out proof stem, lever handle with balancing stops, stem extensions for insulated piping, solder ends.
.2 2-1/2" (65 mm) and Larger - Butterfly type:
  .1 Manufacturer: Kitz 6122EL
  .2 Construction: MSS-SP-67, MSS-SP-25 and API-609; lug type having bi-directional "Dead End Service" pressure rating of 1380 kPa (200 psi) with the downstream flange removed; stainless steel stem with top and bottom bushings of dissimilar materials and with positive stem retention mechanism, aluminum bronze disc and molded or bonded style EPDM seat; suitable for both chilled water and hot water operation; supplied with 10 position locking lever handle 2" extended neck to allow for insulation. Provide gear operators for valves 150 mm and larger, and chain-wheel operators for valves mounted over 8-Ft (2400 mm) above floor.

2.11 THROTTLING VALVES

.1 Up To and including 2" (50 mm) - Globe type:
  .1 Manufacturer: Kitz 10.
  .2 Construction: MSS SP-80, 860 kPa (125psig) 200 WOG, bronze body to ASTM B62, rising stem, union bonnet, inside screw, PTFE disk, solder ends.

.2 2-1/2" (65 mm) and Larger - Globe type: (NOT READY)
  .1 Manufacturer: Kitz 76 (Globe)
  .2 Construction: Cast iron body globe

.3 2-1/2" (65 mm) and Larger - Butterfly type
  .1 Manufacturer: Kitz 6122EL
  .2 Construction: MSS-SP-67, MSS-SP-25 and API-609; lug type having bi-directional "Dead End Service" pressure rating of 1380 kPa (200 psi) with the downstream flange removed; stainless steel stem with top and bottom bushings of dissimilar materials and with positive stem retention mechanism, aluminum bronze disc and molded or bonded style EPDM seat; suitable for both chilled water and hot water operation; supplied with 10 position locking lever handle 2" extended neck to allow for insulation. Provide gear operators for valves 150 mm and larger, and chain-wheel operators for valves mounted over 8-Ft (2400 mm) above floor.

2.12 CHECK VALVES

.1 Up To and Including 3" (75 mm):
  .1 Manufacturers: Kitz 23
  .2 Construction: MSS SP-80, 860 kPa (125psig) 200 WOG, bronze body to ASTM B62, bronze trim, solder ends

.2 4" (100mm) and Larger:
  .1 Manufacturers: Kitz 78
  .2 Construction: MSS SP-71, 1380 kPa Class 125 / 200 WOG, Cast iron body to ASTM A126 Class B, Bronze trim, Bolted Bonnet, flanged ends.

2.13 DRAIN VALVES

.1 Up to 150 psig - Ball type:
  .1 Manufacturers: Kitz 68C
  .2 Construction: 150 psig (1034 kPa), 600 WOG, brass body to ASTM C37700, two piece body, full port, PTFE seats and stem packing or double "O" ring, blow-out proof stem, Chrome Plated ball, lever handle with cap and chain, (3/4") 20 mm hose connection.

2.14 WATER PRESSURE REDUCING VALVES

.1 Up to 2" (50 mm):
  .1 Manufacturers:

.1 Armstrong Model GD 24.
.2 Watts Model Series 223.

.2 MSS SP-80, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded ends.

.2 Over 2" (50 mm):
.1 Manufacturers:
.1 Armstrong Model GD 200.200H.
.2 Watts Model Series N223.

.2 MSS SP-85, cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged.

2.15 RELIEF VALVES

.1 Pressure Relief:
.1 Manufacturers:
.1 Watts Model Series 40.

.2 AGA Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.

2.16 STRAINERS

.1 Up to 125 psig:
.1 Size 2" (50 mm) and Under:
.1 Manufacturers: Mueller Steam 351M
.2 Construction : 860 kPa (125 psig) 200 WOG Rating, Bronze body, Screwed Cap, Y Pattern, 304 stainless steel screen with 20 Mesh perforation, Threaded Ends.

.2 Size 2-1/2" (65 mm) and larger:
.1 Manufacturers: Mueller Steam 758
.2 Construction : 860 kPa (125 psig)/ 200 WOG Rating, Cast Iron body, Bolted Cover, Y Pattern, 304 stainless steel screen with 1/16 & 1/8 perforation, Threaded Ends.

.2 Up to 250 psig:
.1 Size 2" (50 mm) and Under:
.1 Manufacturers: Mueller Steam 11M
.2 Construction : Class 250, 400 psig WOG, cast iron body, Y-pattern, screwed cap and ends, A167 304 stainless steel screen with 1/32" perforations.

.2 Size 2-1/2" (65 mm) and larger:
.1 Manufacturers: Mueller Steam 758
.2 Construction : 300 psig non-shock WOG, cast iron, Y-pattern, bolted cover, blow-out plug, A167 304 stainless steel screen with 1/32" perforations, flanged ends.

2.17 DISINFECTION CHEMICALS

.1 Chemicals: AWWA B300, Hypochlorite,

3 EXECUTION

3.1 EXAMINATION

.1 Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

.1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
.2 Remove scale and dirt, on inside and outside, before assembly.
.3 Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

.1 Install to manufacturer's instructions.
.2 Provide non-conducting dielectric connections wherever jointing dissimilar metals.
.3 Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
.4 Install piping to maintain headroom, conserve space, and not interfere with use of space.
.5 Group piping whenever practical at common elevations.
.6 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
.7 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
.8 Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with general trades.
.9 Establish elevations of buried piping outside the building to ensure not less than 5'6" (1.6 m) of cover.
.10 Install vent piping penetrating roofed areas to maintain integrity of roof assembly; coordinate with Division 07.
.11 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer (maximum VOC content of 80 g/L) to welding.
.12 Provide support for utility meters to requirements of utility companies.
.13 Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting where required. Coordinate with general trades.
.14 Excavate and backfill as required for work of this Section.
.15 Install bell and spigot pipe with bell end upstream.
.16 Install valves with stems upright or horizontal, not inverted.
.17 Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
.18 Sleeve pipes passing through partitions, walls and floors.

.19 Inserts:
- .1 Provide inserts for placement in concrete formwork.
- .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
- .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

.20 Pipe Hangers and Supports:
- .1 Install to OBC (Plumbing Code)
- .2 Support horizontal piping as scheduled.
- .3 Install hangers to provide minimum 1/2" (15 mm) space between finished covering and adjacent work.
- .4 Place hangers within 12" (300 mm) of each horizontal elbow.
- .5 Use hangers with 1-1/2" (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- .6 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
- .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- .8 Provide copper plated hangers and supports for copper piping.
- .9 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- .10 Provide hangers adjacent to motor driven equipment with vibration isolation.
- .11 Support cast iron drainage piping at every joint.

3.4 ISINFECTION OF DOMESTIC WATER PIPING SYSTEM

.1 Disinfect all new and altered water distribution piping.

.2 Verify that piping system is complete and has been flushed, cleaned, inspected, and pressure tested.

.3 Isolate existing piping to full extent possible. Ensure that all fixtures, exiting and new that are served from piping being disinfected, are taken out of service and signs are placed at each fixture prohibiting use during the disinfection period.

.4 Schedule and perform disinfecting activities with start-up, testing, adjusting, balancing, and demonstration procedures.Coordinate with related systems.

.5 Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

.6 Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

.7 Bleed water from outlets to ensure distribution and test for disinfectant residual at

minimum 15 percent of outlets.

.8 Maintain disinfectant in system for 24 hours.

.9 If final disinfectant residual tests less than 25 mg/L, repeat treatment.

.10 Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

.11 Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze to AWWA C651.

3.5 SERVICE CONNECTIONS

.1 Provide new sanitary sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

.2 Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves pressure reducing valve.

.3 Provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 1.75 kPa. Provide regulators on each line serving gravity type appliances, sized to equipment.

3.6 SCHEDULES

.1 Pipe Hanger Schedule:

- .1 Metal Piping:
  - .1 Pipe size: 1/2" to 1-1/4" (15 to 32 mm):
    - .1 Maximum hanger spacing: 6.5' (2 m).
    - .2 Hanger rod diameter: 3/8" (9 mm).
  - .2 Pipe size: 1-1/2" to 2" (40 to 50 mm):
    - .1 Maximum hanger spacing: 10' (3 m).
    - .2 Hanger rod diameter: 3/8" (9 mm).
  - .3 Pipe size: 2-1/2" to 3" (65 to 75 mm):
    - .1 Maximum hanger spacing: 10' (3 m).
    - .2 Hanger rod diameter: 1/2" (13 mm).
  - .4 Pipe size: 4" to 6" (100 to 150 mm):
    - .1 Maximum hanger spacing: 10' (3 m).
    - .2 Hanger rod diameter: 1/2" (15 mm).
  - .5 Pipe size: 8" to 12" (200 to 300 mm):
    - .1 Maximum hanger spacing: 14' (4.25 m).
    - .2 Hanger rod diameter: 3/4" (22 mm).
  - .6 Pipe size: 14" (350 mm) and Over:
    - .1 Maximum hanger spacing: 20' (6 m).
    - .2 Hanger rod diameter: 1" (25 mm).

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 22 01 01.

1.2 SECTION INCLUDES

.1 Medical oxygen system.
.2 Medical vacuum system.
.3 Valves and zone valve boxes.
.4 Master and Area Alarm panels
.5 Medical Gas terminal units.
.6 High & Low pressure and vacuum switches.
.7 Ceiling Service Column.
.8 Patient Service Modules (PSM)

1.3 REFERENCE STANDARDS

.1 ANSI B40.1 - Gauges, Pressure and Vacuum, Indicating Dial Type-Elastic Element.
.2 ASME Boiler and Pressure Vessel Code.
.3 ASTM A167 - Stainless and Heat-Resisting Chromium - Nickel Steel Plate.
.4 ASTM A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
.5 ASTM A403/A403M - Wrought Austenitic Stainless Steel Piping Fittings.
.6 AWS A5.8 - Filler Metals for Brazing and Braze Welding.
.7 CGA P-2.1 - Medical-Surgical Vacuum Systems in Health Care Facilities.
.8 CGA V-5 - Diameter Index Safety System (Non- Interchangeable Low Pressure Connections for Medical Gas Applications).
.9 C22.1 Canadian Electrical Code Part 1
.10 Ontario Electrical Safety Code (OESC) and Ontario Electrical Safety Code Bulletins
.11 CSA Z32.2 Use of Electricity in Patient Care Areas
.12 CSA Z32.4-M Essential Electricity in Patient Care Areas
.13 CSA B51 Boiler and Pressure Vessels
.14 CSA Z7396.1-01 Medical Gas Pipeline Systems - Part 1: Pipelines for Medical Gases and Vacuum
.15 CSA Z7396.1-09 Medical Gas Pipeline Systems - Part 1: Pipelines for Medical Gases and Vacuum
.16 CSA Z7396.2-02 Medical Gas Pipeline Systems - Part 2: Anaesthetic gas scavenging disposal systems
.17 FM - Factory Mutual System - Approval Guide.
.18 FS WW-V-35 - Valve Ball.
.19 FS WW-V-54 - Valve, Gate, Bronze (125, 150 and 200 Pound, Screwed, Flanged, Solder End, For Land Use).
.20 MIL-R-36557 - Regulator, Pressure, Medical Gas Administration Apparatus.

.21 MIL-V-82026 - Valves, Diaphragm, Stop.
.22 MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
.23 MSS SP-69 - Pipe Hangers and Supports - Selection and Application.
.24 MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
.25 NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
.26 NFPA 50 - Bulk Oxygen Systems at Consumer Sites
.27 NFPA 99 - Standard for Health Care Facilities

1.4 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide manufacturers literature and illustrations for all components indicating size, dimensions and configuration.
.3 Shop Drawings: Indicate general assembly of components, mounting and installation details, and general layout of control and alarm panels. Submit detailed medical wall assembly drawings.
.4 Samples: Submit two of each medical gas and gas scavenging outlet.
.5 Project Record Documents: Record actual locations of piping, valving, and outlets.
.6 Operation Data: Include installation instructions, assembly views, lubrication instructions, and assembly views.
.7 Maintenance Data: Include maintenance and inspection data, replacement part numbers and availability, and service depot location and telephone.
.8 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

.1 Perform Work to CSA Z7396-1 and CSA Z7396-2. Maintain one copy of each at the site.
.2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
.3 Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience and brazing procedure(s) registered with T.S.S.A.
.4 Medical Gas Certification Agency: Independant certification agency appointed and paid by the Hospital.

1.6 REGULATORY REQUIREMENTS

.1 Conform to applicable codes for medical gas systems, including;
  .1 CSA B51 Boiler and Pressure Vessel Code
  .2 CSA Z7396.1 Medical Gas Pipeline Systems - Part 1: Pipelines for Medical Gases and Vacuum
  .3 CSA Z7396.2-02 Medical Gas Pipeline Systems - Part 2: Anaesthetic gas

scavenging disposal systems
.4 Ontario Electrical Safety Code
.2 Provide inspection certificate of from authorities having jurisdiction with no remaining deficiencies, including;
.1 TSSA
.2 ESA
.3 Medical Gas Certification Agency
.3 Products Requiring Electrical Connection: Listed and classified by CSA, ULC, cUL or Special Inspection as suitable for the purpose specified and indicated.

2 PRODUCTS

2.1 PIPE AND FITTINGS

.1 Factory Preparation: Wash inside of copper pipe and copper fitting with hot solution of sodium carbonate or trisodium phosphate mixed 1 kg to 25 L of water; rinse with water, and blow dry with oil-free dry nitrogen or compressed air.
.2 Medical Gas Systems, Aboveground:
.1 Copper Tube: seamless, ASTM B819, Type L, hard drawn, de-greased and maked as for medical use
.2 Fittings: ANSI B16.18, cast copper alloy or ANSI B16.22, wrought copper, de-greased and maked as for medical use
.3 Joints: silver brazing alloy conforming to AWS Classification BCuP-5 in conformance with AWS A5.8/A5.8M.
.3 Medical Gas Systems, Buried:
.1 Copper Tube: seamless, ASTM B819, Type K, hard drawn, de-greased and marked as for medical use
.2 Fittings: ANSI B16.18, cast copper alloy or ANSI B16.22, wrought copper, de-greased and marked as for medical use
.3 Joints: silver brazing alloy conforming to AWS Classification BCuP-5 in conformance with AWS A5.8/A5.8M

2.2 VALVES

.1 Factory Preparation for Oxygen Service: Disassemble, clean, degrease, seal, and pack for shipping.
.2 Ball Valves:
.1 Manufacturers:
.1 Class 1
.2 Vitalaire Amico
.2 FS WW-V-35 Type II, Class A, Style 1; MSS SP-110; bronze body, three piece, double-seal ball valves with replaceable neoprene or teflon seat and stem seals, for minimum 4140 kPa cold working pressure, flange or union mounting, labelled for intended service.
.3 Pressure Regulation Valves (Medical Air):

.1 Manufacturers:
  .1 Class 1
  .2 Vitalaire Amico
.2 MIL-R-36557.

2.3 PIPING ACCESSORIES

.1 Hangers and Supports: MSS SP-58 with types as required by MSS SP-69.
.2 Pressure Gauges:
  .1 ANSI B40.1, white dials and black lettering with restrictor.
  .2 Oxygen and nitrous oxide systems: Manufactured and labeled expressly for intended service; UL labeled.
.3 Vacuum Bottle Brackets: Stainless steel, chrome-plated metal, or aluminum with finish matching adjacent outlet.
.4 Flexible Connectors: Corrugated flexible, single ply, seamless or seam-welded tubing of stainless steel or bronze or reinforced teflon bellows or hose.
.5 Valve Cabinets:
  .1 Extruded aluminum, flush-mounted and rigidly assembled to accommodate valves and fittings, punched or drilled sides to receive tubing, anchors to secure to wall construction.
  .2 Cover Plates: Extruded aluminum, with replaceable plastic windows with pull ring to remove window.
  .3 Cabinet Labels: Labeled and colour coded for intended service and area served.
  .4 Valves: Pre-assemble and mount chrome plated valves and tubing extensions.
  .5 Gauges: Provide where indicated and in operating rooms areas downstream of isolating valves.
.6 Piping Identification: Pressure sensitive adhesive tape and decals, colour and labelling to conform with Section 23 05 53.

2.4 2.4 OUTLETS

.1 Outlet Units:
  .1 CGA V-5, Diameter Index Safety System (DISS) non-interchangeable connectors, automatic valves, secondary check valves (except vacuum and evacuation outlets), and capped 8 mm tubing stubs for supply connections, colour coded and labelled for intended service.
.2 Faceplates:
  .1 Flush Outlets: Mount in galvanized steel boxes with stainless steel faceplate with Lexan cover, colour coded with embossed labeling.
  .2 Surface Outlets: Surface mount with colour coded plastic cover and stainless steel faceplate with Lexan cover, colour coded with embossed labeling.

2.5 ALARM SYSTEM

.1 High-Low Pressure Alarm Panels: Closed circuit, self-monitoring type, to monitor oxygen, vacuum, compressed air, nitrous oxide, and nitrogen.
  .1 Green light for systems normal.
  .2 High or low pressure warning:
    .1 Green light extinguishes.
    .2 Audible warning device sounds.
    .3 Red light energizes.
  .3 Gauge indicates pressure or vacuum.
  .4 Switch silences warning device.
  .5 Test switch to test light bulbs and audible warning device.
  .6 Provide system with internal switches, gauges, control unit, and transformer.
.2 Multi-Signal Alarm Panel:
  .1 Closed circuit, self-monitoring type, to monitor oxygen, vacuum, compressed air, nitrous oxide, and nitrogen piping systems pressure or liquid level.
  .2 Green light for systems normal.
  .3 For abnormal condition:
    .1 Green light extinguishes.
    .2 Audible warning device sounds.
    .3 Red light energizes.
  .4 Switch silences warning device.
  .5 Test switch to test light bulbs and audible warning device.
  .6 Design system such that one, two or more monitors may be connected to a single pressure switch.
  .7 Monitor following abnormal conditions:
    .1 Oxygen reserve supply in use.
    .2 Oxygen line pressure high.
    .3 Oxygen line pressure low.
    .4 Vacuum line pressure above normal.
    .5 Vacuum line pressure below normal.
    .6 Vacuum lag pump on
  .8 High-low pressure switch: Dual circuit with two single pole, double throw, snap action switches, tested at 1240 kPa with adjustable range of 26 kPa, preset at 276 kPa and 414 kPa.

3 EXECUTION

3.1 INSTALLATION

.1 Install to NFPA 99.
.2 Pre-Installation Cleaning: Disassemble positive pressure gas systems pipe, fittings, valves, and components, except those supplied cleaned and prepared for intended service, and thoroughly wash in hot solution of sodium carbonate or trisodium phosphate mixed 1 kg to 25 L of water. After washing, rinse with water, dry and cap until installation.

.3 Braze joints in pipe and tubing. Avoid leaving excess flux inside of pipe and fittings. During brazing of pipe connections, purge interior of pipe continuously with nitrogen.

.4 Effect changes in size with reducing fittings. Make changes in direction of required turns or offsets with fittings or tubing shaped by bending tools. Make bends free of flattening, buckling or thinning of tube wall.

.5 Cut pipe and tubing accurately and install without springing or forcing.

.6 Install exposed oxygen piping in wall-mounted sheet steel raceways and junction boxes.

.7 Encase buried oxygen piping in cast-iron pipe. Provide with FM listed heat trace with fixed temperature regulation, set for 27 degrees C maximum, and terminating at junction box, mounted near main oxygen supply shut-off valve. Insulate buried oxygen lines and heat trace with insulation as specified in Section 23 07 19.

.8 Grade piping down in direction of flow.

.9 Provide pipe sleeves where pipes and tubing pass through walls, floors, roofs, and partitions. Finish flush at both ends. Extend 50 mm above finished floors. Pack space between pipe or tubing and sleeve, and caulk.

.10 Identify piping with tape and decals. Provide piping identification code and schematic. Refer to Section 23 05 53. Install labelling on pipe at intervals of not more than 6 metres and at least once in each room and each story traversed by pipeline.

.11 Excavate and backfill pipe trenches as specified in Section 31 23 18 and Section 31 23 23. Coordinate provision of utility warning and identification tape with backfill operation. Provide above all buried lines at a depth of 200 to 300 mm below finish grade.

.12 Support gas piping with pipe hooks or hangers suitable for size of pipe, spaced:

- .1 13 mm pipe or tubing: 1830 mm.
- .2 20 mm or 25 mm pipe or tubing: 2440 mm.
- .3 30 mm or larger (horizontal): 3050 mm.
- .4 30 mm or larger (vertical): Every floor level.

.13 Install underground piping in trench minimum 1070 mm deep adequately protected against physical damage and corrosion, or in ducts and tunnels which are not occupied by fuel oil lines and are vented.

.14 Except where indicated or in flush wall mounted cabinets, install manual shut off valves with stem vertical and accessible for operation and maintenance.

.15 Install strainers on inlet side of pressure reducing valves. Provide main gas valves (pressure reducing or flow control) with by-passes and isolation valves to permit maintenance without interruption of gas.

.16 Provide a valved by-pass around receivers.

.17 Vibration and Noise Isolation: Refer to Section 23 05 48.

.18 Medical Air Compressor Systems: Isolate systems including receivers, dryers, and filters until after completion and approval of purity tests for compressed air system. Tie-in at flange or union joint.

.19 Provide medical air compressors and vacuum pumps with water supply piped from potable water system. Provide reduced pressure back flow preventer on water supply.

.20 Install bulk liquid oxygen system to NFPA 50 and under supervision of manufacturer. Size liquid oxygen tank's concrete foundation and tank anchoring for 3 times fully loaded weight. Provide bulk liquid oxygen systems with shut-off valve and connection point with valve for portable emergency oxygen supply. Install bulk oxygen to inlet side of oxygen manifold.

.21 Provide electric motor drive equipment with electrical equipment and wiring. Refer to Section 26 05 80.

.22 Install service isolation valve separating pipeline distribution system from any medical gas zone isolation valve. The first service isolation valve upstream of the zone valve shall be on the same floor as the zone valve.

3.2 PIPING SYSTEMS CLEANING AND PRESSURE TESTING

.1 After erection of pipe and tubing but prior to installation of service outlet valves, blow systems clear of free moisture and foreign matter with nitrogen gas.

.2 Install service outlet valves, subject system to test pressure of 1034 kPa with nitrogen or dry compressed air. Check with soapy water. Provide 24-hour standing pressure test.

3.3 FIELD QUALITY CONTROL

.1 Independent testing agency to certify system is complete, zone valves installed, alarm systems functional, and tests performed. Document tests and submit.

.2 Reduce pressure in piping systems other than system under investigation to atmospheric.

.3 Test system with dry compressed air or dry nitrogen with test pressure in piping system at 345 kPa.

.4 Check each station outlet of every piping system to determine test gas is dispensed only from outlet of system under investigation. Measure pressure with gauge attached to specific adaptor. Do not use universal adaptors.

.5 Disconnect test gas and connect proper gas to each system. Purge entire system to remove test gas. Check with analyzer suitable for gas installed.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Read and conform to:
  .1 Division 1 requirements and documents refered to therein.
.2 Section 23 01 01 applies to and governs the work of all Sections of Division 23.
.3 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work..
.4 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.
.5 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the most costly arrangement.

1.2 WORK INCLUDED

.1 Products and methods mentioned or shown in the Contract Documents complete with incidentals necessary for a complete operating installation. Provide all tools, equipment and services required to do the work.
.2 Cutting and patching of new or existing work
.3 Identification of equipment, piping, ductwork, and valves and controllers
.4 Concrete equipment bases, housekeeping pads, sump pits and trenches.
.5 Motors required for equipment supplied under this Division.
.6 Variable frequency drives for motors and equipment supplied under this Division.
.7 Internal wiring, relays, contactors, switches, transformers, motor starters, and all controls necessary for the intended operation, furnished with terminals and external controls suitable for connection to power source at a single easily accessed location for equipment items that are supplied with motors and/or electrical or electronic components under this Division.
.8 Disconnect switches for exhaust fans located on the roof complete with;
  .1 EEMAC 1 enclosure if housed within a weatherproof cabinet,
  .2 EEMAC 3 enclosure if exposed to weather
.9 Take such measures and include in Bid Price for the proper protection of the existing building and its finishes at all times during alterations and constructionof the new addition. Coordinate this protective work with all trades.
.10 Refer to Mechanical/Electrical Equipment Schedule for extent of wiring and electrical characteristics.
.11 Verify the correct operation of each equipment item provided and/or altered and each system in total and obtain the Owner's approval prior to starting and/or returning to operation.

1.3 RELATED WORK

.1 Power wiring, conduit and connections for motors under this Division will be by Division 26.
.2 Power wiring, conduit and connections to variable frequency drives for motors under this Division will be by Division 26. Wiring and connections from VFD to motors under this Division will be by Division 26.
.3 Flashings for mechanical equipment and services located on or passing through roofs will be provided under Division 7. Supply counter flashings, and integral flashing collars on equipment and piping under this Division.
.4 Painting of exposed piping and ductwork other than for identification will be supplied under Division 9.
.5 Concrete equipment bases, housekeeping pads, sump pits and trenches will be provided under Division 3.

1.4 SUBMITTALS

.1 Approval Drawings: Prepare and submit drawings necessary for approval to any authority having jurisdiction, and obtain two (2) copies of approved drawings for retention by Consultant prior to commencement of work under this Division.
.2 Shop Drawings: Prepare and submit two (2) hard copies and one (1) electronic copy of shop drawings of major equipment items (including those items specifically indicated under Part 1: General of each Section), to the Consultant for review. The Consultant will return one copy, marked with comments and his review stamp as he deems appropriate. Prepare the necessary number of copies of the returned set and distribute to the Owner, the Prime Consultant, the General Contractor, the site, and to subcontractors and suppliers.
    .1 Clearly indicate manufacturer's and supplier's names, catalogue model numbers, details of construction, accurate dimensions, capacities and performance. Prior to submission check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of the shop drawings, reviewed by Consultant, has been returned to Contractor.
    .2 Clearly indicate the weight, location, method of support and anchor point forces and locations for each piece of equipment on shop drawings.
    .3 The Consultant will not review shop drawings that fail to bear the Contractor's stamp of approval or certification.
    .4 Read the following in conjunction with the wording on the shop drawing review stamp applied to each and every drawing submitted:
    'This review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review shall not mean that the Consultant approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that

pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub trades."

.3 Sleeving Drawings: Prepare and submit 4 copies of sleeving drawings to clearly and accurately indicate the exact location, elevation and size of any and all formed holes, recesses and sleeving required in the work of Division 23. Obtain Consultant's approval in writing prior to sleeving, forming or cutting any such opening. Provide a copy of approved sleeving drawings to the reinforcement detailer well in advance of planned pours.

.4 Composite Wiring Diagrams: Prepare and submit three (3) copies of complete composite wiring diagrams of each specific mechanical system. Indicate all electrical equipment and wiring, both internal and external, for review and coordination of trades.

.5 Contractor's Material and Test Certificates: Prepare and submit certificates for each system installed. Where certificates are prescribed by regulations, codes or standards ensure they conform to the requirements of those documents (eg. NFPA-standards). Include a copy of each certificate in the Operation and Maintenance manual. Certificates shall include the following:

.1 description of the system (description and type),

.2 description of the tests conducted and results observed, including re-testing, where necessary,

.3 description of any corrective measures undertaken,

.4 description of materials used (pipe and fittings),

.5 list of witnesses for each test conducted,

.6 date system left ready for service,

.7 signature of installing Contractor.

.6 Directories & Schematics

.1 Submit five (5) copies of a neat typewritten directory indicating the valve number, related service,and location of each valve under this Division.

.2 Submit five (5) copies of system control schematics for each mechanical system indicating relative locations of equipment and control devices.

.3 Enclose one (1) copy of each directory/schematic under glass in a neat polished 18" x24" (460 mm x 610 mm) metal frame, complete with mounting clips.

.7 Maintenance Data and Operating Instructions

.1 Submit three (3) copies of Operation and Maintenance Manual individually bound in hard backed three-ring binders.

.2 Provide a list of names, addresses and telephone numbers of equipment suppliers, installing contractors, general contractors, architect and Consultant. Include special telephone numbers for service departments on normal and emergency call basis.

.3 Provide descriptive literature (shop drawings) of each manufactured item. Include a bill of material with purchase order numbers and vendor's identification of equipment orders for each item.

.4 Include copies of start-up reports and checklists and all certificates issued with

respect to this contract.

.5 Ensure operating instructions include the following:
- .1 General description of each mechanical system.
- .2 Step by step procedure to follow in putting each piece of equipment into service.
- .3 Schematic control diagrams for each separate mechanical system, control thermometers, freezestats, firestats, pressure gauges, automatic valves, and refrigeration accessories. Mark correct operating settings for each control device on these diagrams.
- .4 Diagram of the electrical control system indicating the wiring of all related electrical components such as PE and EP switches, firestats, freezestats, fuses, interlocks, electrical switches and relays.
- .5 Drawings of each control panel including temperature control and electrical panels, completely identifying all components on the panels and their function.

.6 Ensure maintenance instructions include the following:
- .1 Manufacturer's maintenance instructions for each item of mechanical equipment installed under this Division. Instructions shall include installation instructions, parts numbers and lists, name of supplier and maintenance and lubrication instructions.
- .2 Summary list of each item of mechanical equipment requiring lubrication, indicating the name of the equipment item, location of all points of lubrication, type of lubricant recommended, and frequency of lubrication.
- .3 Equipment directory indicating name, model, serial number and nameplate data of each item of equipment supplied, and system with which it is associated.
- .4 Balancing and testing reports.
- .5 Copy of valve directory.

.8 As-Built Records: Contractor to Prepare and submit complete as-built records prior to Substantial Performance of the Contract. Refer to Division 1 for requirements.

.9 Requests for Shut-Down: Obtain permission for systems shut-down and/or service interruption from the Owner prior to disruption of any system or service in use by the Owner. Employ the Owner's standard form of request where available. Refer to Division 1 for additional requirements.

.10 Requests for Start-up: Obtain permission from the Owner to start-up or to return to service any item of equipment, system or service installed new or previously shut-down. Refer to Division 1 for additional requirements.

1.5 QUALITY ASSURANCE

.1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.

.2 Ensure materials supplied under this Division conform to minimum requirements and recommendations or better of applicable standards of the following:
.3 Use latest editions and amendments in effect on date of Bid call subject to requirements of OBC.
.4 Arrange and pay for permits and inspections by authorities having jurisdiction, required in the undertaking of this Division. Make modifications required by authorities.
.5 All tradesmen employed on the project shall hold valid trade certificates/licenses and shall make a copy available for review by the Consultant and/or Owner when requested.
.6 All welding and brazing shall be executed by certified welders in accordance with registered procedures.
.7 All refrigeration work shall be executed only by mechanics with valid ODP cards.

1.6 PRODUCT DELIVERY, HANDLING AND STORAGE

.1 Immediately after letting of contract, review material and equipment requirements for this work, determine supply and delivery dates for all items, and notify Consultant of any potential delays in completion of this project in order that remedial action may be taken.
.2 Store neatly out of the way and protected from damage and theft, materials and equipment supplied under this Division that are received at the site by this Division.

1.7 JOB CONDITIONS

.1 Visit site and examine existing conditions which may affect work of this Division.
.2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
.3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
.4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.8 WARRANTY

.1 Refer to General Conditions. Arrange with each manufacturer/supplier to extend warranties as necessary to coincide with warranty period or those periods specified.
.2 Make submissions necessary to register product warranties to the benefit of the Owner.
.3 Submit to Consultant, prior to Substantial Performance of the Contract, manufacturer's written warranties covering periods longer than one year or offering greater benefits than required in specifications and in the Owner's name.

1.9 DEFINITIONS

.1 The following are definitions of words found in this specification and on associated drawings under this Division:

.1	"Concealed"	- locations hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
.2	"Exposed"	- mechanical work normally visible to building occupants.
.3	"Furnish"	- (and its derivatives) has the same meaning as the term "Supply".
.4	"Install"	- (and its derivatives) - receive, store and handle at the site, mount and support and connect all required services. Includes adjustment and calibration, testing, commissioning, inspection by authorities having jurisdiction and documentation.
.5	"Provide"	- (and its derivatives) - supply, install in place, connect the associated required services ready for operation, adjust and calibrate, test, commission, warrant, and document. Includes inspection by authorities having jurisdiction.
.6	"Supply"	- (and its derivatives) purchase and deliver to the site for installation. Includes submittals, manufacturer's field inspection and warranty.
.7	"Wet"	- locations exposed to moisture, requiring special materials and arrangement.

1.10 INTERRUPTIONS

.1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.

.2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.

.3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.

.4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.

.5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

1.11 PHASING AND SCHEDULING

.1 Refer to Division 1 for PHASING AND SCHEDULING OF THE WORK.

.2 Coordinate work of all Sections of Division 23 with other trades and assist in the development of the Phasing Strategy.

.3 Refer to O.B.C. Division C, Part 1, Subsection 1.3.3 Occupancy of Unfinished Building

.4 Refer to Article 8.0 of Section 01120.

.5 Where occupancy of a part of the work is required prior to completion of the entire project, ensure that equipment, systems and services that serve the areas to be occupied are completed, tested and fully operational 2-weeks prior to scheduled turn over and ensure that reports, certifcates and documentation are submitted at that time.

2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

.1 Ensure materials and equipment provided under this Division are new and free from defects and bear labels of approval as required by codes referred to in this Division and/or by inspection authorities.

.2 Ensure apparatus and equipment provided under this Division bears manufacturer's nameplate indicating name of manufacturer, model number or type, size, capacity, CRN, and other pertinent information. Ensure nameplates are easily read and clearly visible, with openings provided where equipment is insulated.

.3 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products are suitably labeled and supplied with Material Safety Data sheets. Obtain the Owner's approval in writing to bring hazardous materials onto the site prior to doing so.

.4 When utilizing any products that are hazardous, keep Material Safety Data sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide Workplace Labels on such containers.

2.2 ACCEPTABLE PRODUCTS

.1 First item named or specified by catalogue number meets specifications regarding performance, quality of material and workmanship, and is acceptable to the Consultant.

.2 Items, other than first named, meeting specifications regarding quality of materials and workmanship are acceptable to the Consultant, only, if they also meet performance and/or capacities specified and can be accommodated within the space allotted.

.3 General approval indicated by inclusion of other manufacturers named is subject to final review of shop drawings, performance data and test reports.

2.3 EQUIVALENTS AND ALTERNATIVES

.1 Suppliers wishing approval for additional equipment items as equivalent to those specified must submit complete description, technical and performance data to Consultant at least ten (10) working days prior to Bid closing date. Such equivalent

equipment, if accepted, to conform to specifications with regard to all details, accessories, modifications, features and performance. Deviations from specifications must be stated in writing at time of submission for approval.

.2 Bid Prices shall include only products specified or approved equivalents. Contractors may propose unsolicited alternatives to the products specified. Alternative proposals shall be submitted in sealed envelope at time of general contract Bid submission and shall include full description and technical data, and a statement of the related increase or decrease in Bid Price should alternatives be accepted. All additional costs associated with unsolicited alternative proposals such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in alternative price. Prior approval by Consultant is not required for unsolicited alternative proposals.

.3 Where the Contractor uses equipment other than that first named, on which the design is based, he shall be responsible for all details of installation including equipment size, arrangement, fit, and maintenance of all required clearances. Contractor shall prepare and submit revised layouts to iindicate arrangement of all affected piping, ductwork, conduit, lighting, equipment, etc. Failure by Contractor to provide such drawings will be considered indication that original arrangements and space allocations are adequate. All additional costs associated with equivalent equipment such as larger motor starters, larger power feeders, space revisions to associated equipment, controls, etc. shall be included in Bid Price.

2.4 SUBSTITUTIONS DURING PROGRESS OF WORK

.1 If during the progress of work, specified products are not obtainable, equivalent or similar products by other manufacturers may be permitted by Consultant.

.2 Apply, in writing, to Consultant for substitution of any products, indicating the following:

.1 Manufacturer's name, model number, details of construction, accurate dimensions, capacities and performance of proposed products.

.2 Reason for substitution.

.3 Any revisions to the contract price made necessary by substitution.

.4 Any revisions to the contract time made necessary by substitution.

.5 Any revisions to layout, arrangement or services made necessary by substitution.

.3 No substitutions will be permitted without written authorization from the Consultant.

2.5 CONSULTANT'S REVIEW

.1 The consultants will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor. Such review and evaluation work will be undertaken by the Consultant on an additional fee basis. The Contractor shall reimburse the Owner for all costs associated with such reviews and evaluations.

.2 The Contractor shall also reimburse the Owner for any and all costs incurred in updating Contract Documents to reflect such changes.

3 EXECUTION

3.1 RELATIONSHIP WITH OTHER TRADES

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.
.2 Provide materials to be built-in, such as sleeves, anchors, and inserts, together with templates and/or measurements, promptly when required by other trades.
.3 Provide structural supports for equipment to be mounted on or in walls, supported above floors and/or suspended from the structure.

3.2 INSTALLATION REQUIREMENTS

.1 The Consultant's drawings and instructions govern the location of all items. Prepare fully coordinated installation drawings prior to installation.
.2 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.
.3 Confirm the exact location of outlets, fixtures and connections. Confirm location of outlets for equipment supplied under other Divisions.
.4 Install equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.
.5 Install metering and/or sensing devices to provide proper and reliable sampling of quantities being measured. Install instruments to permit easy observation.
.6 Provide suitable shielding and physical protection for devices.
.7 Install products and services in accordance with the manufacturer's requirements and/or recommendations.
.8 Provide bases, supports, hangers and fasteners. Secure products and services so as not to impose undue stresses on the structure and systems.
.9 Do not use power activated tools without written permission of the Consultant. Use them in accordance with the Owner's health and safety policies.
.10 Ensure that the load onto structures does not exceed the maximum loading per square metre indicated on the structural drawings or as directed by the Consultant.

3.3 CONTRACT DRAWINGS

.1 The drawings of this Division are performance drawings and indicate general arrangement of the work. They are diagrammatic except where specific details are given.
.2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement. Location and elevation of services are approximate. Verify them before construction is undertaken.
.3 Make changes where required to accommodate structural conditions, (beams, columns, etc.). Obtain Consultant's approval before proceeding.

.4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. Note that outlets and/or equipment may be relocated up to 10 feet (3 m) in any direction without a change to the contract price.

.5 Note that the layout and orientation of the ceiling outlets on the architectural reflected ceiling drawings may differ from that shown on the mechanical drawings. Make the installation in accordance with the latest architectural ceiling drawings. Provide the equipment as specified and/or shown on the documents of this Division.

.6 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the mechanical documents. If there is a difference in quantity between the architectural and drawings of this Division, base the contract price on the greater quantity.

.7 Prepare installation (construction) drawing to reflect the latest architectural ceiling layout.

3.4 CONSTRUCTION DRAWINGS

.1 Prepare fully dimensioned drawings showing devices, fixtures, equipment, outlets, sleeves and openings through structure. Indicate locations and weights on load points.

.2 Prepare fully dimensioned construction drawings of products and services suitably interfaced with work of the sub-trades, in mechanical rooms, service and ceiling spaces, and other critical locations. Coordinate the work with other divisions. Base drawings on reviewed shop drawings and latest architectural drawings. Indicate details pertaining to the following: access, clearances, cleanouts, sleeves, electrical connections, drain locations and elevation of pipes, ducts, conduits.

.3 Prepare drawings of pits, curbs, sills, equipment bases, anchors, inertia slabs, etc.

.4 Submit construction drawings to other Divisions. Provide one (1) transparency and four (4) print copies of construction drawings to the Consultant for record purposes.

.5 Submit construction drawings prior to commencement of work.

3.5 RECORD DRAWINGS

.1 Maintain project "as-built" record drawings. Obtain white prints from the Consultant for this purpose and pay printing costs. Identify each set as "Project Record Copy".

.2 Record deviations from contract documents caused by site conditions or by changes ordered by the Consultant. Record deviations in red ink clearly and accurately, using industry standard drafting procedures consistent with quality and standards of Consultants documents.

.3 Record deviations as work progresses throughout the execution of this contract. Maintain record drawings on site in clean, dry, legible condition, making them available for periodic review by the Consultant.

.4 Record location of concealed services, particularly underground services. Before commencing any backfilling, obtain accurate measurements and information

concerning correct location and depth of services.

.5 Transfer records from the "Project Record Copy" to a DVD in Autocad format matching the Consultant's documents. Arrange computer file in layers to exactly match the layering system of the Consultant.

.6 Submit the "Project Record Copy" on one or more DVD with white prints of each drawing to the Consultant at the time of Substantial Performance.

3.6 USE OF EQUIPMENT

.1 For the duration of this contract, do not use any piece of equipment provided under this contract for the purposes of heating, ventilation or air conditioning without the specific authorization of the Owner and Consultant. Ensure the building is "broom clean" and painting is finished before asking permission for testing to commence.

.2 Where specific written authorization is given for the use of equipment while work is still in progress, seal off ductwork, grilles, diffusers, and registers or other openings to the air distribution systems or air handling equipment that is not in use. Provide filters over openings in ductwork, over grilles, diffusers and registers and in or at any air handling equipment that is in use. Ensure that the edges are sealed so that the filters are not bypassed. Change the filters frequently, to the satisfaction of the Consultant, until the building is turned over the Owner.

3.7 SPECIAL TOOLS AND SPARE PARTS

.1 Within 30 days of award of contract, prepare a complete itemized list of special tools and spare parts and submit to Consultant for review. List will be used as a checklist and should include provision for sign off by the Owner on receipt.

.2 On completion of the project furnish spare parts to the Owner as follows:

- .1 One set of mechanical seals for each pump.
- .2 One casing joint gasket for each pump.
- .3 One head gasket for each heat exchanger.
- .4 One glass for each gauge glass installed.
- .5 One set of v-belts for each piece of machinery.
- .6 One set of new filters for each filter bank installed.

.3 Identify spare parts containers as to contents and replacement parts number.

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

.5 Furnish one grease gun and adaptors to suit different types of grease and fittings.

3.8 EXTRAS AND CREDITS

.1 Accompany all price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:

- .1 Materials, quantities and unit costs including any applicable contractors trade discount clearly identified.
- .2 Labour hours and unit costs.

.3 Total materials and labour costs.
.4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

3.9 INSTRUCTION

.1 Instruct and familiarize Owner's operating personnel with the various mechanical systems. Arrange instruction for each system separately.
.2 Provide instruction for each system on two separate occasions, coordinated with the Owner's staff operating schedule, in order that interested personnel may arrange to attend.
.3 Ensure each instruction period includes, but is not limited to the following;
  .1 a classroom seminar with operating manuals, product and system drawings and such other audio/visual aids as may be appropriate,
  .2 instruction during the classroom seminar by the manufacturer's representative regarding the proper operating and maintenance procedures for each item of equipment,
  .3 demonstration of the proper operating procedures for each item of equipment,
  .4 explanation of the purpose and function of all safety devices provided,
  .5 demonstration of all measures required for safe and proper access for operation and maintenance.
.4 Provide a period of follow-up instruction (on two occasions) approximately one month after completing Owner's instruction to clarify and reinforce earlier instructions.
.5 Submit a letter from the Owner's management staff indicating the instruction has been given satisfactorily to the Consultant prior to substantial completion of the project.

3.10 COMMISSIONING

.1 Refer to Section 01 80 50 Commissioning.
.2 The Contractor shall start-up and completely commission all equipment and systems installed and/or modified under this contract. Commissioning work shall be completed to the satisfaction of the Consultant prior to acceptance of the Work or any part thereof.
.3 Commissioning shall conform to CAN/CSA Z318.0 Commissioning of Health Care Facilities
.4 The Commissioning Team shall be comprised of;
  .1 Representatives of the Commissioning Coordinator (Commissioning Agent)
  .2 The individual, company or agency undertaking the work of each Section,
  .3 Representatives of the Contractor and his sub-contractors as required,
  .4 Representatives of equipment manufacturers,
  .5 Representatives of the Consultants,
  .6 Representatives of the Owner.

.5 The Contractor and his sub-contractors shall each assign an individual representing each of the relevant trades to the commissioning team and shall ensure that representatives of the equipment manufacturers are present during the relevant commissioning tasks.

.6 The Contractor shall provide all necessary labour, materials, equipment, testing apparatus and incidentals necessary to completely start-up, verify, test and commission each system provided as part of the Work.

.7 Each Section shall prepare Check Sheets in accordance with the standards listed above and shall issue them to the commissioning team for use during the commissioning process.

.8 Three (3) copies of commissioning manuals shall be provided, bound in hard cover D-ring binders with transparent cover on front and spine personalized to indicate;

.1 name and logo of Health Care Facility,

.2 name of the project,

.3 the Owner's project number,

.4 identification of the system commissioned,

.5 the date that the system was commissioned.

.9 Commissioning manuals shall include machine printable index dividers to organize each manual by system and by commissioning stage.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 WORK INCLUDED

.1 Identification of existing services and utility connections.
.2 Installation, protection and maintenance of temporary services as required to support continuing operation of the facility.
.3 Disconnection and removal of various mechanical equipment in areas to be turned over to the Owner.
.4 Disconnection and making safe of various mechanical systems and equipment in areas to be demolished and/or renovated.
.5 Disposal of waste materials in accordance with waste management requirements.
.6 Re-certification and inspection of changes made to any equipment, machine or apparatus by authorities having jurisdiction including requirements for marking of equipment.

1.3 REGULATORY REQUIREMENTS

.1 Notify all authorities of intent to demolish and schedule for the work. Obtain required permits from authorities.
.2 Conform to all codes for demolition work, dust control, products requiring disconnection and re-connection.
.3 Do not close or obstruct egress width to any building or site exit.
.4 Do not disable or disrupt building fire or life safety systems without 3 days prior written notice to Owner.
.5 Conform to procedures applicable when hazardous or contaminated materials are discovered.
.6 Arrange for re-certification and inspection of changes made to any equipment, machine or apparatus by authorities having jurisdiction. This includes requirements for marking of equipment under rules 2-100 and 2-102 of the Ontario Electrical Safety Code.

1.4 JOB CONDITIONS

.1 Visit site and examine existing conditions which may affect work of this Division.
.2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
.3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
.4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

1.5 INTERRUPTIONS

.1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.

.2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.

.3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.

.4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.

.5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

1.6 PHASING AND SCHEDULING

.1 Refer to Division 1 PHASING AND SCHEDULING OF THE WORK.

.2 Coordinate with the work of all Sections of Division 23 with other trades and assist in the development of the Phasing Strategy.

2 PRODUCTS

Not Applicable

3 EXECUTION

3.1 PREPARATION

.1 Prior to start of work under this Section, ensure that the General Trades;

- .1 Provide, erect, and maintain temporary barriers at locations indicated.
- .2 Erect and maintain weatherproof closures for exterior openings.
- .3 Erect and maintain temporary partitions to prevent spread of dust, odours, and noise to permit continued Owner occupancy.
- .4 Prevent movement of structure; provide bracing and shoring.

.2 Install, protect and maintain temporary services as required to support continuing operation of the facility.

.3 Protect services and equipment which are not to be demolished.

.4 Coordinate all service shut downs with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.

.5 Notify affected utility companies before starting work and comply with their requirements.

.6 Mark location and termination of utilities.

.7 Provide appropriate temporary signage including signage for exit or building egress.

3.2 RELATIONSHIP WITH OTHER TRADES

.1 Cooperate with other trades whose work affects or is affected by work of this Division to ensure satisfactory installation and to avoid delays.
.2 Remove and dispose of built-in items such as sleeves, anchors, and inserts.
.3 Remove and dispose of bases, supports and anchors for piping, equipment and ductwork mounted on or in walls, supported above floors and/or suspended from the structure.

3.3 PROTECTION

.1 Protect existing and new work to remain free from damage due to execution of work under this Division with tarpaulins and other protective coverings as necessary .
.2 Repair any and all damage to the building and components resulting from failure to provide suffcient protection, to the satisfaction of the Consultant.
.3 All existing air intake and exhaust openings that may be affected by dust and/or debris from the construction work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from construction work with new filters.
.4 In the event that dust and debris from construction work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.
.5 Temporary filters shall be removed on completion of the construction works.

3.4 DEMOLITION

.1 Notify all authorities of intent to demolish and schedule for the work.
.2 All demolition work shall conform to all codes, regulations, standards and by-laws applicable to the work.
.3 Isolate and drain systems as required to effect demolition. Disconnect, cap and make safe all mechanical services to the building including, but not limited to; sanitary sewer(s), storm sewer(s), water service, natural gas service, steam service, condensate return, water supply to standpipe and sprinkler systems, fire suppression systems hot water heating systems, steam and condenstae systems.
.4 Protect existing equipment and services to remain from debris and unwanted materials. Clean as necessary to maintain service during demolition period and on completion of the work.
.5 Coordinate all service shut downs with Owner's project coordinator. Provide notice as required by Owner and submit schedule for the work.
.6 Remove and dispose of all redundant mechanical services and equipment within the limits of the demolition site and where demolished systems extend beyond these limits.
.7 Turn over items identified for recovery by the Owner.

.8 All demolition work shall conform to Occupational Health & Safety and Environmental regulations. Ensure that all parties are familiar with requirements and experienced in the work to be undertaken.

.9 Waste disposal shall conform to the requirements of Division 1, municipal By-Laws and Ministry of the Environment regulations and standards.

.10 All existing air intake and exhaust openings that may be affected by dust and/or debris from the demolition work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from demolition work with new filters.

.11 In the event that dust and debris from demolition work does penetrate the building and/or its air distribution systems, this Section shall be responsible for cleaning the affected areas and/or systems.

.12 Disconnect remove, cap and identify all utilities within demolition areas.

.13 Demolish in an orderly and careful manner. Protect existing supporting structural members.

.14 Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.

.15 Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

.16 Remove temporary Work.

3.5 RENOVATIONS

.1 Isolate and drain systems as required to effect renovations, modifications and/or repairs. On completion of renovations, modifications and/or repairs, test entire system as if new. Report repairs or replacements required of existing equipment, piping, fittings or devices that are not included in contract to Consultant and Owner for instruction. Flush, clean and refill renovated systems as specified for new.

.2 Relocate or remove existing items so designated unless specifically indicated to be relocated or removed under other Sections.

.3 Existing items to be relocated shall be cleaned and repaired or altered as required to suit new location. All damaged or ineffective parts shall be replaced and the item made "as new".

.4 Existing items to be removed remain the property of the owner and shall be delivered to a location on site designated by the owner. If the owner declares no interest in the removed items, assume ownership and remove the items from the site.

.5 Make good all surfaces and finishes in areas from which items have been removed and in which items are relocated. Cap all existing services required to be severed to effect alterations and do all other work necessary to make good such areas to satisfaction of consultant.

.6 Openings in existing floor assemblies and vertical fire separations necessitated by installation of equipment and systems or construction in general must be temporarily

sealed with fire barrier materials such as mineral wool or other noncombustible insulation.

.7 If during alteration work existing asbestos material, other than known asbestos, is discovered (e.g. fireproofing, acoustic or thermal insulation, tank covering), stop work in the affected area and immediately notify consultant.

.8 Existing refrigerant indicated to be removed shall not be discharged to the atmosphere, but shall be salvaged and reclaimed or disposed of following the guidelines of the authority having jurisdiction.

.9 All existing air intake and exhaust openings that may be affected by dust and/or debris from the renovation work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary.The Contractor shall replace existing filters that become contaminated with dust and/or debris from renovation work with new filters.

.10 In the event that dust and debris from renovation work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.

.11 Temporary filters shall be removed on completion of the renovation work.

3.6 INSPECTION AND RE-CERTIFICATION

.1 Where any equipment, machine or apparatus is modified, rebuilt or rewound with any change resulting in its performance or capacity rating and characteristics it shall be inspected and re-certified as required by authorities having jurisdiction.

.2 A nameplate giving the name of the person or firm making the change and the resulting changes in performance or capacity shall be provided and afixed to the equipment, machine or apparatus adjacent to the original nameplate. Where the original nameplate is removed, the original manufacturer's name and original identifying data, such as serial numbers, shall be added to the nameplate.

.3 Refer to rules 2-100 and 2-102 of the Ontario Electrical Safety Code.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 COMMON WORK RESULTS

.1 Section 23 05 00 applies to and governs all work of Division 23.

1.3 REFERENCE STANDARDS

.1 Provide all work in accordance with requirements of Regulatory Agencies and conform to:
- .1 Local and district by-laws, regulations and published engineering standards.
- .2 the Ontario Building Code as amended,
- .3 the Ontario Gas Utilization Code as amended
- .4 Regulations for Construction Projects under The Occupational Health and Safety Act.
- .5 Fire Code made under the Fire Marshal's Act.

.2 Conform to following CSA Standards:
- .1 CAN/CSA-Z317.2: Special Requirements for Heating, Ventilating and Air Conditioning (HVAC) in Health Care Facilities.
- .2 CSA B242 Groove and Shoulder Type: Mechanical Pipe Couplings.
- .3 CSA W48 series Electrodes.
- .4 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.
- .5 CAN/CSA-W117.2, Safety in Welding, Cutting and Allied Processes

.3 Conform to following National Research Council Canada publications:
- .1 National Building Code of Canada and Supplements to National Building Code of Canada
- .2 National Fire Code of Canada.
- .3 Canadian Plumbing Code.
- .4 Model National Energy Code for Buildings

.4 Conform to following American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) Standards:
- .1 ANSI/ASME B31.1 Power Piping.
- .2 ANSI/ASME B31.3, Process Piping.
- .3 ANSI/ASME Boiler and Pressure Vessel Code:
  - .1 Section 1: Power Boilers.
  - .2 Section V: Nondestructive Examination.
  - .3 Section IX: Welding and Brazing Qualifications.
- .4 ASME A13.1 - Scheme for the Identification of Piping Systems.
- .5 ASME B40.100 - Pressure Gauges and Gauge Attachments.

.5 Conform to following American Welding Society (AWS) Standards:
- .1 AWS C1.1, Recommended Practices for Resistance Welding.

.2 AWS Z49.1, Safety Welding, Cutting and Allied Process.
.3 AWS W1, Welding Inspection.

.6 Conform to following American Society for Testing and Materials (ASTM) Standards:
.1 ASTM E1 - Specification for ASTM Thermometers.
.2 ASTM E77 - Inspection and Verification of Thermometers.

.7 Conform to following Underwriters Laboratories (UL) Standards:
.1 UL 393 - Indicating Pressure Gauges for Fire-Protection Services.
.2 UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.
.3 AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

.8 Conform to AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

.9 Conform to IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.

.10 Conform to NEMA MG 1 - Motors and Generators.

.11 Provide work where indicated in conformance with guide Specification of the Victaulic System for Building Services, G-100.

.12 The above documents or portions thereof are referenced within the work of Division 23 and shall be considered part of the requirements of this document as though fully repeated herein.

1.4 1.4 QUALIFICATIONS

.1 Motor manufacturer: Company specializing in manufacture of electric motors for HVAC use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.

.2 Firestop Sealant Manufacturer: Company specializing in manufacture of sealants with minimum three years documented product development, testing, and manufacturing experience.

.3 Firestop components and assemblies shall be ULC listed and tested in accordance with ULC S115 Standard Method of Fire Test for Firestop Sustems.

1.5 SUBMITTALS

.1 Submit shop drawings in accordance with refer to section 01 33 00 & 23 01 01

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Transport, handle, store, and protect products. refer to Division 1 requirements as well.

.2 Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.7 WASTE MANAGEMENT & DISPOSAL

.1 Separate and recycle waste materials in accordance with Division 1 Waste Management and Disposal, and with the Contractor's Waste Reduction Workplan.

.2 Place materials defined as hazardous or toxic waste in designated containers.

.3 Ensure emptied containers are sealed and stored safely for disposal away from children.

1.8 WARRANTY

.1 Provide extended coverage five year warranty for motors larger than 20 HP (15 kW).

2 PRODUCTS

2.1 PIPING SPECIALTIES

.1 Cast brass, pressure, copper to copper unions shall be used with seamless copper tubing smaller than 3" (75 mm).
.2 Cast brass flanges shall be used with seamless copper tubing, type L for tubing 3" (75 mm) and larger.
.3 Dart type, 125 lb. (860 kPa) black malleable iron unions shall be used with all steel pipe for piping 2-1/2" (65 mm) and smaller.
.4 Slip-on, 150 lb. (1000 kPa) carbon steel flanges with 1/16" (4 mm) raised face shall be used with all steel pipe for piping larger than 2-1/2" (65 mm).
.5 Gaskets for joining flanged steel pipe shall be 1/16" (4 mm) Cranite ring type gaskets.
.6 Piping specialties including backflow preventers, strainers, valves etc. shall be line size unless indicated otherwise on drawings.

2.2 ADHESIVES, SEALANTS, PAINTS AND COATINGS

.1 Adhesives, Sealants, Paints and Coatings: Use only low VOC emitting materials meeting following criteria;
  .1 Paint for Mechanical Identification: maximum VOC emission of 250g/L
  .2 Touch-Up Paint: maximum VOC emission of 250g/L
  .3 Zinc-Rich Primer: maximum VOC emission of 250g/L
  .4 Adhesives for Mechanical Identification: maximum VOC emission of 70g/L
  .5 Sealants for service penetrations: maximum VOC emission of 650g/L clear and 350 g/L pigmented
  .6 Sealants for Firestopping: max. VOC emission of 650g/L clear and 350 g/L pigmented
  .7 Acrylic Sealant for supports and anchors: maximum VOC emission of 250g/L
  .8 Insulation Vapour Barrier Lap Adhesive: maximum VOC emission of 80g/L
  .9 Insulation Joint Sealer: maximum VOC emission of 250g/L
  .10 Insulation Vapour Barrier Mastic: maximum VOC emission of 400g/L
  .11 Flame Retardent Adhesive: maximum VOC emission of 650g/L clear and 350 g/L pigmented

2.3 WELDING ELECTRODES

.1 Electrodes: in accordance with CSA W48 Series.

2.4 NAMEPLATES

.1 Provide laminated plastic plates with black face and white centre of minimum size 3-1/2" x 1-1/2" x 3/32" (90 x 40 x 2 mm) nominal thickness, engraved with 1/4" (6 mm) high lettering. Use 1" (25 mm) lettering for major equipment.

.2 Fasten nameplates securely in conspicuous place. Where nameplates cannot be mounted on cool surface, provide standoffs.

.3 Identify equipment type and number and service of areas or zone of building served.

.4 For each item of equipment which may be started automatically or remotely, add a red lamacoid plate, 2-1/2" x 9" (65 x 230 mm), reading: "WARNING. THIS EQUIPMENT IS AUTOMATICALLY CONTROLLED AND MAY START AT ANY TIME."

2.5 TAGS

.1 Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background colour. Tag size minimum 1-1/2" (40 mm) diameter. **OR**

.2 Metal Tags: Brass, aluminum or stainless steel with stamped letters; tag size minimum 1-1/2" (40 mm) diameter with smooth edges.

.3 Chart: Typewritten letter size list in anodized aluminum frame.

2.6 STENCILS

.1 Stencils: With clean cut symbols and letters of following size:

- .1 3/4"-1-1/4" (20-30 mm) Outside Diameter of Insulation or Pipe: 8" (200 mm) long colour field, 1/2" (15 mm) high letters.
- .2 1-1/2"-2" (40-50 mm) Outside Diameter of Insulation or Pipe: 8" (200 mm) long colour field, 3/4" (20 mm) high letters.
- .3 2-1/2"-6" (65-150 mm) Outside Diameter of Insulation or Pipe: 12" (300 mm) long colour field, 1-1/4" (30 mm) high letters.
- .4 8" - 10" (200-250 mm) Outside Diameter of Insulation or Pipe: 24" (600 mm) long colour field, 2-1/2" (65 mm) high letters.
- .5 Over 10" (250 mm) Outside Diameter of Insulation or Pipe: 32" (800 mm) long colour field, 3-1/2" (90 mm) high letters.
- .6 Ductwork and Equipment: 2-1/2" (65 mm) high letters.

2.7 PRESSURE GAUGES

.1 Manufacturer: Trerice Model 600C.

.2 Other acceptable manufacturers offering equivalent products.

- .1 Weiss
- .2 Winter
- .3 Morrisson
- .4 Taylor

.3 Gauge: 4-1/2" (115mm) diameter black cast aluminum, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background, mid-scale accuracy: 1%, scale: psi and kPa.

.4 Gauge Cock: Tee or lever handle, brass for maximum 150 psi (1034 kPa0.
.5 Needle Valve: Brass, 1/4" (6 mm) NPT for minimum 150 psi (1034 kPa).
.6 Pulsation Damper: Pressure snubber, brass with 1/4" (6 mm) connections.
.7 Syphon: Steel, Schedule 40, 1/4" (6 mm) angle or straight pattern.

2.8 STEM TYPE THERMOMETERS

.1 Manufacturer: Trerice Model BX91403-1/2.
.2 Other acceptable manufacturers offering equivalent products.
  .1 Weiss Model 9VS3-1/2.
  .2 Winter
  .3 Morrison
  .4 Taylor
.3 Thermometer: 9" (230mm) scale, red appearing thermal fluid with black figures on white scale, calibrated in both degrees F and degrees C, accuracy to ASTM E77 of 2%, clear glass lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device, 3/4" (20mm) NPT brass stem.
.4 All thermometers to include a separable well.
.5 Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
.6 Flange: 3" (75 mm) outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.9 DIAL THERMOMETERS

.1 Manufacturer: Trerice
.2 Other acceptable manufacturers offering equivalent products.
  .1 Weiss.
  .2 Winter.
  .3 Morrisson.
  .4 Taylor
.3 Thermometer: ASTM E1, stainless steel case, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
  .1 Size: 2" (50 mm) diameter dial.
  .2 Lens: Clear glass.
  .3 Accuracy: 1 percent.
  .4 Calibration:Degrees C Both degrees F and degrees C.

OR

.4 Thermometer: ASTM E1, stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
  .1 Size: 3" (75 mm) diameter dial.
  .2 Lens: Clear glass.
  .3 Accuracy: 1 percent.

.4 Calibration: Degrees F.

OR

.5 Thermometer: ASTM E1, stainless steel case, vapour or liquid actuated with brass or copper bulb, copper or bronze braided capillary, white with black markings and black pointer glass lens.
- .1 Size: 2-3/8" (60 mm) diameter dial.
- .2 Lens: Clear glass.
- .3 Length of Capillary: Minimum 60" (1500 mm).
- .4 Accuracy: 2 percent.
- .5 Calibration:Degrees C Both degrees F and degrees C.

.6 Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

.7 Flange: 3" (75 mm) outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.10 THERMOMETER SUPPORTS

2.11 TEST PLUGS

.1 Manufacturer: Pete's Plug.

.2 Other acceptable manufacturers offering equivalent products.
- .1 Watts TP.

.3 Test Plug: 1/4" or 1/2" (6 mm or 15 mm) brass fitting and cap for receiving 1/8" (3 mm) outside diameter pressure or temperature probe with neoprene core for temperatures up to 93°C (200°F).

.4 Test Kit: Carrying case, internally padded and fitted containing one diameter pressure gauges, one gauge adapters with 1/8" (3 mm) probes, two 1" (25 mm) dial thermometers.

2.12 STATIC PRESSURE GAUGES

.1 Manufacturer: Trerice

.2 Other acceptable manufacturers offering equivalent products.
- .1 Weiss.
- .2 Winter.
- .3 Taylor.
- .4 Substitutions: Refer to Section 01 62 00.

.3 3-1/2" (90 mm) diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.

.4 Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.

.5 Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4" (6 mm) diameter tubing.

2.13 ACCESS DOORS

.1 Standard Universal Flush
  .1 Material: Upt to 16" x 16" (400x400) 16 Gauge mounting frame, over 16" x 16" (400x400) 14 gauge door, 16 gauge mounting frame.
  .2 Hinge: Continuous, concealed.
  .3 Latch: Stainless steel screwdriver operated cam latch
  .4 Finish: Steel: 5-stage iron phosphate preparation with prime coat of white, Alkyd Baking Enamel or stainless steel type 304, No. 4 satin polish.
  .5 Manufacturers:
    .1 Acudoor UF-500
    .2 CEB
    .3 MIFAB
    .4 Cendrex Contour
.2 Recessed Access Door
  .1 Material: Steel or stainless steel, 22 gauge door, 22 gauge mounting frame. Door -recessed 5/8"
  .2 Hinge: Continuous, concealed.
  .3 Latch: Stainless steel screwdriver operated cam latch
  .4 Finish: Satin coat steel
  .5 Manufacturers:
    .1 Acudoor UF-5015
    .2 CEB
    .3 MIFAB
    .4 Cendrex Contour
.3 Fire Rated
  .1 Access doors in fire separations or fire rated assemblies: ULC labelled. Refer to Architectural drawings for ratings of fire separations and assemblies. Minimum 12 gauge.
  .2 Hinge: Continuous, concealed.
  .3 Latch: Stainless steel screwdriver operated cam latch
  .4 Finish: Steel: 5-stage iron phosphate preparation with prime coat of white, Alkyd Baking Enamel or stainless steel type 304, No. 4 satin polish.
  .5 Manufacturers:
    .1 Acudoor
    .2 CEB
    .3 MIFAB
    .4 Cendrex Contour

2.14 MOTOR CONSTRUCTION AND GENERAL REQUIREMENTS

.1 Motors less than 0.33 HP (250 W), for intermittent service may be equipment manufacturer's standard and need not conform to these specifications.
.2 Electrical Service:
  .1 Motors 0.35 HP (0.38 kW) and Smaller: 115 volts, single phase, 60 Hz.
  .2 Motors Larger than 0.35 HP (0.38 kW): 575 volts, three phase, 60 Hz.

.3 Type:
  .1 Open drip-proof except where noted otherwise.
  .2 Design for continuous operation in 104°F (40°C) environment.
  .3 Design for temperature rise to NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
  .4 Motors with frame sizes 254T and larger: NEMA premium efficiency.

.4 Motors smaller than 0.5 HP (372 W): Provide continuously rated squirrel cage induction type with capacitor start, EEMAC `N' starting characteristics and a minimum of Class `A' insulation.

.5 Motors 0.5 HP (372 W) and over: Provide continuously rated squirrel cage induction type with EMAC `B' starting characteristics and a minimum of Class `B' insulation.

.6 Provide drip-proof type motors with a 1.15 service factor, unless specified or required otherwise by the motor location.

.7 Provide fan cooled totally enclosed motors having a 1.0 service factor.

.8 Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.

.9 Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

.10 Wiring Terminations:
  .1 Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code, threaded for conduit.
  .2 For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

.11 Provide motors within the 1-500 horsepower range of the "high efficiency" or "premium efficiency" as required under provincial regulations. Ensure this is indicated on the motor nameplate. Provide "T" frame (NEMA Specifications) motors approved under the Ontario Electrical Safety Code. If delivery of specified motor will delay delivery of any equipment, install an acceptable motor for temporary use. Final acceptance of equipment will not occur until the specified motor is installed.

.12 Coordinate with Division 26 the sizing of electrical protective devices supplying new and relocated mechanical equipment that contain integral motor starters and contactors.

.13 Motor ratings rated in watts refer to output watts.

.14 Provide constant speed motors with reduced voltage starters where specified.

.15 Motors for use with variable frequency drives shall be rated for invertor duty. Motors for pumps and fans shall be rated for inverter duty whether or not VFD are included at this time.

.16 Design BHP shall not exceed 80% of nominal motor HP.

2.15 SINGLE PHASE POWER - SPLIT PHASE MOTORS

.1 Starting Torque: Less than 150 percent of full load torque.

.2 Starting Current: Up to seven times full load current.
.3 Breakdown Torque: Approximately 200 percent of full load torque.
.4 Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
.5 Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.16 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

.1 Starting Torque: Exceeding one fourth of full load torque.
.2 Starting Current: Up to six times full load current.
.3 Multiple Speed: Through tapped windings.
.4 Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.17 SINGLE PHASE POWER - CAPACITOR START MOTORS

.1 Starting Torque: Three times full load torque.
.2 Starting Current: Less than five times full load current.
.3 Pull-up Torque: Up to 350 percent of full load torque.
.4 Breakdown Torque: Approximately 250 percent of full load torque.
.5 Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
.6 Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
.7 Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

2.18 THREE PHASE POWER - SQUIRREL CAGE MOTORS

.1 Starting Torque: Between 1 and 1-1/2 times full load torque.
.2 Starting Current: Six times full load current.
.3 Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
.4 Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
.5 Insulation System: NEMA Class B or better.
.6 Testing Procedure: To IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
.7 Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
.8 Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for

wiring into motor starter; refer to Section 26 29 23 - Variable Frequency Controllers.

.9 Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt centre line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

.10 Sound Power Levels: To NEMA MG 1.

.11 Part Winding Start Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

.12 Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

.13 Nominal Efficiency: As scheduled at full load and rated voltage when tested to IEEE 112.

.14 Nominal Power Factor: As scheduled at full load and rated voltage when tested to IEEE 112.

2.19 ADHESIVES, SEALANTS, PAINTS & COATINGS

.1 Adhesives, Sealants, Paints and Coatings: Use only low VOC emitting materials meeting following criteria;

- .1 Sealants for Service Penetrations: maximum VOC emission of 650g/L clear and 350 g/L pigmented
- .2 Sealants for Firestopping: max. VOC emission of 650g/L clear and 350 g/L pigmented

2.20 FIRESTOPPING COMPOUNDS

.1 Manufacturer: 3M products indicated.

.2 Other acceptable manufacturers offering equivalent products.

- .1 Dow Corning
- .2 John Manville
- .3 Hilti Firestop Systems

.3 Fire Rated Sealants: intumescent material, synthetic elasomers, capable of expanding up to 8 to 10 times when exposed to temperatures of 250°F (121°C) or higher. ULC listed and labelled.

2.21 SLEEVES

.1 Materials: minimum schedule 20 galvanized steel or cast iron.

2.22 ESCUTCHEONS

.1 Finish: Polished chrome

2.23 FLASHINGS AND COUNTERFLASHINGS

.1 Thaler or equivalent mechanical/electrical flashings as recommended for specific purpose.
.2 Stainless steel flashing sleeve, integral deck flange and EPDM seal.

2.24 PENETRATION SEALS

.1 Manufacturer: Link-Seal
.2 Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut.

3 EXECUTION

3.1 INSPECTION

.1 Inspect installed work of other trades and verify that such work is complete to point where work under this Division may properly commence.
.2 Verify that work of this Division may be executed in accordance with pertinent codes and regulations, specifications, drawings, and referenced standards.
.3 Review drawings and verify dimensions at the site. Report discrepancies immediately to Consultant before proceeding with any construction work or shop drawings.

3.2 PREPARATION

.1 Existing services and equipment shall be relocated or removed to suit new construction and renovation work.
.2 Services that are no longer required shall be removed or cut back and capped to the satisfaction of Consultant.
.3 Obtain written authorization from Consultant for renovation work that is not specifically indicated.
.4 Where modifications or connections to existing systems require shutdown of the system the Contractor shall submit a request for system shutdown describing the system or part to be shutdown, the duration of the shutdown, the work planned and steps to be taken to reinstate the system to full operation. The request shall be submitted in the format stipulated by the Owner.
.5 All work required to prepare systems for shutdown and/or re-instatement, such as draining, chemical treatments, and re-filling shall be included in this Bid Price.

3.3 PIPING INSTALLATION - ABOVE GROUND

.1 Cooperate with other trades whose work affects or is affected by work of this Section, to ensure satisfactory installation and to avoid delays. Provide all materials to be built-in such as sleeves, anchors, etc., together with accurate dimensions or templates, promptly.

.2 Layout all work accurately, installing piping parallel to lines of building.
.3 Install piping, wherever possible, in partitions and above ceiling. Do not install piping in outside walls unless so shown on drawings. Wrap uninsulated piping in masonry walls with building paper.
.4 Install concealed piping close to building structure to minimize furring dimensions.
.5 Provide adequate space around piping to facilitate application of insulation.
.6 Use dielectric couplings where piping of dissimilar metals connect.
.7 Where piping passes through concrete floors, or walls, sleeves shall be sized to permit the pipe to expand freely without binding or crushing pipe insulation.
.8 Where branch pipes are welded into main without the use of "T" connections, torch cut openings must be cut true, bevelled and filed smooth. Branch pipes must not be allowed to project inside of main pipe. Openings must not be cut large enough to permit entry of welding metal and slag within the pipe.
.9 Arrange all take-offs from mains to allow for expansion and contraction of pipes. Hot water branches serving downfeed risers must be taken from lower sides or bottom of mains and grade down slightly to risers. Branches which serve units above the mains shall be taken from the top or sides of mains.
.10 Install automatic control valves and wells supplied under other Sections.

3.4 PIPING JOINTS

.1 Make joints in piping installed under this Division using persons familiar with the particular materials being used and in accordance with CSA B51 and CSA B52, manufacturer's instructions, and as specified herein.
.2 Use only welder and/or brazer operators, with a valid identification card, as issued under The Boiler and Pressure Vessels Act, to make joints in Registered Piping Systems, as indicated under Section 23 01 01, and 23 05 00.
.3 Use silver solder or Silfos for joining copper tubing 4" (100 mm) and larger in size.
.4 Carefully ream joints in threaded pipe and paint with approved graphite type joint sealer on male connections only. Make connections with proper wrench to suit pipe size. Where leaks occur, the joint shall be disassembled and corrected if possible, or replaced. Over-tightening, caulking or peening will not be acceptable.
.5 When using Victaulic Grooved Piping Method:
  .1 Make joints in grooved piping with couplings and gaskets in accordance with Victaulic Company of Canada Ltd, General Catalogue G-100, latest edition. Cut or roll grooves using tools specifically designed for that purpose.
  .2 Use Zero-flex or rigidlok couplings in locations where rigidity is required, in particular in mechanical rooms on coils, headers and pumps.
  .3 Vic-Boltless couplings may be used.
.6 Install unions or welding flanges at connections to valves, etc. to facilitate removal.
.7 Use butt welding and/or schedule 40 carbon steel welding fittings to join sections of steel piping with welding ends.

3.5 WELDING

.1 Welder's Qualifications
  .1 Welding qualifications to be in accordance with CSA B51.
  .2 Use qualified and licensed welders possessing certificate for each procedure to be performed from authority having jurisdiction.
  .3 Furnish welder's qualifications to Consultant and Owner.
  .4 Each welder to possess identification symbol issued by authority having jurisdiction.
.2 Inspector's Qualifications: qualified to CSA W178.2
.3 Welding Procedures
  .1 Registration of welding procedures in Procedures accordance with CSA B51.
  .2 Copy of welding procedures to be available for inspection at all times.
  .3 Safety in welding, cutting and allied processes to be in accordance with CAN/CSA-W117.2.
.4 Workmanship: Welding to be in accordance with ANSI/ASME B31.1 and B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, special procedures specified elsewhere in Division 15 applicable requirements of provincial authority having jurisdiction.
.5 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.
.6 Inspection and Testing:
  .1 Hydrostatically test all welds to requirements of ANSI/ASME B31.1.
  .2 Review all weld quality requirements and defect limits of applicable codes and standards with Consultant before any work is started.
  .3 Formulate "Inspection and Test Plan" in co-operation with Consultant.
  .4 Do not conceal welds until they have been inspected, tested and approved by inspector.
  .5 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2 and approved by Consultant, to ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
  .6 Visual examinations: include entire circumference of weld externally and wherever possible internally.
  .7 Failure of visual examinations: on failure of any weld by visual examination, perform additional testing as directed by Consultant of a total of up to 25% of all welds, selected at random by Consultant, by particle tests.
  .8 Inspect and test all welds in high pressure steam and high pressure condensate piping in accordance with "Inspection and Test Plan" by

magnetic particle (hereinafter referred to as "particle") tests.

.7 Defects Causing Rejection: as described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code, plus;
  .1 Undercutting greater than 1/32" (0.8 mm) adjacent to cover bead on outside of pipe.
  .2 Undercutting greater than 1/32" (0.8 mm) adjacent to root bead on inside of pipe.
  .3 Undercutting greater than 1/32" (0.8 mm) at combination of internal surface and external surface.
  .4 Incomplete penetration and incomplete fusion greater than total length of 1-1/2" (38 mm) 97% in any 6" (150 mm) length of weld depth of such defects being greater than 1/32" (0.8mm).
  .5 Repair all cracks and defects in excess of 1/32" (0.8mm) in depth.
  .6 Repair defects whose depth cannot be determined accurately on the basis of visual examination or particle tests.
.8 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

3.6 FLUSHING AND CLEANING

.1 Thoroughly flush all piping installed by this Division.
.2 Remove, clean and replace all strainers in systems after flushing.
.3 Thoroughly clean and lubricate HVAC equipment, and leave all items in perfect order ready for operation.

3.7 PIPING SYSTEMS TESTING AND INSPECTION

.1 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures.
.2 Test all piping at the completion of roughing-in, before connecting to existing systems, and prior to concealment, insulation or covering of piping.
.3 Make tests, that are required by any authority having jurisdiction, in the presence of the authority's authorized inspector and shall be certified by him.
.4 Conduct tests in the presence of:
  .1 Authorized inspector(s) for authorities having jurisdiction.
  .2 The Commissioning Agent
  .3 The Owner's Representative
  .4 The Consultant
.5 Notification must be given at least 48 hours in advance of tests being conducted, to all persons required to be present.
.6 Repair all leaks exposed during testing and retest. If defects in pipe or fittings are discovered in the system, they shall be removed and replaced.
.7 Certify tests not required by authorities having jurisdiction.

3.8 EQUIPMENT TESTING AND INSPECTION

.1 Test operation of equipment installed under this Division according to instructions in appropriate articles of this Division. Make any required adjustments or replacements to ensure equipment is operating as intended. Retest equipment requiring adjustment or replacement.
.2 Pay all fuel consumption charges for equipment under testing and during commissioning.
.3 Conduct tests before application of external insulation and before concealment of piping or ductwork.
.4 Arrange and pay for inspections by authorities as required by code and complete any changes or alterations required by such inspections.
.5 Conduct tests in the presence of:
  .1 Authorized inspector(s) for authorities having jurisdiction.
  .2 The Commissioning Agent.
  .3 The Consultant.
  .4 The Owner's Representative.
.6 Notification must be given at least 48 hours in advance of tests being conducted, to all persons required to be present.

3.9 TESTING AND BALANCING

.1 Allow sufficient time for testing and verification prior to substantial completion. Notify Testing and Balancing Agency on completion of adjusting and balancing of systems.
.2 Adjust systems and components (drives, sheaves, belts, etc.) as required by Testing and Balancing Agency.
.3 Maintain systems in full operation during testing and verification.
.4 Make adjustments to control systems as required to facilitate verification. Maintain all safety controls in operation.
.5 Check and correct alignment of V-belts, drive shaft coupling drives, etc. as required by Testing and Balancing Agency.
.6 Provide pitot tube test fittings at all main branches of sheet metal work and at intake and discharge locations of air handling systems as required by Testing and Balancing Agency.

3.10 ELECTRICAL COMPONENTS AND WIRING

.1 Conform to requirements of Division 26 for all wiring included in Division 23. Includes pre-wired equipment provided by Sections under Division 23.
.2 Ensure that all pre-wired electrical equipment is CSA approved. Arrange and pay for special approval where this is not possible.
.3 Coordinate all wiring requirements with other Divisions. Line voltage wiring from power distribution panels to starters and from starters to motors will be provided under Division 26. All ther field wiring for equipment shall be included under Division 23, unless specifically called for under Division 25.

3.11 PROTECTION

.1 Protect finished and unfinished work by tarpaulins, or other covering, from damage due to execution of work under this Division.
.2 Repair to satisfaction of Consultant, damage to building resulting from failure to provide such protection.
.3 All existing air intake and exhaust openings that may be affected by dust and/or debris from the construction work shall be fitted with appropriate filter media to protect against entry of dust and/or debris into the building and its air distribution systems. Filters shall be closely monitored and replaced when necessary. The Contractor shall replace existing filters that become contaminated with dust and/or debris from construction work with new filters.
.4 In the event that dust and debris from construction work does penetrate the building and/or its air distribution systems, the Contractor shall be responsible for cleaning the affected areas and/or systems.
.5 Temporary filters shall be removed on completion of the construction works.

3.12 CUTTING AND PATCHING

.1 Include cutting and patching as required in execution of work under respective Sections of this Division.
.2 Holes through the structure will not be permitted without written approval of the Consultant. Any and all openings required through the completed structure must be clearly and accurately shown on a copy of the relevant structural drawing(s). Exact locations, elevations and size of the proposed opening must be identified well in advance of the need for the work.
.3 All sleeved or formed openings through the structure must be shown on sleeving drawings and must be approved by the Structural Consultant prior to construction.
.4 The Contractor shall conduct exploratory work including x-ray of the existing structure, shall mark the location of embedded reinforcements, anchors, conduits and piping on exposed surfaces of adjacent floors and/or walls and shall pay all associated costs.
.5 Reinforcing shall not be cut or modified without prior approval of the Structural Consultant. Should reinforcement be cut without such prior approval, the cost of any additional reinforcement deemed necessary by the Structural Consultant shall be the responsibility of this Contractor.
.6 Alternative imaging techniques are subject to the approval of the Structural Consultant.
.7 Ensure that cutting and patching of roofs and reinforced concrete structures is executed by specialists familiar with the materials affected, and is performed in a manner to neither damage nor endanger the work. Coordinate and supervise such cutting and patching.
.8 Maintain the integrity of fire rated assemblies where they are pierced by ducts and pipes.
.9 Make good surfaces affected by this work and repair finish to satisfaction of Consultant. Finish painting, where required, will be provided under Division 9.

.10 Stop work immediately upon discovery of any hazardous material and report discovery to the Owner and Consultant. Obtain instruction prior to proceeding with the work.

3.13 EXCAVATING AND BACKFILLING

.1 Be responsible for excavation and backfilling necessary for installation of underground work under this Division.

.2 Excavate with suitable machinery or by hand as may be necessary and as follows:

.1 Excavate to the depth and dimensions shown on drawings.

.2 Keep excavation free of water by bailing, pumping or a system of drainage as required.

.3 Cut and trim banks of excavation evenly, as nearly vertical as possible, and shore if required to prevent caving-in.

.4 Keep bottom of excavation clean and clear of loose material. Slope or grade as required.

.5 Provide shoring in accordance with The Occupational Health and Safety Act and Regulations for Construction Projects.

.6 Notify Consultant immediately in case of encountering any unstable ground, unsuitable for bearing of pipes. Consultant will decide the method of installation of pipes in unstable ground.

.7 Inform Consultant immediately if the excavation reveals seepage zones, springs or other unexpected sub-surface conditions which may necessitate revisions to drainage or water supply systems.

.3 Obtain Consultant's approval prior to commencement of backfilling of trenches. Backfill the trenches carefully to prevent injury to the work and subsequent settlement and execute backfilling generally as follows:

.1 provide minimum 6" (150 mm) fine gravel or coarse sand bedding (Class B) or as indicated for the bottom of trenches.

.2 backfill above pipe bedding with granular material specified, hand tamp in layers of 6" (150 mm) thickness. Extend backfill 12" (300 mm) above pipe.

.3 backfill and consolidate remainder of trench depth below paved or graveled areas with granular Class "B" aggregate in 6" (150 mm) layers to an elevation to allow for thickness of Class "A" aggregate and asphalt pavement.

.4 backfill and consolidate reminder of trench depth below sodded or seeded areas with specified granular material or material obtained from site excavation where approved by Consultant, in 9" (225 mm) layers to an elevation 6" (150 mm) below of proposed grades in sodded/seeded areas.

.5 compact each layer thoroughly at optimum moisture content with approved hand or mechanical tampers to a density equal to;

.1 95% of Maximum Standard Proctor Density

.1 Behind foundation and retaining walls on grades

.2 Below sodded or seeded areas

.2 100% of Maximum Standard Proctor Density

.1 Below slabs on grade within building areas up to the underside of the crushed stone underlay
.2 Below paved or graveled areas

.6 Do not puddle or flood with water for consolidating backfill. Add Water during the compaction to optimum moisture content of backfilling material.

3.14 SEALANTS & CAULKING

.1 Fill voids around pipes:
.1 Seal between sleeve and pipe in foundation walls and below grade floors with penetration seals (link-seal)). Install as per manufacturer's installation instructions.
.2 Where sleeves pass through non-fire rated walls or floors, caulk space between pipe and sleeve with fibreglass. Seal space at each end with waterproof, fire retardant, non-hardening mastic.
.3 Ensure no contact between copper tube or pipe and ferrous sleeve.
.4 Fill future-use sleeves with easily removable filler.
.5 Coat exposed exterior surfaces or ferrous sleeves with heavy application of zinc rich paint (VOC content not to exceed 250 g/L).
.2 Temporarily plug all openings during construction.

3.15 FIRESTOPPING

.1 All openings in fire separations and fire rated assemblies for service penetrations shall be protected with ULC listed service penetration firestop systems (SP).
.2 The service penetration firestop system shall have F and FT ratings equal to or greater than ratings specified by the Architect for the fire separation (F) and firewall (FT) joint firestop systems (JF).
.3 All components employed in the service penetration firestop system shall conform to the ULC listing.
.4 Contractor shall prepare and submit a schedule of service penetration firestop systems to be employed indicating the ULC listing designation, services involved, location of opening through fire separation and the components of the fire separation assembly.
.5 Refer to architectural drawings for ratings of fire separations and assemblies.

3.16 SLEEVES AND CURBS

.1 Provide pipe sleeves at points where pipes pass through masonry or concrete.
.2 Provide sleeves of minimum schedule 20 galvanized steel or cast iron.
.3 Use cast iron or steel pipe sleeves with annular fin continuously welded at midpoint:
.1 through foundation walls, with penetration seals.
.2 through floors of mechanical rooms and equipment rooms.
.4 Provide 1/4" (6 mm) clearance all around, between sleeve and pipes or between sleeve and insulation.

.5 Where piping passes below footings, provide minimum clearance of 2" (50 mm) between sleeve and pipe. Backfill up to underside of footing with concrete of same strength as footing with concrete of same strength as footing.

.6 Terminate sleeves flush with surface of concrete and masonry and 2" (50 mm) above floors. Not applicable to concrete floors on grade.

.7 Provide watertight concrete curb 4" (100 mm) high around mechanical services (pipes, ducts, conduits) which rise through mechanical (service) room floors. Provide minimum 4" (100 mm) clearance between openings for services within curbs.

.8 For pipes passing through roofs, use cast iron sleeves with caulking recess and flashing clamp device. Anchor sleeves in roof construction, caulk between sleeve recess and pipe, fasten roof flashing to clamp device, make water-tight durable joint. Co-ordinate with roofing Section.

3.17 FLASHINGS

.1 Provide all flashing at each point where piping passes through the roof.

.2 Coordinate this work with the roofing Trades to ensure a satisfactory installation and to avoid delays.

3.18 ESCUTCHEONS AND PLATES

.1 Provide on pipes passing through finished walls, partitions, floors and ceilings.

.2 Use chrome or nickel plated brass, solid type with set screws for ceiling or wall mounting.

.3 Inside diameter shall fit around finished pipe. Outside diameter shall cover opening or sleeve.

.4 Where sleeve extends above finished floor, escutcheon or plates shall clear sleeve extension.

.5 Secure to pipe or finished surface, but not insulation.

3.19 SUPPORT AND ATTACHMENT

.1 Support and attach piping, ductwork fixtures and equipment from load bearing structures such as beams, joists, reinforced concrete slabs and concrete block walls, and do not support from or attach to steel roof deck and/or wall or ceiling finishes. Roof mounted mechanical equipment and services shall be anchored to the roof structure to resist both lateral and uplift wind forces in accordance with requirements of the Ontario Building Code.

3.20 PAINTING

.1 Repair minor damage to finish of equipment with standard factory applied baked enamel finish under the appropriate Sections of this division. Replace entirely, items suffering major damage to finish if too extensive to be repaired in the opinion of the Consultant.

.2 Apply at least one coat of corrosion resistant primer paint to supports, and

equipment fabricated from ferrous metals.

3.21 DISSIMILAR METALS

.1 Separate dissimilar metals in order to prevent galvanic corrosion.
.2 Provide gaskets or shims of approved materials to avoid electrolytic action.
.3 Use dielectric unions and/or flanges where piping of dissimilar metals are connected.

3.22 EQUIPMENT BASES AND CURBS

.1 Supply and erect structural work required for installation of mechanical equipment.
.2 Build concrete bases 6" (150 mm) high, providing all necessary inserts, anchor bolts and other fasteners required, for floor mounted tanks, heaters, pumps, air handlers, boilers, etc. Make concrete bases 2" (50 mm) larger all around than the base of the supported equipment and trowel finish to a neat smooth finish. Anchor equipment to pads using 8" (200 mm) cast-in-place anchor bolts. Ensure concrete supplied under this Division is 2500 psi (17 MPa) compressive strength after 28 days.
.3 Build 4" (100 mm) high concrete curbs around all openings through floors for ductwork. Make allowances for installation of ductwork and fire dampers where required. Ensure joint between curb and floor is watertight and maintains integrity of floor membrane where applicable.

3.23 SERVICE CONNECTIONS

.1 Include in Bid Price all amounts required by utilities for service connections and /or modifications to service connection. Ensure amounts include fees, assessments, charges, etc., required in relation to service connection.

3.24 BELT DRIVES AND SHEAVES

.1 Provide belt driven equipment with V-belt drive, designed for at least 130 percent of motor nameplate horsepower rating and in accordance with manufacturer's recommendations for type of service intended. Ensure belt drives are at least 95 percent efficient. Balance and properly align drives. Provide matched sets of belts for multiple belt assemblies. Select belts to suit starting torque of driver. Do not use single belt drives only for motors larger than two horsepower.
.2 Provide motor sheaves for one and two belt drives of variable pitch type, with Dodge key adjustments. Supply two sets of fixed drive sheaves for drives with three or more belts. Install first set of fixed motor sheaves to obtain the originally specified rpm. After initial test and preliminary adjustment, supply and install the second set of fixed sheaves if necessary, to provide the design flow quantities as established on the job. Obtain correct total flow rate for fans through speed changes and not by throttling.
.3 Provide adjustable sheaves on motor sizes up to 2 HP (1492 w) and fixed sheaves on larger motors.

3.25 GUARDS

.1 Provide OSHA compliant guards for exposed drives as follows;
  .1 expanded metal screen (both sides) welded to 1" (25 mm) steel angle frame.
  .2 18 ga. 1" (25 mm) thick galvanized sheet metal tops and bottoms.
  .3 removable sides for servicing.
  .4 1-1/2" (40 mm) dia. holes on both shaft centres for insertion of tachometer.
.2 Provide means to permit lubrication and use of test instruments with guards in place.
.3 Install belt guards to permit movement of motors for adjusting belt tension.
.4 For flexible couplings, provide removable, "U" shaped, 12 ga. 1/10" (2.7 mm) thick galvanized frame and 18 ga. 1/25" (1.2 mm) thick expanded mesh face.
.5 Provide 3/4" (20 mm) galvanized mesh wire screen on inlet or outlet of exposed fan blades such that net free area to openings is not less than 1.25 of original openings.

3.26 FIELD QUALITY CONTROL

.1 Temporary and Trial Usage
  .1 Allow the Owner the privilege of temporary and trial usage of installed equipment, as soon as work is complete, for a period of time required to conduct a thorough test.
  .2 Do not construe such usage as evidence of acceptance of work by Owner.
  .3 Repair damage to work tested, resulting from such trial usage, by this Contractor at no cost to Owner.
.2 Systems Verification:
  .1 Verify the correct installation and proper operation of equipment and systems installed. Adjust and balance each system as necessary to achieve optimum operation of each system.
  .2 Co-operate with the TAB agency as follows:
    .1 provide assistance when and as requested,
    .2 co-ordinate completion of work systematically to permit orderly verification and adherence to schedules,
    .3 provide additional necessary flow balancing devices as directed by agency,
    .4 notify TAB Agency of tests being conducted.

3.27 ADJUST AND CLEAN

.1 Clean equipment and fixtures, lubricate mechanical equipment installed under this Division and leave items in perfect order ready for operation.
.2 Test and adjust control devices, instrumentation, relief valves, dampers, etc., installed in this Division after cleaning of systems and leave in perfect order ready for operation.
.3 Remove from the premises upon completion of work of this division, debris, surplus, and waste materials resulting from operations.

3.28 MECHANICAL IDENTIFICATION INSTALLATION

.1 Degrease and clean surfaces to receive adhesive for identification materials.
.2 Prepare surfaces for stencil painting.
.3 Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer (VOC content not to exceed 680 g/L).
.4 Install tags with corrosion resistant chain.
.5 Comply with standard detail drawing plate, "Detail of Piping Identification".
.6 Apply stencil markings on all covered piping.
.7 Install plastic tape pipe markers complete around bare pipe to manufacturer's instructions.
.8 Identify medical gas piping in accordance with CSA Z305.1 and CSA Z7396-1
.9 Identify anaesthetic gas scavenging piping in accordance with CSA Z7396-1.
.10 Label piping that is heat traced or equipped with heating cable "HEAT TRACED" in addition to other identification. Locate such labels adjacent to other identifications.
.11 Clearly identify abandoned services left in place as "ABANDONED".
.12 Mark drain from hot lab sink with radiation warning symbols at 10 ft. (3 m) intervals.
.13 Install underground plastic pipe markers 6"-8" (150-200 mm) below finished grade, directly above buried pipe.
.14 Identify pumps, water heating equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
.15 Identify control panels and major control components outside panels with plastic nameplates.
.16 Identify valves in main and branch piping with tags. Consecutively number valves in each system.
.17 Identify piping, concealed or exposed, with stencilled painting and plastic tape pipe markers . Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 6 m on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
.18 For each item of equipment which may be started automatically or remotely, add a red lamacoid plate, 2-3/8" x 9" (60 x 230 mm), reading: **"WARNING. THIS EQUIPMENT IS AUTOMATICALLY CONTROLLED. IT MAY START AT ANY TIME."**
.19 Provide colour coded self-adhesive dots to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

3.29 MECHANICAL IDENTIFICATION SCHEDULES

.1 Consult the Owner and identify piping, ductwork and equipment as directed;
  .1 conforming to the Owner's existing identification practices, or
  .2 conforming to the following Pipe and Valve Identification Table:

SERVICE	COLOURS		LEGEND
	BACKGROUND	LETTERS	
City water	Green	Black	CITY WATER
Condenser water supply	Green	Black	COND. WTR. SUPPLY
Condenser water return	Green	Black	COND. WTR. RETURN
Chilled water supply	Green	Black	CH. WTR. SUPPLY
Chilled water return	Green	Black	CH. WTR. RETURN
Hot water heating supply	Yellow	Black	HEATING SUPPLY
Hot water heating return	Yellow	Black	HEATING RETURN
Make-up water	Yellow	Black	MAKE-UP WTR
Boiler feed water	Yellow	Black	BLR. FEED WTR
Steam [_____] kPa	Yellow	Black	[_____] kPa STEAM
Steam condensate (gravity)	Yellow	Black	ST.COND.RET (GRAVITY)
Steam condensate (pumped)	Yellow	Black	ST.COND.RET (PUMPED)
Safety valve vent	Yellow	Black	STEAM VENT
Intermittent blow-off	Yellow	Black	INT. BLOW-OFF
Continuous blow-off	Yellow	Black	CONT. BLOW-OFF
Plumbing vent	Green	Black	SAN. VENT
Refrigeration suction	Yellow	Black	REF. SUCTION
Refrigeration liquid	Yellow	Black	REF. LIQUID
Refrigeration hot gas	Yellow	Black	REF. HOT GAS
Gas regulator vents	to Code		

3.30 MANUFACTURER'S NAMEPLATES

.1 Provide metal nameplates on each piece of equipment, mechanically fastened with raised or recessed letters.

.2 Include registration plates, Underwriters' Laboratories and CSA approval, as required by respective agency and as specified. Indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors, all factory supplied.

.3 Locate nameplates so that they are easily read. Do not insulate or paint over plates.

3.31 FLOW DIAGRAMS AND DIRECTORIES

.1 Provide Consultant with six identification flow diagrams of approved size for each system. Include tag schedule, designating number, service, function, and location of each tagged item and normal operating position of valves.
.2 Install where agreed with the Owner one copy of each flow diagram and valve schedule mounted in glazed frame. Provide one copy of each in Operation and Maintenance Manual.

3.32 INSTALLATION OF GAUGES AND THERMOMETERS

.1 Install to manufacturer's instructions.
.2 Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.
.3 Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
.4 Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide syphon on gauges in steam systems. Extend nipples and syphons to allow clearance from insulation.
.5 Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-3/8" (60 mm) for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
.6 Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
.7 Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
.8 Locate test plugs adjacent thermometers and thermometer sockets.

3.33 INSTALLATION OF ACCESS DOORS

.1 Supply access doors for access to equipment requiring service, lubrication or adjustment and all concealed valves, cleanouts, trap primers, control and volume dampers, and other such equipment.
.2 Turn over access doors to the appropriate general trade for installation under other Sections.
.3 Refer to architectural drawings for ratings of fire separations and assemblies. install fire rated access doors in fire rated partitions, walls, and ceilings.
.4 Access doors in ceilings shall be minimum 24" x 24" (600mm x 600mm), unless otherwise approved by the Consultant.
.5 Provide concealed access doors in GWB ceilings and coordinate in-fill with general trades.
.6 Provide Air Seal Flush Mount access doors in all Clean Rooms, Laboratories and Health Care Facility Class 1 rooms [e.g. operating rooms, procedure rooms, ICU, CCU, PACU, and all sterile environments].

3.34 MOTOR APPLICATIONS

.1 Single phase motors for shaft mounted fans: Split phase type.
.2 Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.
.3 Single phase motors for fans: Capacitor start type.
.4 Single phase motors for fans: Capacitor start, capacitor run type.
.5 Motors located in exterior locations: Totally enclosed type.
.6 Motors located in outdoors: Totally enclosed weatherproof epoxy-treated type.
.7 Motors located in outdoors: Totally enclosed weatherproof epoxy-sealed type.

3.35 INSTALLATION OF MOTORS

.1 Install motors to manufacturer's instructions.
.2 Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
.3 Check line voltage and phase and ensure agreement with nameplate.

3.36 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

HP	kW	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6 - 1/3	0.12-0.25	1.35	1.35	1.35	1.35
1/2	0.38	1.25	1.25	1.25	1.15
3/4	0.5	1.25	1.25	1.15	1.15
1	0.75	1.25	1.15	1.15	1.15
1/6 - 150	0.1-111	1.15	1.15	1.15	1.15

3.37 PERFORMANCE SCHEDULE: THREE PHASE - ENERGY EFFICIENT, OPEN DRIP-PROOF

3 PHASE, ODP					
HP	**KW**	**RPM(Syn)**	**NEMA Frame**	**Minimum Efficiency %**	**Minimum Power Factor %**
1	0.75	1200	145T	81	72
1-1/2	1.1	1200	182T	83	73
2	1.5	1200	184T	85	75
3	2.25	1200	213T	86	60
5	3.7	1200	215T	87	65
7-1/2	5.6	1200	254T	89	73
10	7.5	1200	256T	89	74

`	11	1200	284T	90	77
20	15	1200	286T	90	78
25	18	1200	324T	91	74
30	22.5	1200	326T	91	78
40	30	1200	364T	93	77
50	37	1200	365T	93	79
60	45	1200	404T	93	82
75	56	1200	405T	93	80
100	75	1200	444T	93	80
125	93	1200	444T	93	84

3 PHASE, ODP					
HP	**KW**	**RPM(Syn)**	**NEMA Frame**	**Minimum Efficiency %**	**Minimum Power Factor %**
1	0.75	1800	143T	82	84
1-1/2	1.1	1800	145T	84	85
2	1.5	1800	145T	84	85
3	2.25	1800	182T	86	86
5	3.7	1800	184T	87	87
7-1/2	5.6	1800	213T	88	86
10	7.5	1800	215T	89	85
15	11	1800	256T	91	85
20	15	1800	256T	91	86
25	18	1800	284T	91	85
30	22.5	1800	286T	92	88
40	30	1800	324T	92	83
50	37	1800	326T	93	85
60	45	1800	364T	93	88
75	56	1800	365T	93	88
100	75	1800	404T	93	83
125	93	1800	405T	93	86

150	112	1800	444T	93	85
200	150	1800	445T	94	85

3 PHASE, ODP					
HP	**KW**	**RPM(Syn)**	**NEMA Frame**	**Minimum Efficiency %**	**Minimum Power Factor %**
1-1/2	1.1	3600	143T	82	85
2	1.5	3600	145T	82	87
3	2.25	3600	145T	84	85
5	3.7	3600	182T	85	86
7-1/2	5.6	3600	184T	86	88
10	7.5	3600	213T	87	86
15	11	3600	215T	89	89
20	15	3600	254T	90	89
25	18	3600	256T	90	92
30	22.5	3600	284T	91	91
40	30	3600	286T	92	92
50	37	3600	324T	93	89
60	45	3600	326T	93	91
75	56	3600	364T	93	88
100	75	3600	365T	92	88

3.38 PERFORMANCE SCHEDULE: THREE PHASE-ENERGY EFFICIENT, TOTALLY ENCLOSED, FAN COOLED

3 PHASE, TEFC					
HP	**KW**	**RPM(Syn)**	**NEMA Frame**	**Minimum Efficiency %**	**Minimum Power Factor %**
1	0.75	1200	145T	81	72
1-1/2	1.1	1200	182T	83	73

2	1.5	1200	184T	85	75
3	2.25	1200	213T	86	60
5	3.7	1200	215T	87	65
7-1/2	5.6	1200	254T	89	73
10	7.5	1200	256T	89	74
15	11	1200	284T	90	77
20	15	1200	286T	90	78
25	18	1200	324T	91	74
30	22.5	1200	326T	91	78
40	30	1200	364T	93	77
50	37	1200	365T	93	79
60	45	1200	404T	93	82
75	56	1200	405T	93	80
100	75	1200	444T	93	80
125	93	1200	444T	93	84

3 PHASE, TEFC					
HP	**KW**	**RPM(Syn)**	**NEMA Frame**	**Minimum Efficiency %**	**Minimum Power Factor %**
1	0.75	1800	143T	82	84
1-1/2	1.1	1800	145T	84	85
2	1.5	1800	145T	84	85
3	2.25	1800	182T	86	86
5	3.7	1800	184T	87	87
7-1/2	5.6	1800	213T	88	86
10	7.5	1800	215T	89	85
15	11	1800	256T	91	85
20	15	1800	256T	91	86
25	18	1800	284T	91	85
30	22.5	1800	286T	92	88
40	30	1800	324T	92	83

50	37	1800	326T	93	85
60	45	1800	364T	93	88
75	56	1800	365T	93	88
100	75	1800	404T	93	83
125	93	1800	405T	93	86
150	112	1800	444T	93	85
200	150	1800	445T	94	85

3 PHASE, TEFC					
HP	**KW**	**RPM(Syn)**	**NEMA Frame**	**Minimum Efficiency %**	**Minimum Power Factor %**
1-1/2	1.1	3600	143T	82	85
2	1.5	3600	145T	82	87
3	2.25	3600	145T	84	85
5	3.7	3600	182T	85	86
7-1/2	5.6	3600	184T	86	88
10	7.5	3600	213T	87	86
15	11	3600	215T	89	89
20	15	3600	254T	90	89
25	18	3600	256T	90	92
30	22.5	3600	284T	91	91
40	30	3600	286T	92	92
50	37	3600	324T	93	89
60	45	3600	326T	93	91
75	56	3600	364T	93	88
100	75	3600	365T	92	88

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

.1 Flexible pipe connectors.
.2 Expansion joints and compensators.
.3 Pipe loops, offsets, and swing joints.
.4 Anchors and guides

1.3 REFERENCES

.1 CSA B51 Boiler, Pressure Vessel and Pressure Piping Code
.2 ASME B31.1 Code for Power Piping
.3 ASME B31.3 Process piping
.4 MIL-E-17814E - Expansion Joints, Pipe, Slip-Type, Packed.

1.4 PERFORMANCE REQUIREMENTS

.1 Provide structural work and equipment required to control expansion and contraction of piping.
.2 Verify that anchors, guides, and expansion joints provided, adequately protect system.
.3 Arrange all piping so that expansion and contraction of any piping may take place without placing undue strain on the piping or connections to the equipment. Use swing joints and suitable expansion joints wherever necessary due to field conditions and where indicated on the drawings.
.4 This Section shall analyze each section of pipe installed between constraints and shall determine the potential for expansion of the pipe based on pipe temperature at installation and pipe temperatures throughout the pipe's operating range. Where potential expansion exceeds 1" (25 mm) over the length of the pipe section, expansion compensators shall be installed. Pipe sections are constrained where they penetrate walls, partitions, floors, ceilings, roofs and movement of the pipe is restricted and where the pipe is anchored to the building structure.
.5 Expansion Calculations:
  .1 Safety Factory: 30 percent.
  .2 Installation Temperature: 50°F (10°C).
  .3 Hot Water Heating: 210°F (99°C).
  .4 Domestic Hot Water: 140°F (60°C).
  .5 Steam (100psig WP): 350°F (177°C).
  .6 Steam (15psig WP): 300°F (150°C).
  .7 Condensate (to 125 psig): 350°F (177°C).
  .8 Condensate & feedwater (to 300 psig): 500°F (260°C)

1.5 SUBMITTALS

.1 Refer to Section 23 01 01.
.2 Product Data:

.1 Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per metre and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
.2 Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

.3 Design Data: Submit detailed construction drawings for expansion compensation and piping anchors, signed and sealed by a professional engineer licenced in Ontario. Provide selection criteria used.

.4 Manufacturer's Installation Instructions: Indicate special procedures, and external controls.

1.6 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.

.2 Design expansion compensating system under direct supervision of a Professional Engineer experienced in design of this work and licenced in the Province of Ontario.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Transport, handle, store, and protect products.

.2 Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

.3 Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.8 WARRANTY

.1 Warranty: 5-year replacement warranty.

1.9 EXTRA MATERIALS

.1 Section 23 01 01: Submittals for project closeout.

.2 Provide two 340 gm containers of packing lubricant and cartridge style grease gun.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Manufacturers must be certified by the Expansion Joint Manufacturers Association (EJMA)

.2 Flexible Pipe Connectors
.1 Flex-Pression Ltd.
.2 Sr. Flexonics
.3 Ontario Hose
.4 Colton Industries

.3 Expansion Joints
.5 Flex-Pression Ltd.
.6 Hyspan Precision Products, Inc.
.7 Sr. Flexonics

.4 Pipe Alignment Guides

.8 Flex-Pression Ltd.
.9 Hyspan Precision Products, Inc.
.10 Sr. Flexonics

2.2 PIPE ALIGNMENT GUIDES

.1 Steel Pipe:
.1 radial "spider" type, minimizing piping motions in non-axial planes.
.2 constructed of carbon steel with a 360-degree two-piece bolted housing, and 360-degree two-piece bolted clamps with spider type legs.
.3 provide an insulation clearance of 1.5" on sizes 6" IPS and under, and 2.0" on sizes 8" IPS and over.
.4 axial travel shall be 3" for sizes 2" IPS and under, and 6" for sizes 2-1/2" IPS and over.
.5 refer to piping and expansion joint schedules for specific insulation and motion requirements.
.6 Basis of design: Hyspan Series 9500.
.2 Copper Pipe:
.1 radial "spider" type, minimizing piping motions in non-axial planes.
.2 constructed of carbon steel with non-metallic coating on the tube clamps, and a 360-degree two-piece bolted housing, and 360-degree two-piece bolted clamps with spider type legs.
.3 provide an insulation clearance of 1.5".
.4 axial travel shall be 3" for sizes 2-1/2" and under, or 6" for sizes 3" and 4".
.5 refer to piping and expansion joint schedules for specific insulation and motion requirements.
.6 Basis of design: Hyspan Series 9500.

2.3 FLEXIBLE PIPE CONNECTORS

.1 Copper Piping:
.1 Inner Hose: Bronze
.2 Exterior Sleeve: Braided bronze.
.3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).
.4 Joint: As specified for pipe joints.
.5 Size: Use pipe sized units
.6 Maximum offset: 3/4" (20 mm) on each side of installed centre line.
.2 Steel Piping, 2" (50 mm) diameter and smaller:
.1 Inner Hose: braided bronze.
.2 Exterior Sleeve: None.
.3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).
.4 Joint: Threaded
.5 Size: Use pipe sized units.
.6 Maximum offset: 3/4" (20 mm) on each side of installed centre line.
.3 Steel Piping, 2-1/2" to 3-1/2" (65mm to 90mm) diameter :
.1 Inner Hose: braided bronze.
.2 Exterior Sleeve: None.
.3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).
.4 Joint: Flanged.
.5 Size: Use pipe sized units.

.6 Maximum offset: 3/4" (20 mm) on each side of installed centre line.

.4 Steel Piping, 4" (100mm) diameter and larger:
- .1 Inner Hose: braided 321 stainless steel.
- .2 Exterior Sleeve: None.
- .3 Pressure Rating: 125 psi (862 kPa) WSP and 450°F (232°C).
- .4 Joint: Flanged.
- .5 Size: Use pipe sized units.
- .6 Maximum offset: 3/4" (20 mm) on each side of installed centre line.

2.4 EXPANSION JOINTS - COPPER PIPING

.1 Bronze Bellows Type:
- .1 Construction: 2-ply bronze with anti-torque device, limit stops, internal guides.
- .2 Pressure Rating: 125 psi (862 kPa) WSP and 400°F (204°C).
- .3 Maximum Compression: 1-3/4" (45 mm).
- .4 Maximum Extension: 1/4" (6 mm).
- .5 Joint: Soldered.
- .6 Size: Use pipe line sized units
- .7 Application: Copper piping.

2.5 EXPANSION JOINTS - DESIGN 150 PSIG / 500°F

.1 Ratings
- .1 Design Pressure: 150 psig (1035 kPa)
- .2 Test Pressure: 225 psig (1552 kPa)
- .3 Design Temperature: 500 °F (260°C)

.2 Stainless Steel Bellows Type:
- .1 Construction multi-ply ASTM A240 type 321 stainless steel bellows, ASME A53, Gr. B carbon steel housing,
- .2 Pressure Rating: 150 psi (1035 kPa) WSP and 500°F (260°C).
- .3 Maximum Compression: 1-3/4" (45 mm).
- .4 Maximum Extension: 1/4" (6 mm).
- .5 Joint: Flanged.
- .6 Size: Use pipe line sized units
- .7 Application: Steel piping 2-1/2" (65 mm) and smaller.

.3 Externally Pressurized:
- .1 Construction: Self-equalizing type with three or four ply ASTM A240 type 321 stainless steel bellows; ASME A53, Grade B carbon steel housing and pipe nipples; ASME-A36 steel plate guide rings and flanges; ASME A105, 3000-lb thread-o-let drain port & plug.
- .2 Pressure Rating: 300 psi (2070 kPa) WOG and 500°F (260°C).
- .3 Maximum Compression: 8" (200 mm).
- .4 Maximum Extension: 2" (50 mm).
- .5 Joints: Flanged.
- .6 Size: Use pipe line sized units
- .7 Application: Steel piping 3" (75 mm) and larger.

2.6 EXPANSION JOINTS - DESIGN 300 PSIG / 500°F

.1 Ratings

.1 Design Pressure: 300 psig (2070 kPa)
.2 Test Pressure: 450 psig (3105 kPa)
.3 Design Temperature: 500 °F (260°C)

.2 Externally Pressurized:
.1 Construction: Self-equalizing type with three or four ply ASTM A240 type 321 stainless steel bellows; ASME A53, Grade B carbon steel housing and pipe nipples; ASME-A36 steel plate guide rings and flanges; ASME A105, 3000-lb thread-o-let drain port & plug.
.2 Pressure Rating: 300 psi (2070 kPa) WOG and 5000°F (260°C).
.3 Maximum Compression: 8" (200 mm).
.4 Maximum Extension: 2" (50 mm).
.5 Joints: Flanged.
.6 Size: Use pipe line sized units
.7 Application: Steel piping 3" (75 mm) and larger.

2.7 LAMINATED, ULTRA-LOW PRESSURE FORCE SERIES 1501-1506

.1 Ratings:
.1 Design Pressure: 150 PSIG 300 PSIG
.2 Test Pressure: 225 PSIG 450 PSIG
.3 Maximum Temperature: 500 F.
.2 Basis of design: Hyspan series 1501-1506.
.3 Expansion joints shall be low area, three-ply, internally pressurized designs, single or dual configurations as scheduled.
.4 Integral pipe attachments must have a radius where the bellows neck is received.
.5 Expansion joints with larger effective area, welded to the pipe OD, not of three plies, or attached to a pipe without a radius will not be accepted.
.6 Bellows shall be three ply, type 304 or 321 stainless steel, with the effective areas listed below, and attached to the pipe ID. Alloy 625 bellows shall be provided when chloride-ion, stress-corrosion cracking is a concern.

Pipe Size	Effective Area (In^2)	Pipe Size	Effective Area (In^2)
1-1/2"	2.3	6"	33.3
2"	4.1	8"	56.8
2-1/2"	5.8	10"	87.2
3"	8.8	12"	122.0
4"	15.4	14"	152.0

.7 Internal liners of stainless steel shall remain within the joint over all dimensions under design motions.
.8 Bellows receivers of A53 Gr. B (or A106 Gr. B) standard weight pipe, with internal radii.
.9 Flanges shall be A36 carbon steel plate, or A105 forged, with ANSI B16.5 drilling and outside diameter. Flanges may be fixed or lap joint stub end as specified.
.10 Butt weld ends of schedule standard A53 Gr. B (or A106 Gr. B).
.11 Dual joints must include an intermediate anchor base.

2.8 LAMINATED, ULTRA-LOW PRESSURE FORCE, SERIES 1501-1502 HYRISER

.1 Ratings:
  .1 Design Pressure: 150 PSIG
  .2 Test Pressure: 225 PSIG
  .3 Maximum Temperature: 500 F.
.2 Basis of design: Hyspan series 1501/1502 HYRISER.
.3 Expansion joints shall be low area, three-ply, internally pressurized designs, single configuration incorporating an internal guide liner.
.4 Integral pipe attachments must have a radius where the bellows neck is received.
.5 Expansion joints with larger effective area or axial spring rate welded to the pipe OD, not of three plies, or attached to a pipe without a radius will not be accepted.
.6 Bellows shall be three ply, type 304 or 321 stainless steel, with the effective areas listed below, and attached to the pipe ID. Alloy 625 bellows shall be provided when chloride-ion, stress-corrosion cracking is a concern.

Pipe Size	Effective Area (In^2)	Axial Spring Rate (lbs/in)
4"	15.4	155
5"	23.5	190
6"	33.3	348
8"	56.8	325
10"	87.2	411
12"	122.0	614

.7 Internal liners of stainless steel shall remain within the joint over all dimensions under design motions and self-drain.
.8 Bellows receivers of A53 Gr. B (or A106 Gr. B) standard weight pipe, with internal radii.
.9 Flanges shall be A36 carbon steel plate, or A105 forged, with ANSI B16.5 drilling and outside diameter. Flanges may be fixed or lap joint stub end.
.10 Butt weld ends of schedule standard A53 Gr. B (or A106 Gr. B).
.11 Dual joints must include an intermediate anchor base.
.12 Warranty required: 5-Year limited.

2.9 TIED UNIVERSAL EXPANSION JOINTS, SERIES 1511R-1512R

.1 Ratings:
  .1 Design Pressure: 50, 150, or 300 PSIG
  .2 Test Pressure: 75, 225, or 450 PSIG
  .3 Lateral Motions: 2", 3", 4"
  .4 Maximum Temperature 500 F.
.2 Expansion Joints shall be the tied universal configuration incorporating two independent bellows. The expansion joint shall be installed perpendicular to the piping run inducing lateral motion. The expansion joint induces only spring forces to the piping when only lateral motions are absorbed.
.3 Bellows shall be one-to-four plies as required of austenitic stainless steel.
.4 Flanges shall be A36 carbon steel plate, with ANSI B16.5 drilling and outside diameter. Flanges may be fixed, or vanstoned as indicated on the schedule. Carbon steel vanstone flanges

allow slight rotation for misalignment and/or to allow *stainless steel wetted surfaces for corrosion resistance.

.5 Butt weld-ends, shall be schedule standard A53 Gr. B, or the schedule and material grade otherwise indicated.

.6 Tie/Limit rods are required to absorb pressure thrust forces and provide safety limits for design motions.

.7 Internal liners shall be provided for;

.1 liquid flows at 10 feet per second or higher in pipes 6" IPS and over,

.2 flows exceeding 2 feet per second per inch of diameter in pipes under 6" diameter,

.3 flow rates exceeding 100 feet per second

.4 steam service,

.5 abrasive flows.

.8 Tied Universal expansion joints shall be Hyspan series 1511R flanged or 1512R weld end.

2.10 EXTERNALLY-PRESSURIZED & LAMINATED EXPANSION JOINT SERIES 3501-3506

.1 Ratings:

.1 Design Pressure 150 300 PSIG

.2 Test Pressure 225 450 PSIG

.3 Maximum Temperature 500 F.

.2 Expansion joints shall be externally pressurized, with internal and external guides.

.3 Bellows must be three plies with the specified effective areas and attached via independent collars.

.4 Materials of construction are A-53 Gr.B (or A-106 Gr.B) standard weight liner and housing, carbon steel guide rings, and type 304 stainless steel bellows with the effective areas listed below. Attach the bellows to internal and external guide rings via 304 S.S. collars. Use Alloy 625 bellows when chloride-ion, stress-corrosion cracking is a concern.

.5 Bellows welded to guide rings at the root or crest radii are not acceptable.

.6 Vent internal guide rings to reduce the effects of sudden pressure changes.

.7 Include a lifting lug and drain port.

.8 Flanges shall be A36 carbon steel plate, or A105 forged, with ANSI B16.5 drilling and outside diameter. Flanges may be fixed or lap joint stub end.

.9 Butt weld ends of schedule standard A53 Gr. B (or A106 Gr. B).

.10 Dual joints must include an intermediate anchor base.

.11 Design basis: Hyspan series 3500.

Pipe Size	Effective Area (in^2)	Pipe Size	Effective Area (in^2)
1-1/2"	8.2	6"	50.3
2"	8.2	8"	80.5
2-1/2"	10.6	10"	115
3"	13.7	12"	164
4"	22.7	14"	206
5"	35.3	16"	258
		18"	318

2.11 EXTERNALLY-PRESSURIZED & LAMINATED SERIES 8500

.1 Ratings:
- .1 Design Pressure: 200 PSIG
- .2 Test Pressure: 300 PSIG
- .3 Maximum Temperature: 500 F.
- .4 Axial Compression: 2" or 3"

.2 Expansion compensators will be externally pressurized, with internal and external guides. The Expansion Joint Manufacturers Association (EJMA) must certify the manufacturer. Bellows must be two plies minimum with the specified effective areas.

.3 Materials of construction for steel piping compensators are: Butt weld, male pipe thread and steel groove ends with integral liner are schedule standard A53 Grade B, carbon steel housing and guide rings, and *304 s/s or 321 s/s bellows with the effective areas listed below. Flanges, if specified, are provided fixed with ANSI B16.5 drilling and outside diameter. Attach bellows necks to internal and external guide rings. Bellows welded to guide rings at the convolution root or crest radii are not acceptable. **Use Alloy 625 bellows when chloride-ion, stress-corrosion cracking is a concern.*

.4 Materials of construction for copper tube compensators are: Type L copper tube ends male or female sweat, 304 s/s housing and guide rings, *304 or 321 s/s bellows with the effective areas listed below. Attach the bellows necks to internal and external guide rings. Bellows welded to guide rings at the convolution root or crest radii are not acceptable.

.5 Expansion compensators will be Hyspan series 8500, or other engineer approved equal.

Steel Pipe Size	Effective Area (in^2)	Copper Tube Size	Effective Area (in^2)
3/4"	1.5	3/4"	1.1
1"	2.1	1"	1.7
1-1/4"	3.3	1-1/4"	2.4
1-1/2"	4.3	1-1/2"	3.2
2"	6.3	2"	5.1
2-1/2"	8.8	2-1/2"	7.6
3"	13.1	3"	10.6
4"	20.8	4"	17.9

2.12 PRESSURE BALANCED, EXTERNALLY-PRESSURIZED, LAMINATED SERIES 3500PB

.1 Ratings:
- .1 Design Pressure 150 300 PSIG
- .2 Test Pressure 225 450 PSIG
- .3 Maximum Temperature 500 F.

.2 Expansion joints pressure balanced, externally pressurized, laminated bellows type, with internal and external guides

.3 Bellows shall be three plies with specified spring rates per Hyspan catalog 574H and attached via independent collars.

.4 Materials of construction are A-53 Gr.B (or A-106 Gr.B) standard weight liner and housing,

carbon steel guide rings, and type 304 stainless steel bellows with three plies. Attach the bellows to internal and external guide rings via 304 S.S. collars. Use Alloy 625 bellows when chloride-ion, stress-corrosion cracking is a concern.

.5 Bellows welded to guide rings at the root or crest radii are not acceptable.

.6 Vent internal guide rings to reduce the effects of sudden pressure changes.

.7 Include a lifting lug and drain port.

.8 Flanges shall be A36 carbon steel plate, or A105 forged, with ANSI B16.5 drilling and outside diameter. Flanges may be fixed or lap joint stub end

.9 Butt weld ends of schedule standard A53 Gr. B (or A106 Gr. B).

.10 Dual joints must include an intermediate anchor base.

.11 Design basis: Hyspan series 3500PB.

2.13 SLIP EXPANSION JOINT, SERIES 6500 PERMA-PAX

.1 Expansion joints shall be packed-slip type containing injectable flaked graphite packing and graphite seals. Packing ports allowing packing under full line pressure are required. Non-injectable packing designs are not acceptable. Non-graphite packing and seals are not acceptable.

.2 Internal and external line-bore machined guides of ASTM SB169-C614. Non-ASME rated bearing materials are not acceptable. Joint Seal Force is 850 pounds per inch of diameter or less in published catalog.

.3 A stainless steel extension limit stop ring covering approximately 360 degrees will be included on each slip tube. Limit-stop pins are not acceptable.

.4 The slip tube will be made from A53-Gr.B pipe, schedule 80 from 1-1/4" through 16" IPS and schedule 60 from 18" through 24" IPS sizes. The slip tube will be hard-chromed-plated .002" thick according to ASTM B650.

.5 One-piece body required.

.6 Include a drain port on each joint.

.7 See the expansion joint schedule for required weld end fittings of schedule standard, schedule 40 or schedule 80, or flanges.

.8 Joint design and manufacturing in compliance with ASTM F1007 and MIL-E-17814F.

.9 Expansion joints will be Hyspan Series 6500 Perma-Pax .

Nominal Size (NPS)	Effective Area (in^2)	Joint Seal Force (lbs)
2	4	1700
2-1/2	5.9	2125
3	8.9	2550
4	15	3400
5	23.2	4250
6	32.5	5100
8	55.9	6800
10	86.6	8500
12	123	10,200

14	148	11,900
16	195	13,600
18	247	15,300
20	306	17,000
24	443	20,400

2.14 BALL JOINTS, TYPE N, SERIES 6500

.1 Hyspan-Barco Type N Series I Ball Joints
- .1 Angular motion of plus and minus 7.5 degrees and torsional motion of 360 degrees
- .2 Ball, Case and Bolting Retainer of carbon steel - stronger than schedule standard pipe of equivalent size
- .3 Bolted Retainer Ball Joints allowing field tightening/adjustment of bearing/seals and unbolting replacement of bearing/seals via bolt removal. Cutting and rewelding of ball joint case for bearing/seal removal and replacement will not be accepted
- .4 Ball hard-chromed-plated .002" thick according to ASTM B650.
- .5 Bearing seals of composite phenolic material not requiring field lubrication
- .6 Design basis: Hyspan series 6500

.2 Hyspan-Barco Type N Series II Ball Joints
- .1 Angular motion of plus and minus 7.5 degrees and torsional motion of 360 degrees
- .2 Ball, Case and Bolting Retainer of carbon steel - stronger than schedule standard pipe of equivalent size.
- .3 Bolted Retainer Ball Joints allowing field tightening/adjustment of bearing/seals and unbolting replacement of bearing/seals via bolt removal. Cutting and rewelding of ball joint case for bearing/seal removal and replacement will not be accepted. Injectable graphite secondary seal shall be included.
- .4 Flake graphite packing injected, plugged and tested at the factory.
- .5 Ball hard-chromed-plated .002" thick according to ASTM B650.
- .6 Bearing seals of ductile iron, composite phenolic, Inconel or other factory clarified material
- .7 Design basis: Hyspan series 6500

2.15 HIGH PERFORMANCE TYPE N BALL JOINTS

.1 Design Conditions;
- .1 Design Pressure: psig
- .2 Test Pressure: psig
- .3 Design Temperature: °F

.2 Description: flanged, bolted retainer type with _____ seals and integral recharge cylinders designed for injection of asbestos-free pure flaked graphite sealant and shall be capable of sealing without the use of additional bypass containment seals. Injectors shall include an integral stainless steel shut off valve for injection of sealant under full continuous operating conditions of the system. Ball joints shall provide 360° of rotation and 15° total angular flex.

.3 Materials and Construction;
- .1 All pressure containing parts and bolting shall be designed and manufactured from materials conforming to code requirements of ASME Section II and ANSI/ASME B31.1

.2 Carbon steel ball spheres shall be plated with 2 mils of chrome consisting of 1 mil hard chrome over 1 mil of crack-free chrome. The chrome plating shall be protected by a baked-on molybdenum disulfide coating.

.3 Ball joint pipe connection ends shall be beveled for welding to standard wall pipe (unless otherwise specified) or with ANSI forged steel weld neck flanges

.4 Acceptance Testing:

.1 All flexible ball joints shall be hydrostatically tested at one-and-one half times design pressure.

.2 Each ball joint shall be pressurized with 50 psig saturated steam, or thermal equivalent, inspected for leakage and have bolts properly torqued prior to shipment

.3 Ball joints shall be capable of certification to Mil-Std 167 vibration test and Mil-S-901 shock test.

.5 Design basis: Hyspan-BarcoStyle III High Performance Type N ball joints **or** Hyspan-BarcoStyle III High Performance Type N ball joints with Type V Injectors

3 EXECUTION

3.1 INSTALLATION

.1 Install flexible pipe connectors and expansion joints to manufacturer's instructions.

.2 Ratings and bolt patterns for flanges shall suit design pressure and design temperature of piping system and match those of installed components.

.3 Construct spool pieces to exact size of flexible connection for future insertion.

.4 Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.

.5 Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

.6 Pipe anchors shall be installed securing the piping system to the building structure in order to control the direction and the amount of pipe movement. In addition, pipe anchors shall be installed to prevent separation of pipe due to hydraulic pressures. Pipe anchors shall be designed by the Contractor to accommodate all forces experienced. Prepare calculations for each anchor and submit to Consultant for review and approval. Provide pipe guides so movement is directed along axis of pipe only. Not less than two guides shall be provided on each side of an expansion joint. Erect piping such that strain and weight is not on cast connections or apparatus.

.7 Provide support and equipment required to control expansion and contraction of piping. Provide pipe offsets, and swing joints, or expansion joints where required. The Contractor may elect to install expansion loops in place of expansion compensators where there is adequate space to do so; subject to the approval of the Consultant. The Contractor shall prepare and submit detailed design calculations for each expansion loop proposed to the Consultant for review and approval prior to installation.

3.2 MANUFACTURER'S FIELD SERVICES

.1 Prepare and start systems to Section 15010.

.2 Provide inspection services by manufacturer's representative for final installing and certify installation is to manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

.1 Pipe and equipment hangers and supports.
.2 Equipment bases and supports.
.3 Sleeves and seals.
.4 Flashing and sealing equipment and pipe stacks.

1.3 REFERENCES

.1 ASME B31.1 - Power Piping.
.2 ASME B31.2 - Fuel Gas Piping.
.3 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
.4 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
.5 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
.6 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
.7 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
.8 NFPA 13 - Installation of Sprinkler Systems.
.9 NFPA 14 - Installation of Standpipe, Private Hydrants, and Hose Systems.
.10 UL 203 - Pipe Hanger Equipment for Fire protection Service.

1.4 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
.3 Product Data: Provide manufacturers catalogue data including load capacity.
.4 Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
.5 Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 REGULATORY REQUIREMENTS

.1 Conform to CSA B-51 for support of piping.

2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

.1 Manufacturers:
  .1 Anvil
  .2 Myat

.3 Hunt

.2 Hydronic Piping:

.1 Conform to CSA B-51 and ASME B31.9.

.2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.

.3 Hangers for Cold Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.

.4 Hangers for Hot Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.

.5 Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.

.6 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.7 Multiple or Trapeze Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Steel channels with welded spacers and hanger rods, cast iron roll.

.8 Wall Support for Pipe Sizes to 3" (76 mm): Cast iron hook.

.9 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.

.10 Wall Support for Hot Pipe Sizes 6" (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

.11 Vertical Support: Steel riser clamp.

.12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.13 Floor Support for Hot Pipe Sizes to 4" (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.14 Floor Support for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

.15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.3 Steam and Steam Condensate Piping:

.1 Conform to CSA B-51 and ASME B31.1.

.2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.

.3 Hangers for Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.

.4 Hangers for Pipe Sizes 6" (150 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.

.5 Multiple or Trapeze Hangers for Pipe Sizes to 4" (100 mm): Steel channels with welded spacers and hanger rods.

.6 Multiple or Trapeze Hangers for Pipe Sizes 6" (150 mm) and Over: Steel channels with welded spacers and hanger rods; cast iron roll and stand.

.7 Wall Support for Pipe Sizes to 2-3/4" (70 mm): Cast iron hook.

.8 Wall Support for Pipe Sizes 4" to 5" (100 to 125 mm): Welded steel bracket and wrought steel clamp.

.9 Wall Support for Pipe Sizes 6" (150 mm) and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll.

.10 Vertical Support: Steel riser clamp.
.11 Floor Support for Pipe Sizes to 4" (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
.12 Floor Support for Pipe Sizes 6" (150 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
.13 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.2 ACCESSORIES

.1 Hanger Rods: galvanized, carbon steel continuous threaded.
.2 Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.3 EQUIPMENT ROOF CURBS

.1 Fabrication: Welded 0.05" (1.2 mm) galvanized steel shell and base, mitred 3" (75 mm) cant, variable step to match roof insulation, factory installed wood nailer.

2.4 ROOFTOP PIPE/DUCT SUPPORTS

.1 Acceptable manufacturers;
  .1 Portable Pipe Hangers, Inc.
  .2 Unistrut
.2 Pre-engineered pipe/duct support system including;
  .1 Bases: weather resistant and UV radiation resistant with seismic attachments
  .2 Framing: 1-5/8" (41.3mm) strut or 1-7/8" (47.6mm) strut, fabricated of steel to ASTM A570, Grade 33., roll formed of 12-gauge (2.7mm thick) steel into 3-sided or tubular shape.
  .3 Pipe Supports and Hangers: Conform to MSS SP-58 and MSS SP-69, fabricated of carbon steel. Single roller supports for piping subject to expansion and contraction.
  .4 Finishes:
    .1 Plastics as moulded with UV radiation protection.
    .2 Metal surfaces hot dip galvanized free of roughness, whiskers, unsightly spangles, icicles, runs, barbs, sags, droplets and other surface blemishes. Galvanizing shall conform to ASTM A123 for tubing and to ASTM A153 for hardware and accessories.
  .5 Shop Drawings: Manufacturer to provide detailed shop drawings to indicate layout and supporting capacities of system components with installation and assembly instructions for each application. Shop drawings shall bear the signature and seal of a professional engineer licenced in Ontario.

3 EXECUTION

3.1 INSTALLATION

.1 Install to manufacturer's instructions and best trade practises.

3.2 INSERTS

.1 Provide inserts for placement in concrete formwork.
.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

3.3 PIPE HANGERS AND SUPPORTS

.1 Support horizontal piping as scheduled.
.2 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.
.3 Place hangers within 12" (300 mm) of each horizontal elbow.
.4 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment.
.5 Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.
.6 Support vertical piping at every other floor. Support vertical cast iron pipe at each floor at hub.
.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
.8 Support riser piping independently of connected horizontal piping.
.9 Provide copper plated hangers and supports for copper piping.
.10 Design hangers for pipe movement without disengagement of supported pipe.
.11 Prime coat exposed steel hangers and supports. Refer to Section 09 91 10. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.4 EQUIPMENT BASES AND SUPPORTS

.1 Provide housekeeping pads of concrete, minimum 4" (100 mm) thick and extending 6" (150 mm) beyond supported equipment. Refer to Section 03 30 00.
.2 Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
.3 Construct supports of steel members. Steel pipe and fittings. Brace and fasten with flanges bolted to structure.
.4 Provide rigid anchors for pipes after vibration isolation components are installed.

3.5 ROOFTOP PIPE/DUCT SUPPORT

.1 Coordinate installation of supports and bases with roofing work. Ensure that roofing

surfaces are smooth and flat and are ready to receive work.

.2 Use care in installation of support systems not to damage roofing, flashing, equipment or related materials.

.3 Install and secure support systems in strict accordance with manufacturer's written instruction.

.4 Consult manufacturers of roofing system to determine if walk pads are required. Provide and fully adhere walk pads to roof system where required.

.5 Bases and support framing shall be located as indicated on shop drawings provided by support system manufacturer and as specified herein. The support of all piping shall be complete and adequate, whether or not all required devices are shown.

.6 The use of wood or wire for supporting piping will not be permitted.

.7 Deflection of pipes shall not exceed 1/240th of the span.

.8 Accurately locate and align bases. Where applicable, replace gravel around bases. Set framing posts into bases and assemble framing structure as indicated.

.9 Use galvanized fasteners for galvanized framing, and use stainless steel fasteners for stainless steel framing.

3.6 FLASHING

.1 Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

.2 Flash vent and soil pipes projecting 3" (75 mm) minimum above finished roof surface with lead worked 1" (25 mm) minimum into hub, 8" (200 mm) minimum clear on sides with 24" x 24" (600 x 600 mm) sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.

.3 Flash floor drains in floors with topping over finished areas with lead, 10" (250 mm) clear on sides with minimum 36" x 36" (910 x 910 mm) sheet size. Fasten flashing to drain clamp device.

.4 Seal roof, floor, shower and mop sink drains watertight to adjacent materials.

.5 Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed to manufacturer's instructions for sound control.

.6 Provide curbs for mechanical roof installations 14" (350 mm) minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

.7 Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 SLEEVES

.1 Set sleeves in position in formwork. Provide reinforcing around sleeves.

.2 Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

.3 Extend sleeves through floors 1" (25 mm) above finished floor level. Caulk sleeves.

.4 Where piping or ductwork penetrates floor, ceiling, or wall, close off space between

pipe or duct and adjacent work with stuffing insulation and caulk. air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

.5 Install chrome plated steel escutcheons at finished surfaces.

3.8 SCHEDULES

.1 Imperial Measure (IP)

Pipe Size (in)	Rod Diameter (in)	Support Spacing (Ft)	
		Steel Pipe	Copper Tube
1/2	3/8	7	6
¾	3/8	7	6
1	3/8	7	6
1-1/4	3/8	7	6
1-1/2	3/8	9	8
2	3/8	10	9
2-1/2	3/8	12	10
3	3/8	12	10
4	5/8	14	12
6	7/8	17	
8	7/8	19	
10	7/8	21	
12	7/8	23	
14	1	25	
16	1	27	
18	1	28	

.2 Metric Measure (SI)

Pipe Size (mm)	Rod Diameter (mm)	Support Spacing (m)	
		Steel Pipe	Copper Tube
13	10	2.1	1.8
20	10	2.1	1.8
25	10	2.1	1.8
32	10	2.1	1.8
38	10	2.7	2.4

50	10	3	2.7
65	10	3.6	3
75	10	3.6	3
100	16	4.2	3.6
150	22	17	
200	22	5.7	
250	22	6.4	
300	22	7	

END OF SECTION

1 GENERAL

1.1 SECTION INCLUDES

.1 Heat tracing for piping.
.2 Heat tracing for equipment.
.3 Controls

1.2 REFERENCES

.1 CSA C22.2 No.130.1 and C22.2 No.130.2.

1.3 SUBMITTALS

.1 Shop drawings: heat tracing components, controls and accessories.
.2 Provide manufacturers catalogue information.

2 PRODUCTS

2.1 HEAT TRACING COMPONENTS

.1 ULC Listed, CSA Certified and FM approved heating cables, components and controls.
.2 Self-regulating heating cable with two (2) parallel 16 AWG nickel-copper bus wires embedded in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field.
.3 Cables shall be covered with a radiation-crosslinked, modified polyolefin dialectric jacket.
.4 Cables shall have an overbraid of tinned copper and an outer jacket of as required by code.
.5 Heating cables shall have a self-regulating factor of at least 90%.
.6 Line voltage: 120V or 208V
.7 Component enclosures sahll be rated NEMA 4X
.8 Components that make electrical connections shall be re-enterable for servicing. No component shall use silicone to seal electrical connections, except where a conduit transition is required.
.9 Connection systems that require the installaing contractor to strip the bus wires, or that use crimps or terminal blocks are not acceptable.
.10 Acceptable Products: Raychem Corporation XL-Trace.

2.2 CONTROLS

.1 Manual Control: the system shall be controlled by a switch, either directly or through an appropriate contactor.
.2 Thermostatic Control - Ambient Sensing: the system shall be controlled by an

ambient sensing thermostat set at 40°F either directly or through an appropriate contactor.

3 EXECUTION

3.1 INSTALLATION

.1 Install heating cables in accordance with manufacturer's instructions.
.2 Distribute and fasten cable evenly using pipe strap or fibreglass tape at maximum spacing 0.5 m.
.3 Ensure that heating cables do not touch or cross each other at any point.
.4 Run only cold leads in conduit and ensure sensing bulb does not touch cable.
.5 Loop additional cable at fittings, valves, and flanges.
.6 Ground shield to building ground.
.7 Make power and control connections.
.8 Power connection, end seal, splice and tee kit components shall be applied in the field.
.9 Heating cable circuit shall be protected by a ground-fault device for equipment protection.
.10 Coordinate cable installation with insulation application.
.11 Apply "Electric Traced" labels to outside of thermal insulation.

3.2 TESTING

.1 Perform tests in accordance with manufacturer's instructions.
.2 Use 2500 Vdc megger to test cables for continuity and insulation value and record readings before, during and after installation.
.3 Minimum insulation resistance shall be 20 megohms.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

.1 Vibration control of piping, ductwork and equipment.
.2 Inertia bases.
.3 Coordination with Supports and Anchors
.4 Coordination with Seismic Restraint of Piping & Equipment

1.3 REFERENCES

.1 Ontario Building Code.
.2 SMACNA "HVAC Duct Construction Standards"

1.4 PERFORMANCE REQUIREMENTS

.1 Provide vibration isolation on motor driven equipment over (1/2 HP), plus connected piping and ductwork.
.2 Provide minimum static deflection of isolators for equipment as indicated.
    .1 Basement, Under 15 kW
        .1 Under 400 rpm: RIS
        .2 400 - 600 rpm: 1" (25 mm)
        .3 600 - 800 rpm: 1/2" (12 mm)
        .4 800 - 900 rpm: 1/4" (5 mm)
        .5 1100 - 1500 rpm: 1/8" (4 mm)
        .6 Over 1500 rpm: 1/8" (3 mm)
    .2 Basement, Over 15 kW
        .1 Under 400 rpm: RIS
        .2 400 - 600 rpm: 2" (50 mm)
        .3 600 - 800 rpm: 1" (25 mm)
        .4 800 - 900 rpm: 1/2" (12 mm)
        .5 1100 - 1500 rpm: 1/4" (5 mm)
        .6 Over 1500 rpm: 1/8" (4 mm)
    .3 Upper Floors, Normal
        .1 Under 400 rpm: 1-1/2" (40 mm)
        .2 400 - 600 rpm: 3-1/2" (90 mm)
        .3 600 - 800 rpm: 2" (50 mm)
        .4 800 - 900 rpm: 1" (25 mm)
        .5 1100 - 1500 rpm: 1/2" (12 mm)
        .6 Over 1500 rpm: 1/4" (5 mm)
    .4 Upper Floors, Critical
        .1 Under 400 rpm: 1-1/2" (40 mm)

.2 400 - 600 rpm: 2" (50 mm)
.3 600 - 800 rpm: 3-1/2" (90 mm)
.4 800 - 900 rpm: 2" (50 mm)
.5 1100 - 1500 rpm: 1" (25 mm)
.6 Over 1500 rpm: 1/2" (12 mm)

.3 Consider upper floor locations critical unless otherwise indicated.

.4 Use concrete inertia bases for fans having static pressure in excess of 3.4 IN. WG (0.85 kPa) or motors in excess of 40 HP (30 kW), and on base mounted pumps over 10 HP (7.5 kW).

.5 Provide seismic restraints in accordance with Ontario Building Code requirements for Post Disaster Buildings. Seismic restraints shall be designed, installed and reviewed under the direct supervision of a professional engineer licensed in the Province of Ontario.

1.5 SUBMITTALS

.1 Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.

.2 Product Data: Provide schedule of vibration isolator type with location and load on each.

.3 Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.

.4 Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Manufacturer shall be a member of VISCMA.

.2 Coordinate selection of Manufacturer with Section.

.3 Acceptable manufacturers;
.1 Kinetics Vibron
.2 Vibro Acoustics
.3 The VMC Group (Korfund-Masdom)

2.2 VIBRATION ISOLATORS

.1 Isolators and bases shall be as tabulated on the equipment schedule.

.2 Type 1 Isolators: Model KIP Precompressed Molded Fiberglass Noise and Vibration Isolation Pads, individually coated with a flexible moisture-impervious elastomeric membrane. Pads shall be fine (0.00027"/6.9 micron diameter) bonded annealed glass fibers which have been stabilized during manufacture by compressing the material ten times. Pads shall have a constant natural frequency over the operating load range, and the stiffness shall increase proportionately with load applied. Pads

shall be no taller than the shortest horizontal dimension. Where the equipment base does not provide a uniform load surface, steel plates shall be bonded to the top of the pads. Alternatively, Model RD Neoprene Mounts, incorporating completely enclosed metal inserts to permit bolting to the supported unit, may be used.

.3 Type 2 Floor Isolators: Model FDS Free-Standing, Unhoused, Laterally Stable Steel Springs incorporating levelling bolts and 1/4 in. (6 mm) thick ribbed noise isolation pads.To assure stability, the spring shall have a lateral spring stiffness greater than 1.0 times the rated vertical stiffness, and shall be designed to provide 50% overload capacity. In capacities up to 5,000 lbs. (2268 kg), springs shall be replaceable. In capacities over 5,000 lbs. (2268 kg), springs shall be welded to the top and bottom load plate assemblies.

.4 Type 2 Hangers: Model SFH Combination Spring and Fiberglass Hangers, incorporating pre-compressed moulded fiberglass noise and vibration isolation pads, coated with a moisture impervious elastomeric membrane in series with springs, all encased in welded steel brackets. Springs shall be as specified above. Isolators shall be designed to accommodate rod misalignment over a 30 degree arc. Brackets shall be designed to carry 500% overload without failure.

.5 Type 3 Isolators: Model FLS, Free-Standing, Laterally Stable, Spring Isolators, similar to Type FDS, but incorporating vertical limit stops to assure a constant operating height if the supported weight is removed, and to reduce movement due to wind loads. Limit stops shall be isolated from the housing to prevent short-circuiting.

.6 Type 4 Bases: No base required. Isolators may be attached directly to the supported equipment.

.7 Type 5 or 6 Bases: Model SFB or SBB Structural Steel Bases, designed and supplied by the isolator manufacturer. Bases shall be designed with isolator brackets to reduce the mounting height of the equipment. To assure adequate stiffness, the height of the members shall be a minimum of 8% of the longest span between isolators, or at least 6 inches (152 mm). Where thinner sections are necessary due to head room limitations, etc., the section modulus of the members selected shall equal or exceed the section modulus of wide flange steel members whose thickness is 8% of the longest span between isolators.

.8 Type 7 Bases: Model CIB Reinforced Concrete Inertia Bases, the steel members of which are designed and supplied by the isolator manufacturer. The concrete shall be poured into a welded steel frame, incorporating prelocated equipment anchor bolts, 1/2 in. (13 mm) diameter reinforcing bars on nominal 8 in. (203 mm) centers each way, and recessed isolator mounting brackets to reduce the mounting height of the equipment, but yet remain within the confines of the base. The thickness of the base shall be a minimum of 8% of the longest span between isolators, at least 6 inches (152 mm), or as indicated on the drawings. Where inertia bases are used to mount pumps, the bases shall be large enough to support piping elbows.

.9 Type 8 Bases: Model KSR, KSCR or ESR Isolation Rail System, consisting of two parallel rail systems, incorporating steel spring isolators designed for the specified static deflection, all fabricated to be installed as a part of the roof curb system, and provide continuous support for the isolated equipment.

.10 Piping: All piping 1 in. (25 mm) diameter and over in the mechanical equipment room, and all piping three supports away from other mechanical equipment shall be isolated from the structure by means of vibration and noise control isolators. Suspended piping shall be isolated with Type 2 Hangers as described above. Floor-mounted piping shall be isolated with Type 2 Spring Isolators as described above.

.11 Flexible members shall be incorporated in the ductwork adjacent to all reciprocating equipment, and shall be approved construction.

.12 Flexible connections shall be incorporated in the ductwork adjacent to all air-moving units. The connections shall be neoprene or canvas of approved construction. High pressure ductwork, for a distance of 50 feet (1270 mm) from high pressure fans shall be isolated from the ductwork by means of Type 2 Hangers as described above.

3 EXECUTION

3.1 INSTALLATION

.1 Install to manufacturer's instructions.

.2 Install isolation for motor driven equipment.

.3 Bases:

.1 Set steel bases for 1" (25 mm) clearance between housekeeping pad and base.

.2 Set concrete inertia bases for 2" (50 mm) clearance between housekeeping pad and base.

.3 Adjust equipment level.

.4 Install spring hangers without binding.

.5 On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

.6 Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

.7 Provide pairs of horizontal limit springs on fans with more than (6.0 in wg) static pressure, and on hanger supported, horizontally mounted axial fans.

.8 Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.06" (1.5 mm) maximum clearance. Provide other snubbers with clearance between 1/8" and 1/4" (4 mm and 7 mm).

.9 Support piping connections to isolated equipment resiliently as follows:

.1 Up to 4" (100 mm) Diameter: First three points of support.

.2 5" to 8" (125 to 200 mm) Diameter: First four points of support.

.3 10" (250 mm) Diameter and Over: First six points of support.

.4 Select three hangers closest to vibration source for minimum 1" (25 mm) static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1" (25 mm) static deflection or 1/2 static deflection of

isolated equipment.

.10 Connect wiring to isolated equipment with flexible hanging loop.

3.2 MANUFACTURER'S FIELD SERVICES

.1 Inspect isolated equipment after installation and submit report. Include static deflections.

3.3 VIBRATION ISOLATOR SELECTIONS

.1 Based on Kinetics Selection Guide. Copied with permission.

.2 Notes to Selection Guide

.1 Provide Type 5 or 6 base if required to support equipment properly.

.2 Provide Type 5, 6 or 7 base if required to stabilize supported equipment.

.3 Isolator natural frequency to be 40% of the lowest equipment operating speed.

.4 Provide HSR thrust restraints for air-moving equipment operating at 2.1in. (501 Pa) static pressure and above..5 Provide 12 in. (305 mm) thick Type 7 inertia base for 75 HP (56 kW) and over pumps

.5 Provide Type 7 inertia base weighing a minimum of 10 times the maximum equipment unbalanced forces.

.6 Provide Type 7 inertia base large enough to provide elbow support.

.7 If RTU weight causes additional roof deflection >0.25" (6 mm), stiffen roof structure or relocate RTU so additional deflection is <=0.25" (6mm). RTUs over noise-sensitive areas may require additional acousticaltreatment too reduce airborne noise below.

.8 Extreme care must be taken for equipment located on spans of over 20ft, especially if construction is open web joints or thin, lightweight slabs. The recommended procedure is to determine the additional deflection caused by equipment in the roof. If additional roof deflection is 0.25 in. or less, the isolator should be selected for 10 times the additional roof deflection. If additional roof deflection is over 0.25 in., supplemental roof stiffening should be installed to bring the roof deflection down below 0.25 in., or the unit should be relocated to a stiffer roof position

* Reference notes do not apply.

\+ Reference note #1 does not apply.

.3 Kinetics Products Meeting Selection Guide .

.1 Type 1
Fiberglass Isolation Pad, Model KIP
Fiberglass Isolation Mount, Model AC
Elastomer Isolation Pad, Model NG

Machinery Mount, Model KLM
Vibration Isolation Mount, Model RD
Isolation Hanger, Model RH

.2 Type 2
Free-standing Steel Spring, Model FDS
Isolation Hanger, Model SH
Isolation Hanger, Model SFH
Isolation Hanger, Model SRH

.3 Type 3
Restrained Spring Isolator, Model FLS

.4 Type 4
No Base Required

.5 Type 5
Structural Rail Base, Model SBB

.6 Type 6
Integral Structural Beam Base, Model SFB

.7 Type 7
Concrete Inertia Base, Model CIB-L
Concrete Inertia Base, Model CIB-H
Concrete Inertia Base, Model CIB-SS

.8 Type 8
Roof Curb Rail, Model KSR, Model KSCR, Model ESR

Taken from Kinetics Selection Guide	EQUIPMENT ITEM	Horsepower and Other (Shaft Power, kW and Other)	RPM	GRADE SUPPORTED SLAB			UP TO 20 FT. (6 M) FLOOR SPAN			20-30 FT. (6-9 M) FLOOR SPAN			30-40 FT. (9-12 M) FL		
				BASE TYPE	ISOLATOR TYPE	MIN. DEFLECTION IN. (MM)	BASE TYPE	ISOLATOR TYPE	MIN. DEFLECTION IN. (MM)	BASE TYPE	ISOLATOR TYPE	MIN. DEFLECTION IN. (MM)	BASE TYPE	ISOLATOR TYPE	DI
AIR COMPRESSORS AND VACUUM PUMPS	Tank-Mounted	up to 10 (7.5)	All	4	2	0.75 (19)	4	2	0.75 (19)	4	2	1.75 (44)	4	2	
		15 (11) and over	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
	Base-Mounted	All	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
	Large Reciprocating	All	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
PUMPS	Close Coupled	up to 7.5 (5.6)	All	5/6*	1	0.25 (6)	7	2	0.75 (19)	7	2	0.75 (19)	7	2	
		10 (7.5) and over	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
	In Line	5 to 25 (3.7 to 19)	All	4	2	0.75 (19)	4	2	1.75 (44)	4	2	1.75 (44)	4	2	
		30 (22) and over	All	4	2	1.75 (44)	4	2	1.75 (44)	4	2	1.75 (44)	4	2	
	End Suction	up to 40 (30)	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
		50 to 125 (37 to93)	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
		150 (110) and over	All	7	2	0.75 (19)	7	2	1.75 (44)	7	2	1.75 (44)	7	2	
	Split Case	up to 40 (30)	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
		50 to 125 (37 to 93)	All	7	2	0.75 (19)	7	2	0.75 (19)	7	2	1.75 (44)	7	2	
		150 (110) and over	All	7	2	0.75 (19)	7	2	1.75 (44)	7	2	1.75 (44)	7	2	
AH, AC AND H & V UNITS	All	up to 10 (7.5)	All	4	2	0.75 (19)	4	2	0.75 (19)	4	2	0.75 (19)	4	2	
		15 (11) and over, up to 4" (1 kPa) static pressure	up to 300	4	2	0.75 (19)	4	2	3.50 (89)	4	2	3.50 (89)	7+	2	
			301 to 500	4	2	0.75 (19)	4	2	2.50 (64)	4	2	2.50 (64)	4	2	
			501 and over	4	2	0.75 (19)	4	2	1.75 (44)	4	2	1.75 (44)	4	2	
		15 (11) and over, 4" (1 kPa) static pressure and over	up to 300	5/6	2	0.75 (19)	7	2	3.50 (89)	7	2	3.50 (89)	7	2	
			301 to 500	5/6	2	0.75 (19)	7	2	1.75 (44)	7	2	2.50 (64)	7	2	
			501 and over	5/6	2	0.75 (19)	7	2	1.75 (44)	7	2	1.75 (44)	7	2	
PACKAGED ROOFTOP EQUIPMENT	All	All	All	4/8	1	0.25 (6)	8	2	0.75 (19)	See note #9			See note #'		

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

.1 Engineering, design and calculations for seismic restraint
.2 Seismic restraints for equipment, piping and ductwork
.3 Coordination with Supports and Anchors
.4 Coordination with Vibration Isolation

1.3 REFERENCES

.1 Ontario Building Code
.2 National Building Code
.3 ASHRAE Standard "A Practical Guide to Seismic Restraint",
.4 SMACNA "HVAC Duct Construction Standards"
.5 Good engineering practice.

1.4 SUBMITTALS

.1 All vibration isolation and seismic restraint systems shall be by one manufacturer. Basis of this design is Vibro-Acoustics.
.2 Submit shop drawings for all devices specified herein and as indicated on the drawings. Submittals shall include dimensions, materials, attachment and anchorage requirements. Indicate compliance with each specification item herein.
.3 Provide calculations for selection of seismic restraints, certified by a qualified professional engineer licensed in the province where the project is located.
.4 Shop Drawings:
    .1 Provide detailed drawings of all seismic control measures for equipment, duct, and piping.
    .2 Provide separate shop drawings for each isolated system complete with performance and product data, indicating all calculations for loads and deflections.
    .3 Indicate inertia bases and locate vibration isolators, with static and dynamic loads on each.
    .4 Shop drawings shall include engineering calculations for all seismic restraints and attachment. A Professional Engineer registered in the province of the project shall sign, seal and date the calculations.
.5 Product Data: Provide schedule of vibration isolator type with location and load on each.
.6 Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
.7 Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to

meet or exceed design requirements.

1.5 PROJECT RECORD DOCUMENTS

.1 Record actual locations of seismic restraints including attachment points.

1.6 SEISMIC DESIGN CRITERIA

.1 For post-disaster buildings;
  .1 Importance factor for wind load, IW, is 1.25
  .2 Importance factor for earthquake loads and effects, IE, is 1.5.
.2 Site classification for seismic site response is unknown
.3 Climatic and Seismic Data from the Ontario Building Code for specific location:

Location	Sa(0.2)	Sa(1.0)	q (1/50)
Hamilton	0.33	0.058	0.46

.4 Terms:
  .1 Sa(0.2): Spectral response acceleration for short periods.
  .2 Sa(1.0): Spectral response acceleration for 1-second periods.
  .3 q(1/50): The reference hourly wind velocity pressure in kPa.

1.7 SEISMIC ENGINEER

.1 Professional Engineer holding a Certificate of Authorization in the Province of Ontario with a minimum of 5 years experience in seismic design, and a minimum of $1 million Professional Liability Insurance including Errors and Omissions Insurance.
.2 At the completion of the project, the Seismic Engineer shall review the installations on site, and shall prepare a written report, with a letter signed, sealed and dated by the Seismic Engineer, certifying that the installations have been completed in accordance with their design and shop drawings.

1.8 SEISMIC CONTROL MEASURES

.1 A single Supplier shall provide seismic design, vibration isolation, and seismic restraint. Coordinate with Section 15190.
.2 Seismic restraints are to be provided for all operational and functional components of building services in accordance with current requirements of the Ontario Building Code.
.3 Cable restraint systems, rod stiffener clamps and seismic isolator capacities shall be verified by an independent test laboratory.
.4 Connection materials shall be selected by and site specific designs to be prepared by the Seismic Engineer. The Seismic Engineer may select and specify materials and anchors to be provided by the contractor where this is appropriate.
.5 Contractor shall ensure that the Seismic Engineers' requirements and specification are met.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Manufacturer shall be a member of VISCMA.
.2 Acceptable manufacturers;
  .1 Vibro Acoustics
  .2 Kinetic-VIbron
  .3 The VMC Group (Korfond – Masdom)

2.2 GENERAL

.1 All isolation and seismic restraint products supplied by common manufacturer / supplier.
.2 All isolators are to be seismic rated or to be used with a bracing or snubber system.
.3 Colour code springs for load carrying capacity.
.4 Outdoor springs and housings to be corrosion resistant.
.5 Units containing water that can be drained are to use a vertical limiting spring as F-2.

3 EXECUTION

3.1 SEISMIC RESTRAINT

.1 Pipes and Ducts: the following pipe and duct sizes, and larger, must be restrained:
  .1 2.5" (64 mm) diameter pipe in general areas
  .2 1.25" (32 mm) diameter pipe in mechanical rooms
  .3 1" (25 mm) diameter pipe containing hazardous materials and medical piping (ie natural gas, oil, medical vacuum, etc)
  .4 6 square feet face area for duct
  .5 any trapeze with a component combined weight that exceeds the above items
.2 Pipes and ducts hung with hanger rods less than 12" (300 mm) in length do not require seismic restraint provided the following conditions are all satisfied:
  .1 All hanger rods in the "run" are attached to the structure with non-moment generating connections; and
  .2 At least 12" (300 mm) clearance on each side of the pipe or duct is provided for the entire "run" so that the pipe or duct can swing freely and will not contact anything; and
  .3 All hanger rods in a "run" of pipe or duct must be less than 12" (300 mm) in length. If one hanger rod exceeds 12" (300 mm) in a "run", this exception cannot be applied.
  .4 The 12" (300 mm) rule does not apply to suspended equipment.
.3 Base Mounted Equipment: all base mounted equipment requires attachments and seismic restraint as specified by the Seismic Engineer.
.4 Suspended Equipment: all suspended equipment requires seismic restraint.
.5 Roof mounted equipment shall be installed on a structural frame, seismic rated roof curb, or structural curb or frame mechanically connected to the structure. Items shall

not be mounted on sleepers or pads that are not mechanically attached to the structure.

.6 Roof mounted piping and ductwork is to be installed on curbs or frames mechanically connected to the building structure. Roof anchors and seismic cables or frames shall be used to resist seismic and wind loading. Wind loading forces shall be determined by the Seismic Engineer.

3.2 INSTALLATION - GENERAL

.1 Install to manufacturer's instructions and adjust mountings to level equipment.

.2 Ensure pipe, duct and electrical connections to isolated equipment do not reduce system flexibility. Ensure that pipe, conduit and duct passing through walls and floors do not transmit vibrations.

.3 Install isolation for motor driven equipment.

.4 Bases:

.1 Set steel bases for 1" (25 mm) clearance between housekeeping pad and base.

.2 Set concrete inertia bases for 2" (50 mm) clearance between housekeeping pad and base.

.3 Adjust equipment level.

.5 Install spring hangers without binding.

.6 On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

.7 Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

.8 Provide pairs of horizontal limit springs on fans with more than 1.5 kPa static pressure, and on hanger supported, horizontally mounted axial fans.

.9 Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.06" (1.5 mm) maximum clearance. Provide other snubbers with clearance between 1/8" and 1/4" (4 mm and 7 mm).

.10 Block and shim level bases so that ductwork and piping connections can be made to a rigid system at the operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

.11 Connect wiring to isolated equipment with flexible hanging loop.

3.3 INSTALLATION - EQUIPMENT

.1 Rigid Mounted Equipment:

.1 Anchor floor and wall mounted equipment to structure as per the seismic shop drawings.

.2 Suspended equipment shall be restrained using sway bracing, or struts, and hanger rods as per the seismic shop drawings.

.2 Vibration isolated equipment:
  .1 Seismic control measures shall not compromise the performance of noise control, vibration isolation or fire stopping systems.
  .2 Equipment supported by vibration-isolation hangers shall be detailed and installed with isolation hangers tight to the structure and upward limit stops located directly below the hangers.

3.4 INSTALLATION - PIPING AND DUCT SYSTEMS

.1 Provide seismic control measures with spacing and anchorage engineered for the specific project. Provide rod stiffeners where required.
.2 Maximum Restraint Spacing
  .1 Piping: transverse spacing 40 ft (12 m), longitudinal spacing 80 ft (24 m).
  .2 Duct: transverse spacing 40 ft (12 m), longitudinal spacing 80 ft (24 m).
  .3 Hazardous Material and Medical Piping: transverse spacing 20 ft (6 m), longitudinal spacing 40 ft (12 m).
.3 Support piping connections to isolated equipment resiliently as follows:
  .1 Up to 4" (100 mm) Diameter: First three points of support.
  .2 5" - 8" (125 to 200 mm) Diameter: First four points of support.
  .3 10" (250 mm) Diameter and Over: First six points of support.
  .4 Select three hangers closest to vibration source for minimum 1" (25 mm) static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1" (25 mm) static deflection or 1/2 static deflection of isolated equipment.
  .5 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 2" (50 mm).
  .6 Deflection shall be not less than that for the equipment to which the piping is connected.
.4 Seismic systems are to be compatible with requirements for anchoring and guiding of piping systems.
.5 Drilled or power driven anchors or fasteners not permitted for use with seismic control measures.
.6 Outdoor and roof mounted systems must be mechanically attached to structure. This attachment must account for seismic and wind loading.
.7 Friction due to gravity does not constitute a seismic attachment.
.8 Where equipment is mounted on concrete housekeeping pads the design of reinforcement and anchorage of the pad to the structure shall be performed by the Seismic Engineer. Alternatively, the equipment must be attached through the pad to the base structure, at the Seismic Engineer's discretion.
.9 Do not brace equipment to separate portions of the structure that may act differently in response to an earthquake. For example, do not connect a transverse brace to a wall and a longitudinal brace to a floor or roof at the same brace location.
.10 All duct over 6 square feet is to be hung with a double trapeze at restraint locations,

one angle on the top and one angle on the bottom of the duct.

.11 Unless noted otherwise on seismic shop drawings, all duct is to be screwed to the trapeze (top and bottom) with #10 screws at 12" (300 mm) spacing for every trapeze.

.12 All pipes must be attached to trapeze with pipe clamps.

.13 Where pipe or duct size reduces below required dimensions noted in Section 2.3.1, the final restraint shall be installed at the transition location.

.14 Items mounted into T-bar suspended ceiling grids require 4 wires to attach the unit to the structure. The wires and their attachment do not form part of the seismic restraint system. If the ceiling grid is seismically restrained, then the item does not require independent seismic restraint. This design in not in this scope of work, as the ceiling grid is an architectural component.

.15 Sleepers for roof mounted pipes, duct, and equipment require mechanical connection to the building. The forces imposed on this attachment are to be provided by the seismic engineer.

.16 Seismic restraint connections are not to be connected to the bottom chord of steel joists or the bottom flange of steel beams.

.17 Rod stiffeners are required where the hanger rod exceeds the maximum length as shown in the seismic calculation sheets. They are only required at restraint locations.

.18 Standard beam clamps can only be used on seismically restrained components; they cannot be used to connect the seismic restraint to the structure - only for the hanger rods.

.19 Horizontal penetrations through walls should be through a pre-fabricated metal sleeve with a compressible material between the pipe and the sleeve. Vertical penetrations through floors/roofs should use an oversize hole in the structure with compressible material between the hole and the pipe and the pipe should be supported by a clamp resting on two steel load-distributing plates.

.20 Block walls can be used for transverse restraints if the item penetrates the wall at 90 degrees and is a snug fit. If angles are attached to the item around its perimeter and attached to the wall, then the wall can act as a transverse and longitudinal restraint. Metal stud walls cannot be used for restraint unless specifically designed.

3.5 MANUFACTURER'S FIELD SERVICES

.1 Examine systems to Section 23 01 01.

.2 Inspect isolated equipment after installation and submit report. Include static deflections.

3.6 PIPE ISOLATION SCHEDULE

Pipe Size (mm)	Isolated Distance from Equipment
25	120 diameters (3.0 m)
50	90 diameters (4.5 m)

80	80 diameters (6.0 m)
100	75 diameters (7.5 m)
150	60 diameters (9.0 m)
200	60 diameters (9.0 m)
250	54 diameters (13.5 m)
300	50 diameters (15.0 m)
400	45 diameters (18.0 m)
600	38 diameters (23.0 m)
Over 600	To be determined by Seismic Engineer

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

.1 Testing, adjustment, and balancing of air systems.
.2 Testing, adjustment, and balancing of piping systems.
.3 Testing, adjustment, and balancing of equipment.
.4 Testing, adjustment and balancing of room relative pressures in health care facilities.
.5 Testing, adjustment, and balancing of smoke management systems.
.6 Measurement of final operating condition of HVAC systems.
.7 Sound measurement of equipment operating conditions.
.8 Vibration measurement of equipment operating conditions.

1.3 REFERENCES

.1 Ontario Building Code.
.2 Ontario Fire Code.
.3 AABC - National Standards for Total System Balance.
.4 ACG - AABC Commissioning Guideline.
.5 ADC - Test Code for Grilles, Registers, and Diffusers.
.6 ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.
.7 ASHRAE Guideline 0 The Commissioning Process,
.8 ASHRAE Guideline 1 The HVAC Commissioning Process,
.9 ASHRAE Guideline 1.1 HVAC&R Technical Requirements for the Commissioning Process,
.10 ASHRAE Guideline 5 Commissioning Smoke Management Systems
.11 ASTM E779 Determining Air Leakage Rate by Fan Pressurization.
.12 NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
.13 SMACNA - HVAC Systems Testing, Adjusting, and Balancing.
.14 SMACNA HVAC Systems Commissioning Manual,
.15 CAN/CSA Z318.0 Commissioning of Health Care Facilities,

1.4 SUBMITTALS

.1 Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.
.2 Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
.3 Prior to commencing work, submit report forms or outlines indicating adjusting,

balancing, and equipment data required.

.4 Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Consultant and for inclusion in operating and maintenance manuals.

.5 Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side.

.6 Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.

.7 Test Reports: Indicate data on AABC National Standards for Total System Balance forms. Submit data based on Project designation IP imperial/SI Metric Units.

.8 All reports shall be prepared in electronic (computer) format using MS Word software and all tabulations shall be prepared in electronic (computer) format using MS Excel spreadsheet software. Submittals shall include three (3) copies each of hard copy printout and two (2) copies with text in ".pdf" and tabulations in ".xls" or ".xlsx" formats on CD, DVD, or USB flash drive.

1.5 PROJECT RECORD DOCUMENTS

.1 Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

.2 Record actual locations of flow measuring stations.

1.6 QUALITY ASSURANCE

.1 Perform total system balance to AABC National Standards for Field Measurement and Instrumentation, Total System Balance.

.2 Maintain one copy of each document on site.

1.7 INDEPENDENT AGENCY

.1 All work of Mechanical Testing, Adjusting and Balancing shall be undertaken by a single agency, employed under Division 23. Other agencies may be proposed as an Alternate only, in accordance with Section 23 01 01, paragraph

.2 The work of the agency consists of the furnishing of all labour, materials, equipment and accessories necessary in the testing, verification and documentation of the operational performance of all equipment and systems installed under the Sections of Division 23: Mechanical.

1.8 QUALIFICATIONS

.1 Agency: Company specializing in the testing, adjusting, and balancing of systems under this Section with minimum five years documented experience certified by AABC from prequalified as listed below. **Alternative require consultant approval.**

.2 Work shall be performed under the supervision of an AABC certified Test and Balance Engineer, an NEBB Certified Testing, Adjusting and Balancing Supervisor or a registered Professional Engineer experienced in the performance of this work and licenced at the place where the Project is located.

.3 Prequalified agencies include;
.1 (GTA, Hamilton & Niagara)
.1 Dynamic Flow Balancnig
.2 Clark Balancing Ltd.

1.9 PRE-BALANCING CONFERENCE

.1 Convene one week prior to commencing work of this Section.

1.10 SEQUENCING

.1 Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

1.11 SCHEDULING

.1 Schedule and provide assistance in final adjustment and test of life safety system with Fire Authority.

1.12 CO-OPERATION

.1 Co-operate with installing Contractor(s) in advising them of specific scheduling requirements for systems verification.
.2 Provide advice to installing Contractors regarding the location and installation of devices required to permit system balancing and measurements, prior to start of the installation work.
.3 Coordinate verification of smoke control and automatic sprinkler systems with verification of fire alarm system under Division 26.

2 PRODUCTS

2.1 REFERENCE STANDARDS

.1 All equipment required for the verification of equipment and systems shall be furnished by the agency employed to conduct the Mechanical Systems Verification.
.2 Testing and measuring equipment used in the verification of the mechanical systems shall be calibrated to give true readings within the accuracy specifications of the equipment used. A certificate of calibration from an independent testing laboratory may be required by the Consultant if there is any reason to suspect that the equipment used is giving erroneous readings. In such an event the verification agency shall reconduct its verifications.
.3 All equipment used by the agency in its verification of mechanical systems remains the property/responsibility of the agency and is not included in the supply to the project.

3 EXECUTION

3.1 EXAMINATION

.1 Verify that systems are complete and operable before commencing work. Ensure the following conditions:
- .1 Systems are started and operating in a safe and normal condition.
- .2 Temperature control systems are installed complete and operable.
- .3 Proper thermal overload protection is in place for electrical equipment.
- .4 Final filters are clean and in place. If required, install temporary media in addition to final filters.
- .5 Duct systems are clean of debris.
- .6 Fans are rotating correctly.
- .7 Fire and volume dampers are in place and open.
- .8 Air coil fins are cleaned and combed.
- .9 Access doors are closed and duct end caps are in place.
- .10 Air outlets are installed and connected.
- .11 Duct system leakage is minimized.
- .12 Hydronic systems are flushed, filled, and vented.
- .13 Pumps are rotating correctly.
- .14 Proper strainer baskets are clean and in place.
- .15 Service and balance valves are open.

.2 Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.

.3 Beginning of work represents acceptance of existing conditions in the areas served.

3.2 PREPARATION

.1 Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Consultant to facilitate spot checks during testing.

.2 Provide additional balancing devices as required.

3.3 INSTALLATION TOLERANCES

.1 Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.

.2 Air Outlets and Inlets: Adjust total to within plus 5 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 5 percent of design.

.3 Hydronic Systems: Adjust to within plus or minus 10 percent of design.

.4 Room Pressurization: Adjust to within plus 20 percent and minus 0 percent of design for rooms under positive pressure and within plus 0 percent and minus 20 percent of design for rooms under negative pressure.

3.4 ADJUSTING

.1 Ensure recorded data represents actual measured or observed conditions.

.2 Permanently mark settings of valves, dampers, and other adjustment devices

allowing settings to be restored. Set and lock memory stops.

.3 After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

.4 Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

.5 At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

.6 Check and adjust systems approximately six months after final acceptance and submit report.

3.5 AIR SYSTEM PROCEDURE

.1 Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

.2 Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

.3 Measure air quantities at air inlets and outlets.

.4 Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

.5 Use branch volume control dampers and splitters to regulate air quantities. Devices at air outlets may be used only to the extent that adjustments do not create objectionable air motion or sound levels.

.6 Vary total system air quantities by adjustment of fan speeds. Adjust airflow to design quantity. Provide drive changes as required. Make allowances for loading of filters to 100% of manufacturers' recommendations for final pressure at fans with variable speed drives.

.7 Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

.8 Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan.

.9 Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

.10 Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

.11 Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

.12 Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 in.wg. (12.5 Pa) positive static pressure near the building entries.

.13 Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

.14 For variable air volume system powered units set volume controller to air flow setting

indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

.15 On fan powered VAV boxes, adjust air flow switches for proper operation.

3.6 WATER SYSTEM PROCEDURE

.1 Adjust water systems to provide required or design quantities.

.2 Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

.3 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

.4 Effect system balance with automatic control valves fully open to heat transfer elements.

.5 Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

.6 Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.7 SCHEDULES

.1 Equipment requiring testing, adjusting and balancing:
- .1 Plumbing Pumps
- .2 Steam Condensate Pumps
- .3 HVAC Pumps
- .4 Air Coils
- .5 Terminal Heat Transfer Units
- .6 Air Handling Units
- .7 Fans
- .8 Air Filters
- .9 Air Terminal Units
- .10 Air Inlets and Outlets

.2 Report Forms
- .1 Title Page:
  - .1 Name of Testing, Adjusting, and Balancing Agency
  - .2 Address of Testing, Adjusting, and Balancing Agency
  - .3 Telephone number of Testing, Adjusting, and Balancing Agency
  - .4 Project name
  - .5 Project location
  - .6 Project Architect
  - .7 Project Engineer

.8 Project Contractor
.9 Project altitude
.10 Report date

.2 Summary Comments:
.1 Design versus final performance
.2 Notable characteristics of system
.3 Description of systems operation sequence
.4 Summary of outdoor and exhaust flows to indicate amount of building pressurization
.5 Nomenclature used throughout report
.6 Test conditions

.3 Instrument List:
.1 Instrument
.2 Manufacturer
.3 Model number
.4 Serial number
.5 Range
.6 Calibration date

.4 Electric Motors:
.1 Manufacturer
.2 Model/Frame
.3 HP/BHP
.4 Phase, voltage, amperage; nameplate, actual, no load
.5 RPM
.6 Service factor
.7 Starter size, rating, heater elements
.8 Sheave Make/Size/Bore

.5 V-Belt Drive:
.1 Identification/location
.2 Required driven RPM
.3 Driven sheave, diameter and RPM
.4 Belt, size and quantity
.5 Motor sheave diameter and RPM
.6 Centre to centre distance, maximum, minimum, and actual

.6 Pump Data:
.1 Identification/number
.2 Manufacturer
.3 Size/model
.4 Impeller
.5 Service
.6 Design flow rate, pressure drop, BHP
.7 Actual flow rate, pressure drop, BHP
.8 Discharge pressure
.9 Suction pressure

.10 Total operating head pressure
.11 Shut off, discharge and suction pressures
.12 Shut off, total head pressure

.7 Air Cooled Condenser:
.1 Identification/number
.2 Location
.3 Manufacturer
.4 Model number
.5 Serial number
.6 Entering DB air temperature, design and actual
.7 Leaving DB air temperature, design and actual
.8 Number of compressors

.8 Cooling Coil Data:
.1 Identification/number
.2 Location
.3 Service
.4 Manufacturer
.5 Air flow, design and actual
.6 Entering air DB temperature, design and actual
.7 Entering air WB temperature, design and actual
.8 Leaving air DB temperature, design and actual
.9 Leaving air WB temperature, design and actual
.10 Water flow, design and actual
.11 Water pressure drop, design and actual
.12 Entering water temperature, design and actual
.13 Leaving water temperature, design and actual
.14 Saturated suction temperature, design and actual
.15 Air pressure drop, design and actual

.9 Heating Coil Data:
.1 Identification/number
.2 Location
.3 Service
.4 Manufacturer
.5 Air flow, design and actual
.6 Water flow, design and actual
.7 Water pressure drop, design and actual
.8 Entering water temperature, design and actual
.9 Leaving water temperature, design and actual
.10 Entering air temperature, design and actual
.11 Leaving air temperature, design and actual
.12 Air pressure drop, design and actual

.10 Air Moving Equipment
.1 Location
.2 Manufacturer

.3 Model number
.4 Serial number
.5 Arrangement/Class/Discharge
.6 Air flow, specified and actual
.7 Return air flow, specified and actual
.8 Outside air flow, specified and actual
.9 Total static pressure (total external), specified and actual
.10 Inlet pressure
.11 Discharge pressure
.12 Sheave Make/Size/Bore
.13 Number of Belts/Make/Size
.14 Fan RPM

.11 Return Air/Outside Air Data:
.1 Identification/location
.2 Design air flow
.3 Actual air flow
.4 Design return air flow
.5 Actual return air flow
.6 Design outside air flow
.7 Actual outside air flow
.8 Return air temperature
.9 Outside air temperature
.10 Required mixed air temperature
.11 Actual mixed air temperature
.12 Design outside/return air ratio
.13 Actual outside/return air ratio

.12 Exhaust Fan Data:
.1 Location
.2 Manufacturer
.3 Model number
.4 Serial number
.5 Air flow, specified and actual
.6 Total static pressure (total external), specified and actual
.7 Inlet pressure
.8 Discharge pressure
.9 Sheave Make/Size/Bore
.10 Number of Belts/Make/Size
.11 Fan RPM

.13 Duct Traverse:
.1 System zone/branch
.2 Duct size
.3 Area
.4 Design velocity
.5 Design air flow

.6 Test velocity
.7 Test air flow
.8 Duct static pressure
.9 Air temperature
.10 Air correction factor

.14 Duct Leak Test:
.1 Description of ductwork under test
.2 Duct design operating pressure
.3 Duct design test static pressure
.4 Duct capacity, air flow
.5 Maximum allowable leakage duct capacity times leak factor
.6 Test apparatus
.1 Blower
.2 Orifice, tube size
.3 Orifice size
.4 Calibrated
.7 Test static pressure
.8 Test orifice differential pressure
.9 Leakage

.15 Terminal Unit Data:
.1 Manufacturer
.2 Type, constant, variable, single, dual duct
.3 Identification/number
.4 Location
.5 Model number
.6 Size
.7 Minimum static pressure
.8 Minimum design air flow
.9 Maximum design air flow
.10 Maximum actual air flow
.11 Inlet static pressure

.16 Air Distribution Test Sheet:
.1 Air terminal number
.2 Room number/location
.3 Terminal type
.4 Terminal size
.5 Area factor
.6 Design velocity
.7 Design air flow
.8 Test (final) velocity
.9 Test (final) air flow
.10 Percent of design air flow

.17 Sound Level Report:
.1 Location

.2 Octave bands - equipment off
.3 Octave bands - equipment on

.18 Vibration Test:
.1 Location of points:
.1 Fan bearing, drive end
.2 Fan bearing, opposite end
.3 Motor bearing, centre (if applicable)
.4 Motor bearing, drive end
.5 Motor bearing, opposite end
.6 Casing (bottom or top)
.7 Casing (side)
.8 Duct after flexible connection (discharge)
.9 Duct after flexible connection (suction)
.2 Test readings:
.1 Horizontal, velocity and displacement
.2 Vertical, velocity and displacement
.3 Axial, velocity and displacement
.3 Normally acceptable readings, velocity and acceleration
.4 Unusual conditions at time of test
.5 Vibration source (if non-complying)

3.8 VERIFICATION CHECKLIST

.1 Prepare a series of checklists to record the verification of each item of equipment and each system. Submit a draft of each checklist to the Consultant and the Owner for review and approval. Discuss comments offered the Consultant and Owner and include improvements as directed.

.2 Checklists shall include the following as a minimum;
.1 date(s) of observations and/or tests,
.2 a record of the nameplate data for each equipment item and each associated motor,
.3 a list of observations appropriate to the equipment item or system with space adjacent to indicate whether the item was satisfactory or unsatisfactory,
.4 appropriate space for recording comments and/or instructions given during observations.

3.9 EQUIPMENT VERIFICATION

.1 Test the operation of all equipment installed under Division 23 according to instructions in appropriate articles of this Division. Advise installing contractor of any required adjustments or replacements to ensure that equipment is operating as intended. Retest equipment after adjustment or replacement.

.2 Ensure that the Contractor has given proper advance notification to all persons required to be present as tests are conducted.

.3 Instrumentation: verify installation of air filter gauges, pumps, thermometers,

thermometer wells, pitot traverse stations, and flow-measuring devices ensuring that:

.1 Location of points for readings is appropriate to measure what it is intended to measure;

.2 The scale range is appropriate to place the normal reading near mid-range of the scale;

.3 Proper positioning of instrumentation to allow reading from a convenient location, and for easy access.

.4 Filters Inspection: visually inspect each filter installation. Verify adjustment of latching devices, installation of end spacers in filter boxes, and proper latching and sealing of access doors. Verify the installation of new (clean) filter media after Contractor's start-up procedures.

.5 Pre-start-up Inspection:

.1 Verify proper equipment mounting and setting.

.2 Verify that control, interlock, and power wiring are complete.

.3 Verify proper alignment of motors and drives.

.4 Verify proper piping connections and accessories.

.5 Verify that lubrication is complete.

.6 First Run Observation:

.1 Verify direction of rotation.

.2 Verify setting of safety controls.

.3 Monitor heat build-up in bearings.

.4 Check motor loads against nameplate ratings.

.7 Equipment Checkout:

.1 Verify the proper overload heater sizes.

.2 Verify function of safety and operating controls.

.3 Verify proper operation of equipment.

.4 Report on inspection, observation, and checkout procedures.

.8 Stuffing Boxes and Packing Glands: verify adjustment of boxes on pump shafts and packing glands on valve stems.

.9 Motor Rotation: visually inspect and verify the direction of motor rotation. It is possible for motor rotation to have been checked by the electrician when power connections were made on temporary electric power, then when final connections were made to the permanent transformer bank, crossed phasing may reverse the rotation of all three-phase motors on the system.

.10 Overload Heaters: verify supply voltage to each equipment. If the applied voltage is different from the motor nameplate, determine whether the applied voltage is within the range allowed under the motor guarantee. If not, take the necessary action to have the Contractor change the motor or the applied voltage. When the voltage is off the nameplate value, but within the allowable range, compute the equivalent amperage at nameplate voltage and compare to the overload heater amperage rating range. Then, consider whether the ambient temperature of the starter is above, below, or the same as the ambient temperature are not the same. Advise the Contractor to use overload heaters of higher range for "hot area" starters or ones of lower range for "cold area" starters to compensate the heater trip point for heat

gains or losses with the environment.

.11 Alignment of Drives: verify the alignment of drives, belt and direct coupled, and the adjustment of belt tension.

.12 Control Diagrams and Sequences: provide for coordination with work under the automatic control systems to have the control diagrams and sequences of operation corrected to "as installed", reflecting changes brought about in response to contract modifications and to the more pragmatic changes in diagrams and sequences to make the installed system control the building systems as intended by the designer.

.13 Safety and Operating Control Setpoints: systematically verify the safety and operating controls of equipment, including an operational check of associated control sequences.

.14 Fin Straightening: inspect finned surface heat transfer coils for damages fins and advise Contractor of repairs required.

.15 Verify that manufacturer's start-up procedures have been performed and that equipment is installed in accordance with the manufacturer's written installation recommendations.

.16 Where work is noted to be done in stages a complete air balance and verification report will be required at the end of each stage.

3.10 PIPING SYSTEMS VERIFICATION

.1 Review the drawings, specifications, and installed work to ensure that systems may be properly balanced in accordance with drawings. Advise the installing Contractor of any additional requirements for effective balancing.

.2 Complete air balance must have been accomplished before water balance is verified.

.3 Open all valves to full position, including coil stop valves, close bypass valves, and return line balancing cocks.

.4 Verify that all strainers are clean.

.5 Examine water in system to determine if it has been treated and is clean.

.6 Check and record type and concentration of glycol in systems which require freeze protection.

.7 Check pump rotation.

.8 Check diaphragm expansion tanks to ensure that fill pressure is adequate (re. static head of systems plus 5 psig or 12 psig minimum (35 kPa or 83 kPa minimum).

.9 Check open expansion tanks to make sure they are not air bound and that the system is full of water.

.10 Check all air vents at high points of water systems to make sure they are installed properly and are operating freely. Verify that all air is removed from circulating system.

.11 Set all temperature controls so that all coils are calling for full cooling. This should close all automatic bypass valves at coil and chillers. To balance hot water coils, set systems to call for full heating.

.12 Verify operation of automatic bypass valve.
.13 Verify operating temperature of heat exchangers, to design requirements.
.14 Check and record the following items at each cooling and heating element:
.1 Inlet water and air temperatures. Note rise or drop in temperature train source.
.2 Leaving water and air temperatures.
.3 Pressure drop and flow through each coil.
.4 Pump operating suction and discharge pressure and final t.d.h. and flow delivered.
.5 Pressure drop across bypass valve.
.6 All mechanical specifications of pumps.
.7 Rated and actual running amperage of pump motor.
.15 Witness all piping tests.

3.11 AIR SYSTEM VERIFICATION

.1 Review drawings, specifications and installed work to ensure that systems may be properly balanced in accordance with drawings. Advise installing Contractor of any additional requirements for effective balancing.
.2 In air handling systems which include supply fans with variable speed drives, airflows shall be verified to design with all filters clean and with all filters loaded to filter manufacturer's recommended final (change-out) resistance. Motor and drive capacity to accommodate full range of filter loadings shall be verified.
.3 In air handling systems which include supply fans without variable speed drives, air filters shall be verified to design airflows with air filters loaded so that the air pressure drop through each filter is equal to the average of the manufacturers listed initial resistance and recommended final (change-out) resistance.
.4 Test and record blower rpm for each fan and air handling unit.
.5 Test and record motor full load amperes.
.6 Make Pitot tube traverse of main supply and obtain operating air quantities at fans.
.7 Test and record system static pressures, suction and discharge.
.8 Test and record system operating recirculated air quantities.
.9 Test and record system operating outside air quantities.
.10 Test and record entering drybulb air temperatures (heating and cooling coils).
.11 Test and record entering wet bulb air temperatures (heating and cooling coils).
.12 Test and record leaving dry bulb air temperatures (heating and cooling coils).
.13 Test and record leaving wet bulb air temperatures (cooling coils only).
.14 Measure airflow in all main and zone branch supply and return air ducts.
.15 Test and record airflow at each diffuser, grille, and register.
.16 Witness and verify results of duct leakage tests conducted under section 15810.
.17 Tabulate and certify test results on suitable forms and submit Consultant for approval and record. Identity each diffuser, grille, and register as to location and area. Identify and list size, type, and manufacturer of diffusers, grilles, registers, and all testing equipment. Use manufacturer's rating on all equipment to make required

calculations.

3.12 MODIFICATIONS TO EXISTING SYSTEMS

.1 Where an existing air/water system is shown to be modified in any way, no work shall be done on it until the air/water flows in that system are measured and a report submitted to the Engineer. On completion of the modifications, the balancing report shall show the unaffected air/water flows in that system have been rebalanced to the original quantities. "Water" systems include glycol-water systems.

3.13 FAN PRESSURE TESTING

.1 Rooms required to maintain a relative pressure differential from adjacent rooms shall be constructed to maintain a relative pressure differential of 0.05" w.g. (12.5 Pa) with a maximum leakage of 1 cfm/15.0 cu. ft. (1.1 l/s/m3) of room volume.

.2 Each room shall be tested by the TAB Agency using a portable pressure tester (Fan Pressurization Method) capable of measuring air flow and room static pressure to within +2% accuracy. Room air leakage is to be measured in the inlet duct of the tester by means of a duct traverse.

.3 Each room supply, exhaust and sanitary exhaust air registers shall be sealed with heavy grade plastic prior to the room test. No other temporary sealing of gaps will be allowed.

.4 Rooms that require Fan Pressure Testing include;

- .1 Class 1 rooms required to maintain a relative pressure differential (positive or negative)
- .2 airborne infection, anterooms (positive to associated isolation room)
- .3 airborne infection, isolation room
- .4 airborne infection, precaution room
- .5 negative pressure rooms
- .6 protective environment, anterooms
- .7 protective environment, isolation rooms
- .8 protective environment, burn rooms
- .9 special care and treatment facilities (under O.B.C. 3.3.3.6)

3.14 ROOM RELATIVE PRESSURES

.1 Supply, return and exhaust airflows shall be arranged to move air from clean to less clean areas.

.2 The relative pressure in contaminated or malodourous areas shall be negative in relation to adjacent areas.

.3 The pressure differential between areas shall be greater than 0.762mm (0.03") of water pressure.

.4 Each room shall be visually inspected before ceilings are installed to ensure that room enclosures are well sealed and able to maintain required pressure differentials.

.5 The following areas shall be negative relative to surrounding areas;
  .1 clinical support space, soiled utility
  .2 diagnostic imaging suites, CT, MRI, X-ray, Ultrasound
  .3 soiled linen
.6 The following areas shall be positive relative to surrounding areas;
  .1 surgery, operating rooms
  .2 surgery, pre-operation holding areas
  .3 surgery, recovery room (PACU)

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

.1 Duct work insulation.
.2 Insulation jackets.

1.3 REFERENCES

.1 Section 23 01 01: Requirements for references and standards.
.2 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
.3 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
.4 ASTM C553 - Standard Specification for Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.
.5 ASTM C612 - Standard Specification for Mineral Fibre Block and Board Thermal Insulation.
.6 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
.7 ASTM C1071 - Fibrous Glass Duct Lining Insulation(Thermal Sound Absorbing Material).
.8 ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
.9 ASTM E96 - Water Vapour Transmission of Materials.
.10 ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
.11 ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
.12 NAIMA National Insulation Standards.
.13 NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
.14 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
.15 UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.
.16 CGSB-Canadian General Standards Board.
.17 CAN/CGSB-51.9 Mineral Fiber Thermal Insulation for Piping and Round Ducting.
.18 CAN/CGSB-51.10 Mineral Fiber Board Thermal Insulation
.19 CAN/CGSB-51.11 Mineral Fiber Thermal Insultation Blanket.
.20 CAN/CGSB-5140 Mineral Insulation, Fexible, Elastomeric, Unicellular, Sheet & Pipe Coverup.
.21 CAN/CGSB-51-GP-52 Ma Vapor Barrier, Jacket and Facing Material for Pipe, Duct & Equipment Thermal Insulation.

1.4 SUBMITTALS FOR REVIEW

.1 Section 23 01 01: Procedures for submittals.
.2 Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.5 SUBMITTALS FOR INFORMATION

.1 Section 23 01 01: Procedures for submittals.
.2 Manufacturer's Instructions: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.

1.6 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
.2 Applicator Qualifications: Company specializing in performing the work of this section with minimum 6 years documented experience.

1.7 REGULATORY REQUIREMENTS

.1 Materials: Flame spread/smoke developed rating of 25/50 to the requirements of the Ontario Building Code.

1.8 DELIVERY, STORAGE, AND PROTECTION

.1 Section 23 01 01: Transport, handle, store, and protect products.
.2 Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
.3 Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.9 ENVIRONMENTAL REQUIREMENTS

.1 Section 23 01 01: Environmental conditions affecting products on site.
.2 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
.3 Maintain temperature during and after installation for minimum period of 24 hours.

2 PRODUCTS

2.1 GLASS FIBRE, FLEXIBLE

.1 Manufacturer: Owens Corning Fiberglas
.2 Other acceptable manufacturers offering equivalent products:
  .1 Manson
  .2 Knauf Fiber Glass

.3 Johns Manville
.4 CertainTEED "Soft Touch" with FSK jacket

.3 Insulation: ASTM C553; flexible, noncombustible blanket.
.1 'ksi' value : ASTM C518, 0.045 at 24 °C (0.31 @ 75.2 °F).
.2 Density: 0.75lb/ft3, 1.01lb/ft3
.3 Maximum service temperature: 121 °C (250 °F).
.4 Maximum moisture absorption: 0.20 % by volume.

.4 Vapour Barrier Jacket:
.1 Kraft paper with glass fibre yarn and bonded to aluminized film. (FSK)
.2 Moisture vapour transmission: ASTM E96; 0.02 perm.
.3 Secure with pressure sensitive tape.

.5 Vapour Barrier Tape:
.1 Kraft paper reinforced with glass fibre yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

.6 Outdoor Vapour Barrier Mastic:
.1 Vinyl emulsion type acrylic or mastic, compatible with insulation, black colour.

.7 Tie Wire: Annealed steel, 1/16" (1.5 mm).

2.2 GLASS FIBRE, RIGID

.1 Manufacturer: Owens Corning Fiberglas Model Vapour-Seal.

.2 Other acceptable manufacturers offering equivalent products:
.1 Manson
.2 Knauf Fiber Glass
.3 Johns Manville

.3 Insulation: ASTM C612; rigid, noncombustible blanket.
.1 'ksi' value : ASTM C518,0.036 at 75.2 °F (24 °C).
.2 Maximum service temperature: 250 °F (121 °C).
.3 Maximum moisture absorption: 0.20 percent by volume.
.4 Density: 48 kg/cu m.

.4 Vapour Barrier Jacket:
.1 Kraft paper with glass fibre yarn and bonded to aluminized film.
.2 Moisture vapour transmission: ASTM E96; 0.04 perm.
.3 Secure with pressure sensitive tape.

2.3 ELASTOMERIC INSULATION

.1 Acceptable Manufacturers:
.1 Armacell APArmaflex, APArmaflex SA or ArmaTuff Laminated Sheets and Rolls

.2 Insulation material shall be a flexible, closed-cell elastomeric insulation in sheet form to ASTM C 534, "Specification for preformed elastomeric cellular thermal insulation in sheet and tubular form."

.3 Insulation materials shall have a closed-cell structure to prevent moisture from wicking.

.4 Insulation material shall be manufactured without the use of CFC's, HFC's or HCFC's,

formaldehyde free, low VOC's, fiber free, dust free and shall resist mold and mildew.

.5 Materials shall have a flame spread index of less than 25 and a smoke-developed index of less than 50 when tested in accordance with ULC S102, ASTM E 84, latest revision. In addition, the product, when tested, shall not melt or drip flaming particles, the flame shall not be progressive and all materials shall pass simulated end-use fire tests.

.6 Materials shall have a maximum thermal conductivity of 0.27 Btu-in./h-ft2- °F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.

.7 Materials shall have a maximum water vapor transmission of 0.08 perm-inches when tested in accordance with ASTM E 96, Procedure A, latest revision.

.8 The material shall be manufactured under an independent third party supervision testing program covering the properties of fire performance, thermal conductivity and water vapor transmission.

2.4 JACKETS

.1 Canvas Jacket: UL listed.
- .1 Fabric: ASTM C921, 220 g/sq m, plain weave cotton treated with dilute fire retardant lagging adhesive.
- .2 Lagging Adhesive: Compatible with insulation.

.2 Mineral Fibre (Outdoor) Jacket: Asphalt impregnated and coated sheet, 2.45 kg/sq m.

.3 PVC Jacket (Indoor):
- .1 Jacket: ASTM C921, One piece sheet material.
  - .1 Minimum Service Temperature: -31 °F (-35 °C).
  - .2 Maximum Service Temperature: 150 °F (66 °C).
  - .3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.
  - .4 Maximum Flame Spread: ASTM E84; 25 or less.
  - .5 Maximum Smoke Developed: ASTM E84; 50 or less.
  - .6 Thickness: 20 mil (0.4 mm) minimum.
- .2 Colour: standard off-white OR coloured to suit duct identification [EDIT]
- .3 Covering Adhesive Mastic
  - .1 Compatible with insulation, maximum VOC content of 50 g/L.
- .4 Manufacturer;
  - .1 Ceel-Co 300 series
  - .2 Speedline *Smoke Safe*

.4 Aluminum Jacket: ASTM B209M.
- .1 Thickness: 0.40 mm sheet.
- .2 Finish: Smooth.
- .3 Joining: Longitudinal slip joints and 2" (50 mm) laps.
- .4 Fittings: 0.4 mm thick die shaped fitting covers with factory attached protective liner.
- .5 Metal Jacket Bands: 3/8" (10 mm) wide; 0.015" (0.38 mm) thick aluminum.

.5 Sheet Waterproofing (Outdoor):
  .1 MFM Building Products Corp. Flexclad 400, VentureTape VentureClad 1577-CW, Polyguard Alumaclad LT
  .2 Prefabricated, Self-Adhering, Sheet-Type Waterproofing Membrane:
    .1 Description:
      .1 Top Layer: Stucco-embossed, UV-resistant aluminum weathering surface.
      .2 Middle Layer: Double layer of high-density polyethylene reinforcement.
      .3 Bottom Layer: Uniform layer of rubberized asphalt adhesive, protected by disposable silicone release paper.
    .2 Heat Aging, ASTM D 794: No visible blistering or deterioration.
    .3 Tear Resistance, ASTM D 1424, Average: 660 grams.
    .4 Elongation, ASTM D 412, Minimum: 450 percent.
    .5 Low Temperature Flexibility, 1,000,000 Cycles at -10 Degrees F, 1,200 Cycles at -20 Degrees F: No cracking.
    .6 Water Vapor Transmission, ASTM E 96: 0.009 perms.
    .7 Flame Spread Index, ASTM E84: 0.
    .8 Smoke Density Index, ASTM E84: 5.
    .9 Wind-Driven Rain, SFBC TAS-110-95, 100 mph: No leakage or failure.
    .10 UV Stability: Excellent.
    .11 Adhesive: MFM Spray Adhesive, low VOC.

2.5 ACCESSORIES

.1 Adhesives and finishes shall be as recommended by the insulation manufacturer and shall comply with Section 15100.2.2. Accessories such as adhesives, mastics and cements shall have the same properties as listed above and shall not detract from any of the system ratings specified.
.2 Vapor retarder lap adhesive shall be water based, fire retardant
.3 Tapes shall be of cloth reinforced aluminum, soft adhesive with minimum 2" (50 mm) width.
.4 Tie wire shall be of 1/16" (1.5 mm) ø stainless steel.
.5 Fasteners shall be of 1/8" (4 mm) Ø pins, with 35 mm square clips. Clip length to suit insulation thickness.
.6 Bands shall be 1/2" (12 mm) wide 1/4" (6mm) thick galvanized steel.
.7 Facing shall be of 1" (25 mm) galvanized steel hexagonal wire mesh attached on both faces of insulation.

3 EXECUTION

3.1 EXAMINATION

.1 Verify that ductwork has been tested before applying insulation materials.
.2 Verify that surfaces are clean, foreign material removed, and dry.

3.2 DUCT INSULATION [EDIT]

.1 Insulate new or altered ductwork and re-insulate existing ductwork where insulation has been removed or damaged as follows:

Service	Insulation Type	Thickness
Air supply - rectangular	rigid	1"
Air supply - round	flexible	1"
Exhaust within 6' of outside - rectangular	rigid	3"
Exhaust within 6' of outside - round	flexible	3"
Fresh air intake - rectangular	rigid	3"
Fresh air intake - round	flexible	3"
Exhaust air plenums	rigid	3"
Ductwork outdoors	rigid	3"
Air supply runouts to terminal units < 10' in length - Rectangular	rigid	1"
Air supply runouts to terminal units < 10' in length - Round	flexible	1"
Duct mounted cooling coils	rigid	1 ½"

Service	Insulation Type	Thickness
Air supply - rectangular	rigid	25 mm
Air supply - round	flexible	25 mm
Exhaust within 2m of outside - rectangular	rigid	75 mm
Exhaust within 2m of outside - round	flexible	75 mm
Fresh air intake - rectangular	rigid	75 mm
Fresh air intake - round	flexible	75 mm
Exhaust air plenums	rigid	75 mm
Ductwork outdoors	rigid	75 mm
Air supply runouts to terminal units < 3m in length - Rectangular	rigid	25 mm
Air supply runouts to terminal units < 3m in length - Round	flexible	25 mm
Duct mounted cooling coils	rigid	40 mm

.2 Inline duct silencers shall be insulated in the same manner as ductwork.

3.3 INSTALLATION

.1 Install duct insulations to TIAC National Installation Standards.

.2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturer' written instructions and as specified.

.3 Insulated ductwork conveying air below ambient temperature:

- .1 Provide insulation with vapour barrier jackets.
- .2 Finish with tape and vapour barrier jacket.
- .3 Continue insulation through walls, sleeves, hangers, and other duct penetrations.
- .4 Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

.4 Insulated ductwork conveying air above ambient temperature:

- .1 Provide with all service jacket.
- .2 Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

.5 Ductwork Exposed in Mechanical Equipment Rooms or Finished Spaces below 3 metres above finished floor: Finish with canvas jacket sized for finish painting.

.6 Exterior Applications: Provide insulation with vapour barrier jacket. Cover with outdoor jacket finished as specified.

.7 External Duct Insulation Application:

- .1 Secure insulation with vapour barrier with wires and seal jacket joints with vapour barrier adhesive or tape to match jacket.
- .2 Secure insulation without vapour barrier with staples, tape, or wires.
- .3 Install without sag on underside of duct work. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct work off trapeze hangers and insert spacers.
- .4 Seal vapour barrier penetrations by mechanical fasteners with vapour barrier adhesive.
- .5 Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

.8 Duct and Plenum Liner Application:

- .1 Adhere insulation with adhesive for 90 percent coverage.
- .2 Secure insulation with mechanical liner fasteners. Refer to SMACNA Standards for spacing.
- .3 Seal and smooth joints. Seal and coat transverse joints.
- .4 Seal liner surface penetrations with adhesive.
- .5 Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

.9 Sheet Waterproofing

- .1 Examine surfaces to receive waterproofing membrane. Notify Consultant if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected.
- .2 Surface Preparation:

.1 Prepare surfaces in accordance with manufacturer's instructions.
.2 Ensure tops of ducts have sufficient slope to eliminate ponding water.
.3 Ensure bottoms of ducts have foil-faced rigid insulation boards installed.
.4 Ensure surfaces are clean and dry.

.3 Remove dirt, dust, oil, grease, hand oils, processing lubricants, moisture, frost, and other contaminants that could adversely affect adhesion of waterproofing membrane.

.4 Prime metal, concrete, and masonry surfaces with primers approved by waterproofing membrane manufacturer.

.5 Application:
.1 Apply waterproofing membrane in accordance with manufacturer's instructions at locations indicated on the drawings.
.2 Apply membrane to clean, dry, primed metal ductwork and foil-faced rigid insulation boards. Do not apply over wet or nonrigid insulation.
.3 Apply membrane in accordance with manufacturer's air, material, and surface temperature requirements.
.4 Apply firm, uniform pressure with hand roller to entire membrane to ensure proper adhesion. Concentrate pressure at seams and on underside of ductwork.
.5 Apply membrane to ducts in accordance with manufacturer's instructions.
.6 Apply membrane shingle fashion to shed water over, not against laps.
.7 Do not terminate membrane on bottom of duct.
.8 Apply minimum 3-inch side laps and minimum 6-inch end laps for ductwork applications.
.9 Embed membrane to bottom of ducts over 24 inches wide in light continuous layer of adhesive applied to insulation facer.
.10 Apply membrane to bottom of insulated ducts over 36 inches wide using mechanical attachment, in addition to adhesive, in accordance with manufacturer's instructions. Install pins on 12-inch centers with rows staggered.
.11 Apply adhesive to areas where special adhesion requirements exist, including duct bottoms, flashings, transitions, joints, elbows, valves, tees, and other fittings.

.6 Protect applied waterproofing membrane from damage during construction.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 07 19.

1.2 SECTION INCLUDES

.1 Piping insulation.
.2 Jackets and accessories.

1.3 REFERENCES

.1 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
.2 ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
.3 ASTM C195 - Mineral Fibre Thermal Insulating Cement.
.4 ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
.5 ASTM C449/C449M - Mineral Fibre Hydraulic-setting Thermal Insulating and Finishing Cement.
.6 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
.7 ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
.8 ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
.9 ASTM C547 - Mineral Fibre Pipe Insulation.
.10 ASTM C552 - Cellular Glass Thermal Insulation.
.11 ASTM C578 - Rigid, Cellular Polystyrene Thermal Insulation.
.12 ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
.13 ASTM C591 - Unfaced Preformed Cellular Polyisocyanurate Thermal Insulation.
.14 ASTM C610 - Moulded Expanded Perlite Block and Pipe Thermal Insulation.
.15 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
.16 ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
.17 ASTM D1667 - Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Foam).
.18 ASTM D2842 - Water Absorption of Rigid Cellular Plastics.
.19 ASTM E84 - Surface Burning Characteristics of Building Materials.
.20 ASTM E96 - Water Vapour Transmission of Materials.
.21 NFPA 255 - Surface Burning Characteristics of Building Materials.
.22 UL 723 - Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

.1 Product Data: Provide product description, list of materials and thickness for each service, and locations.

.2 Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

.1 Materials: Flame spread/smoke developed rating of 25/50 or less to ULC S102 and ASTM E84.

1.6 QUALIFICATIONS

.1 Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Transport, handle, store, and protect products.
.2 Deliver materials to site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
.3 Store insulation in original wrapping and protect from weather and construction traffic.
.4 Protect insulation against dirt, water, chemical, and mechanical damage.

1.8 ENVIRONMENTAL REQUIREMENTS

.1 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
.2 Maintain temperature during and after installation for minimum period of 24 hours.

2 PRODUCTS

2.1 GLASS FIBRE

.1 Manufacturers:
  .1 Manufacturer: Owens Corning Fiberglas
.2 Other acceptable manufacturers offering equivalent products:
  .1 Manson
  .2 Knauf Fiber Glass
  .3 Johns Manville
.3 Insulation: ASTM C547; rigid moulded, noncombustible.
  .1 'ksi' value : ASTM C335, 0.035 at 75°F (24°C).
  .2 Minimum Service Temperature: -20°F (-28.9°C).
  .3 Maximum Service Temperature: 302°F (150°C).
  .4 Maximum Moisture Absorption: 0.2 percent by volume.
.4 Vapour Barrier Jacket
  .1 ASTM C921, White kraft paper reinforced with glass fibre yarn and bonded to aluminized film.

.2 Moisture Vapour Transmission: ASTM E96; 0.02 perm.
.3 Secure with self sealing longitudinal laps and butt strips.
.4 Secure with outward clinch expanding staples and vapour barrier mastic.

.5 Tie Wire: 1.3 mm stainless steel with twisted ends on maximum 12" (300 mm) centres.

.6 Vapour Barrier Lap Adhesive
.1 Compatible with insulation.

.7 Insulating Cement/Mastic
.1 ASTM C195; hydraulic setting on mineral wool, VOC content not to exceed 80 g/L.

.8 Fibrous Glass Fabric
.1 Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
.2 Blanket: 1.0 lb/cu ft (16 kg/cu m) density.

.9 Indoor Vapour Barrier Finish
.1 Vinyl emulsion type acrylic, compatible with insulation, white colour, VOC content not to exceed 250 g/L.

.10 Outdoor Vapour Barrier Mastic
.1 Vinyl emulsion type acrylic, compatible with insulation, white colour.

.11 Insulating Cement
.1 ASTM C449, VOC content not to exceed 80 g/L.

2.2 JACKETS

.1 PVC Plastic
.1 Jacket: ASTM C921, One piece moulded type fitting covers and sheet material.
.1 Minimum Service Temperature: -31°F (-35°C).
.2 Maximum Service Temperature: 151°F (66°C).
.3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.
.4 Maximum Flame Spread: ASTM E84; 25 or less.
.5 Maximum Smoke Developed: ASTM E84; 50 or less.
.6 Thickness: 20 mil (0.4 mm) minimum.
.2 Colour: standard off-white OR coloured to suit pipe identification. [EDIT]
.3 Covering Adhesive Mastic
.1 Compatible with insulation, maximum VOC content of 50 g/L.
.4 Manufacturer;
.1 Ceel-Co 300 series
.2 Speedline Smoke Safe

.2 Aluminum Jacket: ASTM B209.
.1 Thickness: 0.02" (0.40 mm) sheet.
.2 Finish: Smooth.
.3 Joining: Longitudinal slip joints and 2" (50 mm) laps.
.4 Fittings: 0.02" (0.40 mm) thick die shaped fitting covers with factory attached protective liner.
.5 Metal Jacket Bands: 3/8" (10 mm) wide; 0.01" (0.38 mm) thick aluminum.

2.3 REMOVABLE / REUSABLE INSULATION COVERS

.1	Material:	Teflon coated, woven fibreglass fabric
.2	Weight:	16.5 oz/sq.yd. (± 10%)
.3	Thickness:	0.015" (± 10%)
.4	Colour:	Gray
.5	Tensile Strength:	400 x 330 lb. (W x F)
.6	Tarp Tear strength:	60 x 40 lb. (W x F)
.7	Mullen Burst Pressure:	650 psi
.8	Insulation thickness:	Match connecting piping
.9	Temperature Range:	-67°F to 500°F
.10	Lacing Hooks:	Stainless Steel
.11	Tie Wire:	16-ga stainless steel

2.4 ACCESSORIES

.1 Adhesives and finishes shall be as recommended by the insulation manufacturer and shall comply with Section 15100.2.2. Accessories such as adhesives, mastics and cements shall have the same properties as listed above and shall not detract from any of the system ratings specified.

.2 Vapor retarder lap adhesive shall be water based, fire retardant

.3 Tapes shall be of cloth reinforced aluminum, soft adhesive with minimum 2" (50 mm) width.

.4 Tie wire shall be of 1/16" (1.5 mm) ø stainless steel.

.5 Fasteners shall be of 1/8" (4 mm) Ø pins, with 35 mm square clips. Clip length to suit insulation thickness.

.6 Bands shall be 1/2" (12 mm) wide 1/4" (6mm) thick galvanized steel.

.7 Facing shall be of 1" (25 mm) galvanized steel hexagonal wire mesh attached on both faces of insulation

3 EXECUTION

3.1 EXAMINATION

.1 Verify that piping has been tested before applying insulation materials.

.2 Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

.1 Install piping insulations to TIAC National Installation Standards.

.2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturer' written instructions and as specified.

.3 On exposed piping locate insulation and cover seams in least visible locations.

.4 Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:

.1 Provide vapour barrier jackets, factory applied or field applied.

.2 Insulate fittings, joints, and valves with moulded insulation of like material and thickness as adjacent pipe.
.3 Finish with glass cloth and vapour barrier adhesive.
.4 PVC fitting covers may be used.
.5 Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
.6 Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

.5 For insulated pipes conveying fluids above ambient temperature:
.1 Provide standard jackets, with or without vapour barrier, factory applied or field applied.
.2 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
.3 Finish with glass cloth and adhesive.
.4 PVC fitting covers may be used.
.5 For hot piping conveying fluids 140°F (60°C) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
.6 For hot piping conveying fluids over 140°F (60°C), insulate flanges and unions at equipment.

.6 Inserts and Shields:
.1 Application: Piping 1-1/2" (40 mm) diameter or larger.
.2 Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
.3 Insert Location: Between support shield and piping and under the finish jacket.
.4 Insert Configuration: Minimum 6" (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
.5 Insert Material: hydrous calcium silicate insulation.

.7 Finish insulation at supports, protrusions, and interruptions.

.8 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapour barrier cement.

.9 Provide integral vapour barrier jacket on insulation on pipe and fittings for exterior applications.

.10 Provide PVC jacket and fitting covers for pipe in mechanical equipment rooms and where exposed in finished spaces.

.11 Provide aluminum jacket and fitting covers with seams located on bottom side of horizontal piping for exterior applications, in boiler rooms and where subject to temperatures > 200°F (93°C).

.12 For buried piping, provide factory fabricated assembly with inner all-purpose service jacket with self sealing lap, and asphalt impregnated open mesh glass fabric, with one mil (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

.13 For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of

horizontal piping.

3.3 PIPE INSULATION

.1 Insulate new or altered piping with rigid pipe insulation and re-insulate existing piping where insulation has been removed or damaged as follows:

RIGID PIPE INSULATION (I-P)			
Service	**Operating Temperature Range °F**	**Pipe Diameter in.**	**Insulation Thickness in.**
Chilled water	40 to 55	All sizes	1-1/2
	< 40	1 and smaller	1-1/2
		1-1/4 and larger	1-1/2
Cold water make-up (outside building)	0 to 850	All sizes	2
Condensate (cold)	0 to 850	All sizes	1/2
Domestic cold water	0 to 850	All sizes	1
Domestic hot water & hot water recirculation	105 and higher	2 and smaller	1
		2-1/2 and larger	1-1/2
High Pressure Steam and Condensate	251 to 350	1 and smaller	2
		1-1/4 to 4	2-1/2
		5 and larger	3
	>350	2 and smaller	'2-1/2
		2-1/2 to 4	3
		5 and larger	3-1/2
Hydronic heating (hot water & glycol/water)	105 to 140	4 and smaller	1
		5 and larger	1-1/2
	141 to 200	All sizes	1-1/2
Low Pressure Steam and Condensate	141 to 200	All sizes	1-1/2
	201 to 250	2 and smaller	1-1/2
		2-1/2 to 6	2
		8 and larger	3-1/2

Sanitary drainage	40 to 55	All sizes	1
Steam humidifer	201 to 250	2 and smaller	1-1/2
		2-1/2 to 6	2
Storm drainage	40 to 55	All sizes	1

FLEXIBLE INSULATION	
Service	**Insulation Thickness**
Horizontal storm and sanitary drainage	1"
Radiant ceiling panels	2"

RIGID PIPE INSULATION (SI)			
Service	**Operating Temperature Range °C**	**Pipe Diameter (mm)**	**Insulation Thickness (mm)**
Chilled water	4 to 13	All sizes	40
	< 4.4	25 and smaller	40
		38 and larger	40
Cold water make-up (outside building)	-18 to 454	All sizes	50
Condensate (cold)	-18 to 454	All sizes	13
Domestic cold water	-18 to 454	All sizes	25
Domestic hot water & hot water recirculation	41 and higher	50 and smaller	25
		65 and larger	40
High Pressure Steam and Condensate	122 to 177	25 and smaller	50
		32 to 100	65
		125 and larger	75
	>177	50 and smaller	65
		65 to 100	75
		125 and larger	90
Hydronic heating (hot water & glycol/water)	41 to 60	100 and smaller	25
		125 and larger	40
	61 to 93	All sizes	40
Low Pressure	61 to 93	All sizes	40

Steam and Condensate	94 to 121	50 and smaller	40
		65 to 150	50
		200 and larger	90
Sanitary drainage	4 to 13	All sizes	25
Steam humidifier	94 to 121	50 and smaller	40
		65 to 150	50
Storm drainage	4 to 13	All sizes	25

FLEXIBLE INSULATION	
Service	**Insulation Thickness**
Horizontal storm and sanitary drainage	25mm
Radiant ceiling panels	50mm

.2 Insulate valves, flanges and pipe connections with removable / reusable insulation covers.

.3 Wrap butt joints with a 4" (100 mm) strip of fire resistant vapour barrier jacket cemented with lagging adhesive.

.4 Where the pipe hanger is around the insulation, provide an insulation protection shield within the pipe saddle. Coordinate with installation of hangers.

.5 Insulate all fittings, flanges and valves on pipes to provide equivalent insulation to that on adjoining pipe.

.6 Continue insulation through sleeves including specified finish.

.7 Cut back covering on strainers and finish off to expose removable head insulation.

.8 Cover expansion joints first with 24 gauge (0.7 mm) galvanized metal sleeve and then insulate to provide equivalent thickness to that on adjoining pipe.

.9 Protect insulation with protection saddles where insulated pipe is supported by rollers.

.10 Insulate pipe hangers supporting new piping carrying water at 70°F (21°C) or less to prevent condensation. Extend insulating material along hanger rod to height 4 times thickness of insulation. Seal insulation with vapourproof sealant.

.11 Extend pipe insulation and covering through walls, floors, ceilings, and concrete beams, unless indicated otherwise on drawings. Protect exposed insulation extending through floors with 4" (100 mm) wide strip of 18 gauge (1.3 mm) galvanized iron.

.12 Pack annular space between pipe sleeves and piping or pipe covering with glass fibre insulation or rockwool insulation. In fire rated assemblies use Dow Silicon RTV or other ULC listed materials. Seal exposed insulation with mastic.

.13 Recover exposed surfaces of insulated piping installed in exposed areas, mechanical rooms, and equipment rooms with PVC jacketing and PVC fitting covers installed in accordance with manufacturers instructions.

.14 Provide aluminum metal cladding over the insulation on the following services;

.1 All exposed piping located outdoors.

.15 Insulate sprinkler and standpipe main from take-off from domestic water to a point approximately 6 feet (1800 mm) after electrically supervised valve.

.16 Oversize insulation of Domestic hot water piping complete with heating cable for pipe sizes 1-1/4" (35 mm) dia. and smaller by 1/4" (6 mm) in inside diameter to allow for installation over heating cable.

3.4 HIGH TEMPERATURE PIPE INSULATION

.1 Applications: cut or mitre insulation where necessary to fit the shape and contour of the vessel. Impale insulation over welded pins on 12" (300 mm) centres. (When 2 layers are used the joints shall be stagger.) Apply Expanded Metal Lath using speed washers to hold insulation and mesh in place. Lace Metal Edges that butt together with 16 ga. (1.7 mm) galvanized annealed wire.

.2 Emergency Generator Exhaust

.1 Insulate the exhaust stack system including silencer (muffler) with 3" (75 mm) of high temperature pipe insulation.

.2 Tightly butt and stagger all joints. Secure blocks with galvanized steel bands. Provide welded studs, clips or angles as required to anchor wire and bands. Secure a 1" (25 mm) hexagonal wire mesh over the insulation.

.3 In exposed areas, cover insulation with 2 coats of Manson No. 375 finishing cement applied in 1/4" (7 mm) layers and trowel to a smooth hard finish.

.4 Cover with:

.1 6 oz./sq.yd. (200 g/m2) canvas neatly pasted in place.

.2 Aluminum jacketing installed to manufacturers instructions.

.5 Insulation shall be extended up through roof sleeve.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.
.2 Comply with Commissioning Requirements of Section 01 91 13.

1.2 COMISSIONING AGENT

.1 The commissioning agent (CA) has been contracted directly by the Owner for this project. The CA has overall responsibility for planning and coordinating the commissioning process. Commissioning involves all parties to the design and construction process, including the Contractor and his sub-contractors and suppliers.

1.3 DESCRIPTION OF WORK

.1 The purpose of the commissioning process is to provide the owner/operator of the facility with assurance that the plumbing systems have been installed according to the contract documents, and operate within the performance guidelines set out in the design intent documents and these specifications. The CA will provide the Owner with an unbiased, objective view of the system's installation, operation, and performance. The commissioning process does not take away or reduce the responsibility of the installing contractors to provide a finished product, installed and fully functional in accordance with the contract documents.
.2 Commissioning is intended to enhance the quality of system start up and aid in the orderly completion and transfer of systems for beneficial use of owner. The CA will be the leader of the commissioning team, planning and coordinating all commissioning activities in conjunction with the design professionals, construction manager, subcontractors, manufacturers and equipment suppliers.
.3 The General Contractor and Division 22 through Division 28 sub-contractors are responsible for cooperating, and coordinating their work, with the CA. They shall also be responsible for carrying out all the physical activities required for installation of components and systems and operating them during the commissioning process as required in this Section.

1.4 RELATED DOCUMENTS

.1 Drawings and General Requirements of the contract, including General and Supplementary General Conditions, General Requirements and applicable Sections of Division 22 through Division 28 apply to work of this Section.

1.5 REFERENCES

.1 Ontario Building Code (OBC).
.2 Ontario Fire Code (OFC).
.3 ASHRAE Guideline 0 The Commissioning Process,

.4 NFPA Standards and Guidelines

1.6 SYSTEMS TO BE COMISSIONED

.1 The following HVAC work shall be commissioned as part of the Work of this contract:
- .1 Hot Water Heating Systems
- .2 Glycol Heating Systems
- .3 Chilled Water-Cooling Systems
- .4 Piping
- .5 Metering
- .6 Pumps
- .7 Heat Exchangers
- .8 Expansion Tanks
- .9 Unit Heaters, Fan Coil Units, Force Flow Heaters
- .10 Heating Coils
- .11 Cooling Coils
- .12 Air Handling Units
- .13 Energy Recovery Ventilators
- .14 Supply Fans
- .15 Return Fans
- .16 Exhaust Fans
- .17 Ductwork Systems
- .18 Heat pumps
- .19 Controls, Point-to-Point
- .20 Air conditioning and refrigeration systems,
- .21 Renewable energy systems
- .22 Duct pressure testing
- .23 HVAC Systems Cleaning

2 PRODUCTS

2.1 COMISSIONING AUTHORITY

.1 The commissioning authority shall consist of representatives of the following:
- .1 Owner and the Owner's Operating and Maintenance Staff
- .2 Architect
- .3 Mechanical Design Engineer
- .4 Electrical Design Engineer
- .5 Commissioning Consultant (CC)
- .6 General Contractor
- .7 Fire Protection Subcontractor
- .8 Mechanical Subcontractor
- .9 Controls Subcontractor
- .10 Electrical Subcontractor

.11 Testing, Adjusting and Balancing Agency
.12 Related Subcontractors and Suppliers.

2.2 SYSTEM STARTUP VERIFICATION CHECKLISTS

.1 This specification section contains the system start-up and verification checklists as listed below:
.1 Hot Water Heating Systems
.2 Glycol Heating Systems
.3 Chilled Water Cooling Systems
.4 Piping
.5 Metering
.6 Pumps
.7 Heat Exchangers
.8 Expansion Tanks
.9 Unit Heaters, Fan Coil Units, Force Flow Heaters
.10 Heating Coils
.11 Cooling Coils
.12 Air Handling Units
.13 Supply Fans
.14 Return Fans
.15 Exhaust Fans
.16 Ductwork Systems
.17 CAV Terminal Boxes
.18 VAV Terminal Boxes
.19 Heat Pumps
.20 Neg Pressure Rooms
.21 Controls, Point-to-Point

2.3 GENERAL

.1 This specification contains functional performance test checklists as listed below:
.1 Hot Water Heating Systems
.2 Glycol Heating Systems
.3 Chilled Water-Cooling Systems
.4 Piping
.5 Metering
.6 Pumps
.7 Heat Exchangers
.8 Expansion Tanks
.9 Unit Heaters, Fan Coil Units, Force Flow Heaters
.10 Heating Coils
.11 Cooling Coils
.12 Air Handling Units
.13 Supply Fans

.14 Return Fans
.15 Exhaust Fans
.16 Ductwork Systems
.17 CAV Terminal Boxes
.18 VAV Terminal Boxes
.19 Neg Pressure Rooms
.20 Heat Pumps
.21 Controls, Point-to-Point

3 EXECUTION

3.1 GENERAL REQUIREMENTS

.1 Refer to commissioning requirements of section 01 91 13.

END OF SECTION

Actuators And Operators

1. **GENERAL REQUIREMENTS**

1. Damper and valve actuators shall be electronic and/or pneumatic, as specified in the System Description section. Exact OEM equivalents of specified actuators/operators shall be acceptable if clearly identified in submittals.
2. The manufacturer shall be ISO 9001 certified.

1.1 Electronic Damper Actuators

1. Spring Return Actuators:
   a. Manufactured, brand labeled or distributed by Johnson Controls or approved equal.
   b. Regulatory Agency Listing: cULus ,CSA C22.2 No. 24-93, and CE marked.
   c. Direct-Coupled Design: Requires no crankarm or linkage for mounting to a shaft.
   d. Coupling: toothed V-bolt clamp and nuts with toothed cradle.
   e. Reversible Mounting: Provides either clockwise or counterclockwise operation.
   f. Power Failure Operation: Mechanical spring return system drives load to the home position. Other forms of internal energy storage for power failure operation are not acceptable.
   g. Motor Technology:
      i. Modulating Types: Microprocessor-controlled Brushless DC motor.
      ii. On/Off Types: DC brush motor.
   h. Overload Protection: Electronic stall detection protects from overload at all angles of rotation without the use of end switches.
   i. Enclosure Ratings:
      i. NEMA type 2 / IP54 mounted in any orientation.
   j. Double-Insulated construction: Eliminate the need for electrical ground wires.
   k. Wiring: Integral cables with colored and numbered conductors.
   l. Sized for torque required to seal damper at load conditions.
   m. Parallel Operation: Actuators shall be available that are capable of being mechanically or electrically paralleled.
   n. Proportional actuators shall be user configurable without the use of external computer software or programming tools. Calibration, input signal range selection, and control logic reversal shall be selectable with an external mode selection switch.
   o. Operating Temperature Range:
      i. 70 lb·in. Torque and below: -40°F to 140°F.
      ii. 71 lb·in. Torque and above: -40°F to 131°F.
   p. Power Requirements:

i. Modulating Types:

- 27 lb·in. Torque and Below: 5VA maximum.
- 70 lb·in. to 19 lb·in.Torque: 8VA maximum.
- 89 lb·in. to 71 lb·in.Torque: 10VA maximum.
- 90 lb·in. to 177 lb·in.Torque: 16VA maximum.
-

ii. 2-Position Types:

- 27 lb·in. Torque and Below: 5VA maximum.
- 70 lb·in. to 19 lb·in.Torque: 7VA maximum.
- 71 lb·in. to 177 lb·in.Torque: 25VA maximum.

2. Non-Spring Return Actuators
   a. Manufactured, brand labeled or distributed by Johnson Controls or approved equal.
   b. Regulatory Agency: Underwriters Laboratories (UL) Listed, CSA Certified, and CE marked.
   c. Direct-Coupled Design: Requires no crank arm or linkage for mounting to a shaft.
   d. Coupling:
      iii. Above 80 lb.·in.: toothed V-bolt clamp and nuts with toothed cradled.
      iv. 80 lb.·in. and below: single cup-point set screw and toothed cradle.
   e. Overload Protection: Electronic stall detection or magnetic slip clutch protects from overload at all angles of rotation without the use of end switches.
   f. Minimum Enclosure Ratings:
      v. Types with covered wiring terminals: NEMA type 2 / IP42 mounted in any orientation.
      vi. Types without covered wiring terminals: NEMA type 1 / IP30 or IP40.
      vii. Types with integrated cables: NEMA 2 / IP42 mounted in any orientation.
   g. Sized for torque required to seal damper at load conditions.
   h. Parallel Operation: Actuators shall be available that are capable of being mechanically or electrically paralleled.
   i. Proportional actuators shall be user configurable without the use of external computer software or programming tools.
   j. Operating Temperature Range: -4°F to 122°F except for VAV and similar indoor applications in which case 32°F to 122°F is acceptable.
   k. Power Requirements: 24 V with models available for both 24 VAC and 24 VDC operation, maximum:
      viii. Above 80 lb.·in.: 7.5 VA at 24 VAC.
      ix. 80 lb.·in. and below: 3.5 VA at 24 VAC.

l. The manufacturer shall provide 5-year limited warranty from the date of sale covering defects in material or workmanship.

.1 23 09 13.23 Sensors and Transmitters

A. General Requirements

3. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements. Exact OEM equivalents of specified sensors and transmitters shall be acceptable if clearly identified in submittals.

B. Temperature Sensors

4. General Requirements

a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.

b. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD. Thermistor sensors of 10,000 or 2,250 ohms resistance may be substituted based on the application.

c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion.

Point Type	Accuracy
Chilled Water	+ .5°F
Room Temp	+ .5°F
Duct Temperature	+ .5°F
All Others	+ .75°F

5. Room Temperature Sensors

a. Room sensors shall be constructed for either surface or wall box mounting.

b. Room sensors shall have the following options when specified:

x. Setpoint warmer/cooler.

xi. Individual heating/cooling setpoint.

xii. Momentary override request for activation of after-hours operation.

xiii. Analog thermometer.

6. Room Temperature Sensors with Integral Display
    a. Room sensors shall be constructed for either surface or wall box mounting.
    b. Room sensors shall have an integral LCD display and the following capabilities when specified:
        xiv. Display room air temperatures.
        xv. Display and adjust room comfort setpoint.
        xvi. Display and adjust fan operation status.
        xvii. Setpoint override request via setpoint adjust dial or buttons.
        xviii. Timed override request via occupancy override with status indication for activation of after-hours setpoint operation.
        xix. Occupancy sensor status.
        xx. Toggle between Degrees F and Degrees C.
        xxi. Toggle between temperature and humidity where specified.
7. Thermowells
    a. Thermowell manufacturer shall have models available in stainless steel, brass body, and copper bulb.
    b. When thermowells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and sensor.
    c. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
    d. Thermowells and sensors shall be mounted in a direct mount (no adapter) offering faster installation or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.
    e. Thermowells constructed of 316 stainless steel shall comply with Canadian Registration Number (CRN) pressure vessel rating.
8. Outside Air Sensors
    a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall be provided with a solar shield.
    b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
    c. Temperature transmitters shall be of NEMA 3R (IP54) or NEMA 4 (IP65) construction and rated for ambient temperatures.
    d. The outdoor sensor shall be capable of being mounted on a roof, pole or side of a building utilizing its preassembled mounting bracket.
    e. Outside air relative humidity sensors 0-100% full range of accurate measurement. Operating temperature -4 to 140°F (-20 to 60°C).

f. Outside air temperature sensors operating temperature range -40 to 140°F, +/- .55°F (+/- .3°C).

9. Duct Mount Sensors

a. Duct mount sensors shall mount in an electrical box through a hole in the duct, positioned to provide ease of accessibility for repair or replacement.

b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.

c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be provided.

10. Averaging Sensors

a. For ductwork greater in any dimension that 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.

b. For plenum applications, such as mixed air temperature measurements, a continuous averaging sensor or a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.

c. Capillary supports at the sides of the duct shall be provided to support the sensing string.

11. Acceptable Manufacturers: Johnson Controls, Minco.

C. Humidity Sensors

12. The sensor shall be a solid-state type, relative humidity sensor of the Thin Film Capacitance or Bulk Polymer Design. The sensor element shall resist service contamination.

13. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.

14. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH at 77°F unless specified elsewhere.

15. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R (IP54) or NEMA 4 (IP65) enclosure with sealtite fittings.

16. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.

17. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.

18. Acceptable Manufacturers: Johnson Controls and Vaisala.

D. CO_2 Sensors

19. Where shown on the drawings, CO_2 sensors shall have the following features:
    a. Jumper selectable: 0-20mA, 4-20mA & 0-10 VDC output.
    b. Liquid Crystal Display (LCD).
20. The CO_2 sensors shall have the ability to monitor and output the following variables as required by the systems sequence of operations:
    a. Zone CO_2.
21. The CO_2 shall transmit the information back to the controller via jumper selectable 0-20mA, 4-20mA & 0-10 VDC output signals:
    a. The CO_2 sensors shall provide a maximum output current of 25mA; Maximum output voltage of 12.5V.
    b. The CO_2 sensors shall be FCC compliant to CFR47 Part 15 subpart B Class A.
22. The CO_2 sensors shall be available with:
    a. CO_2 response time (0-63%) of 1 minute.
    b. Less than 0.083% of full scale/°F temperature dependence of CO_2 output.
    c. Long term CO_2 stability ±5% of full scale for 5 years.
    d. CO_2 measurement accuracy of ±(40ppm + 2.0% of reading.)
    e. CO_2 non-linearity of less than 1.0% of full scale.
23. The CO_2 sensors may include the following items:
    a. Relay output module.
    b. LCD module.
    c. Analog temperature module with linear 0-10 VDC output for 32-122F.

E. Differential Pressure Transmitters

24. General Air and Water Pressure Transmitter Requirements:
    a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
    b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
    c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
    d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.

25. Building Differential Air Pressure Applications (-1" to +1" WC):
    a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
    b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
        xxii. -1.00 to +1.00 WC input differential pressure ranges. (Select range appropriate for system application.)
        xxiii. 4-20 mA output.
        xxiv. Maintain accuracy up to 20 to 1 ratio turndown.
        xxv. Reference Accuracy: +0.2% of full span.
        xxvi. Acceptable Manufacturers: Johnson Controls or approved equal.

26. Low Differential Air Pressure Applications (0" to 2.5" WC):
    a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
    b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications.
        xxvii. (0.00 - 1.00" to 5.00") WC input differential pressure ranges. (Select range appropriate for system application.)
        xxviii. 4-20 mA, 0-5 VDC, 0-10 VDC output.
        xxix. Maintain accuracy up to 20/1 ratio turndown.
        xxx. Reference Accuracy: +0.25%, or 0.5% of full span.
    c. Acceptable Manufacturers: Johnson Controls and Ruskin.

F. Flow Monitoring
    27. Air Flow Monitoring
        a. Fan Inlet Air Flow Measuring Stations
            xxxi. At the inlet of each fan and near the exit of the inlet sound trap, airflow sensors shall be provided that shall continuously monitor the fan air volumes or velocity pressure.
            xxxii. Each sensor shall be surface mount type. Unit shall be capable of monitoring and reporting the airflow and temperature at each fan inlet location through two or four sensing circuits. If a static pressure manifold is used, it shall incorporate dual offset static tips on the opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as + 20° in the approaching air stream.
            xxxiii. Devices creating fan performance degradation, resulting in additional energy consumption, caused from pressure drop associated with probes or mounting apparatus in the center of the fan inlet are not allowed. The device shall not induce a significant pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the air stream. Sensor circuit casings shall be constructed of U.L. 94 flame rated high impact ABS and include a stainless steel thermistor cap that maintains the precise calibrated flow over the heated and ambient measurement points.
            xxxiv. Acceptable manufacturers: Johnson Controls, Air Monitor Corp., Tek-Air Systems, Inc., or Dietrich Standard.
        b. Single Probe Air Flow Measuring Sensor
            xxxv. The single probe airflow-measuring sensor shall be duct mounted with an adjustable sensor insertion length of up to eight inches. The transmitter shall produce a 4-20 mA or 0-10 VDC signal linear to air velocity. The sensor shall be a thermal dispersion and utilize one temperature sensor and a heated thermistor. The sensor pair shall measure the air temperature and airflow velocity.

c. Duct Air Flow Measuring Stations

xxxvi. Furnish and install, at locations shown on plans or as in accordance with schedules, an equalized air measuring probe system piped to a high performance pressure transducer or an electronic type airflow temperature measuring station.

xxxvii. Each device shall be designed and built in order to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of fundamentals, as well as in the Industrial Ventilation Handbook.

xxxviii. Assembly shall be AMCA tested and capable of measuring a range from 70 to 5,000 FPM (22 to 1524 MPM).

xxxix. Equalized air measuring assembly shall measure to ±3% average and consist of 6063T5 extruded aluminum step sensing blade(s) with anodized finish, plenum-rated polyethylene pressure tubing, brass barbed fittings, mounting hardware and a glass-on-silicone capacitance sensor pressure transducer capable of measuring up to five field-selectable pressure ranges up to 2.5 in. WC.

xl. The transducer shall be accurate to ±0.5%, or 0.25% of full scale and be contained in a National Electrical Manufacturer's Association (NEMA) 4 (IP-65) enclosure. Transducer shall be factory mounted and piped to high and low pressure ports through fittings made of brass.

xli. All sensor tubing shall terminate in solid brass barbed fittings.

xlii. Total and static pressure manifolds shall terminate with external ports for connection to control tubing. An identification label shall be present on each unit casing, listing model number, size, area, and airflow capacity.

xliii. Air straightener shall be provided for sizes over 17 square feet (1.6 sq meter).

xliv. Airflow measuring station assemblies shall be fabricated of galvanized steel or aluminum casing of appropriate thickness for slip fits or with 90 Deg. connecting flanges in configuration and size equal to that of the duct into which it is mounted. Each station shall be complete with an air directionalizer and parallel cell profile suppressor (3/4" maximum cell) across the entering air stream and mechanically fastened to the casing in such a way to withstand velocities up to 5000 feet per minute.

xlv. Electronic air measuring station shall be capable of monitoring and reporting the airflow and temperature at each measuring location through one or more measuring probes containing multiple sensor points and a control transmitter that outputs a 4-20 mA linear signal.

xlvi. Probe(s) shall be constructed of an airfoil shaped aluminum extrusion containing the sensor circuit(s).

xlvii. Each sensor circuit shall consist of coated thermistors, for temperature and velocity, mounted to a Printed Circuit Board (PCB). Multiplexer board shall be encased to prevent moisture damage.

xlviii. Control transmitter shall be capable of processing independent sensing points and shall operate on a fused 24 VAC supply.

xlix. Control transmitter shall feature a 16 x 2 character alphanumeric LCD screen, digital offset/gain adjustment, continuous performing sensor/transmitter diagnostics, and a visual alarm to detect malfunctions.

l. Installation Considerations

- The maximum allowable pressure loss through the Flow and Static Pressure elements shall not exceed .04" WC at 1000 feet per minute, or .11" WC at 2000 feet per minute. Each unit shall measure the airflow rate within an accuracy of plus 3-5% as determined by AMCA.
- Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct. Station flanges shall be 1.5 inches to facilitate matching connecting ductwork.
- Where control dampers are provided as part of the airflow measuring station, parallel blade precision controlled volume dampers integral to the station and complete with actuator, and linkage shall be provided.
- Stations shall be installed in strict accordance with the manufacturer's published requirements, and in accordance with ASME Guidelines affecting non-standard approach conditions.

li. All air measuring devices shall be tested according to AMCA Standard 610.

lii. Acceptable manufacturers: Johnson Controls, Air Monitor Corp., Tek-Air, Ruskin, and Dietrich Standard.

d. Static Pressure Traverse Probe

liii. Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.

liv. Acceptable manufacturers: Cleveland Controls.

e. Shielded Static Air Probe

lv. Where indicated on plans or in schedules a shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse suppression chamber, and airflow shielding.

f. Water Flow Monitoring

lvi. Water flow meters shall be electromagnetic type with integral microprocessor-Based electronics. The meter shall have an accuracy of 0.25%.

lvii. Acceptable manufacturers: Onicon.

G. Power Monitoring Devices

28. Current Measurement (amps)

a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.

b. Current Transformer – A split core current transformer shall be provided to monitor motor amps.

lviii. Operating frequency – 50 - 400 Hz.

lix. Insulation – 0.6 Kv class 10Kv BIL.

lx. UL recognized.

lxi. Five amp secondary.

lxii. Select current range as appropriate for application.

lxiii. Acceptable manufacturers: Setra.

c. Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:

lxiv. 6X input over amp rating for AC inrushes of up to 120 amps.

lxv. Manufactured to UL 1244.

lxvi. Accuracy: +.5%, Ripple +1%.

lxvii. Minimum load resistance 30kOhm.

lxviii. Input 0-20 amps.

lxix. Output 4-20 mA.

lxx. Transducer shall be powered by a 24 VDC regulated power supply (24 VDC +5%).

lxxi. Acceptable manufacturers: Setra.

H. Refrigerant Leak Detectors

29. The refrigerant leak detector shall be a standalone device and shall provide SPDT switch contacts to directly energize the refrigeration room exhaust ventilation fans. The detector shall include a sensor or sensors connected to a control panel. Two relay contacts at the control panel shall provide trouble and alarm indication to the Facility Management System. The alarm relay contact shall also directly energize the exhaust fans.

30. The refrigerant leak detector shall sense the type of refrigerant used in the specified chillers. Multiple sensors shall be required to detect different refrigerants and/or provide proper sensing coverage for the area of the refrigeration room.

31. Acceptable manufacturers: Johnson Controls, MSA Instruments.

I. Smoke Detectors

32. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 26 for installation under Division 23. All wiring for air duct detectors shall be provided under Division 26, Fire Alarm System.

J. Status and Safety Switches

33. General Requirements

a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the Building Management System (BMS) when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

34. Current Sensing Switches

a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.

b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.

c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

d. Acceptable manufacturers: Johnson Controls or approved equal.

35. Air Filter Status Switches

a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.

b. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.

c. Provide appropriate scale range and differential adjustment for intended service.

d. Acceptable manufacturers: Johnson Controls, Cleveland Controls.

36. Air Pressure Safety Switches

a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.

b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

c. Acceptable manufacturers: Johnson Controls, Cleveland Controls.

37. Low Temperature Limit Switches

a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.

b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.

c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

d. The low temperature limit switch shall be equal to Johnson Controls A70.

K. Control Relays

38. Control Pilot Relays

a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.

b. Mounting Bases shall be snap-mount.

c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.

d. Contacts shall be rated for 10 amps at 120VAC.

e. Relays shall have an integral indicator light and check button.

f. Acceptable manufacturers: Johnson Controls, Lectro.

.2 23 09 13.33 Control Valves

A. Ball Valves, 1/2 through 2 in.

39. Ball Valves shall have forged brass bodies.

40. Valves shall have available either Chrome Plated Brass Balls or 300 Series Stainless Steel Balls in all sizes.

41. Valves shall have available either Nickel Plated Brass Stems or 300 Series Stainless Steel Stems with a blow-out proof stem design in all sizes.

42. Valves shall have Graphite reinforced Polytetrafluoroethylene (PTFE) seats with Ethylene Propylene Diene Monomer (EPDM) O-ring backing.

43. Stem seals shall be double EPDM O-rings.
44. Flow Characterization Disk shall be manufactured from Amodel AS-1145HS Polyphthalamide Resin and rated for 50 psi maximum differential pressure and shall be inserted against the casting of the valve.
45. All ball valves with internal pipe thread end connections shall be rated to 580 psi maximum static pressure at 203°F (95°C) fluid temperature.
46. All ball valves with sweat end connections or press end connection shall be rated to 300 psig maximum static pressure at 203°F (95°C) fluid temperature.
47. All valves shall be rated for service with hot water, chilled water and 50% glycol solutions.
48. Ball Valves with stainless steel balls and stems shall be rated for use with 15 psig saturated steam.
49. Flow Characteristics shall be equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.
50. Valves shall have a maximum leakage specification of 0.01% of maximum flow for the control port, ANSI/FCI 70-2, Class 4 and 1% of maximum flow, bypass port.
51. Valves shall be maintenance free.
52. Valves shall be provided with a 5 year equipment warranty.
53. Valves shall be rated for 200 psi differential closeoff pressure.
54. Valve actuators shall be UL-recognized or CSA-certified.
55. Valves shall be Johnson Controls VG1000 Series ball valves or approved equal.

B. Ball Valves, 2-1/2 through 4 in. Flanged

56. Ball Valves shall have forged brass bodies with ASME Class 150 ductile iron flanges.
57. Valves shall have 300 Series Stainless Steel Balls.
58. Valves shall have 300 Series Stainless Steel Stems with a blowout proof stem design.
59. Valves shall have Graphite reinforced PTFE seats with EPDM O-ring backing.
60. Stem seals shall be double EPDM O-rings.
61. Flow Characterization Disk shall be manufactured from Amodel AS-1145HS Polyphthalamide Resin and rated for 50 psi maximum differential pressure.
62. Flow Characteristics shall be equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.
63. Valves shall have a maximum leakage specification of 0.01% of maximum flow for the control port, ANSI/FCI 70-2, Class 4 and 1% of maximum flow, bypass port.
64. All valves shall be rated for service with hot water, chilled water, 50% glycol solutions and rated for use with 25 psig saturated steam.
65. Two-Way Valves shall be rated for 100 psi differential closeoff pressure and Three-Way Valves shall be rated for 50 psi differential closeoff pressure.

66. Valves shall be maintenance free.
67. Valves shall be provided with a 5 year equipment warranty.
68. Valve actuators shall be UL-recognized or CSA-certified.
69. Valves shall be Johnson Controls VG1000 Series ball valves or approved equal.

C. Butterfly Valves, 2 through 20 in. resilient seat ASME Class 125/150 Flanged

70. Butterfly Valves shall have cast iron bodies meetings ASTM A126 Class B requirements and meet ASME class 125/150 flange requirements and shall be fully lugged.
71. Butterfly Valves seat shall be EPDM.
72. Butterfly Valve disk shall be Ductile Iron with Nylon 11 coating.
73. Butterfly Valve stems shall be Stainless Steel.
74. Flow Characteristics shall be equal percentage up to 70° of disk rotation.
75. All valves shall be rated for service with hot water, chilled water and 50% glycol solutions.
76. Valves shall be maintenance free.
77. Valve shall be provided with a 3 year equipment warranty.
78. Valve electric actuators shall be UL-recognized or CSA-certified.
79. Valves shall be Johnson Controls VF Series butterfly valves or approved equal.

D. Butterfly Valves, High Performance 2-1/2 through 16 in.

80. Butterfly Valves shall have bodies manufactured from Carbon Steel, ASTM A216 GR WCB/A516 GR 70 and shall be fully lugged per ASME Class 150 or ASME Class 300.
81. Butterfly Valves seat assembly shall be RPTFE (reinforced polytetrafluoroethylene) and the seat retainer shall be Carbon Steel, ASTM A516 GR 70.
82. Butterfly Valve disk shall be Stainless Steel, ASTM A 351 GR CF8M.
83. Butterfly Valve stems shall be 17-4 PH Stainless Steel, ASTM A564-Type 630.
84. Butterfly Valve Stem Seals shall be One Carbon Fiber Ring and Three TFE Rings.
85. Flow Characteristics shall be equal percentage up to 70° of disk rotation.
86. All valves shall be rated for service with hot water, chilled water, 50% glycol solutions and 50 psig saturated steam in modulating service or 150 psig saturated steam in two-position service.
87. Butterfly Valves shall meet the performance requirements of ASME Class 150 or Class 300.
88. Valves shall be maintenance free.
89. Valves shall be provided with a 3 year equipment warranty.
90. Valve electric actuators shall be UL-recognized or CSA-certified.
91. Valves shall be Johnson Controls VF Series butterfly valves or approved equal.

E. Globe Valves, Brass, 1/2 through 2 in.

92. Valves shall have bodies manufactured from a RoHS compliant brass.
93. Valves shall meet the pressure and temperature requirements of ANSI B16.15, Class 250.
94. Valve stems shall be a 300 Series Stainless Steel.
95. Valves with brass plug and seat shall have stem seals with Self-Adjusting Ethylene Propylene Rubber (EPR) Ring Pack U-Cups.
96. Valves with Stainless Steel plug and seat shall valve stem seals with Spring Loaded PTFE and Elastomer V-Rings.
97. Valves with brass trim shall have a maximum leakage specification of 0.01% of maximum flow per ANSI/FCI 70-2, Class 4 and valves with stainless steel trim shall have a maximum leakage of 0.05% of maximum flow.
98. Flow Characteristics shall be equal percentage for two-way valves and linear for three-way valves.
99. Valves shall be serviceable without being removed from the pipe.
100. Valves shall be provided with a 3 year equipment warranty.
101. Valve electric actuators shall be UL-recognized or CSA-certified.
102. Valves shall be Johnson Controls VG7000 Series globe valves or approved equal.

F. Globe Valves, Cast Iron, 2-1/2 through 6 in.

103. Valves shall have bodies manufactured from cast iron.
104. Valves shall meet the pressure and temperature requirements of ANSI B16.1, Class 125.
105. Valve stems shall be a 316 Series Stainless Steel.
106. Valves shall have stem seals with Ethylene Propylene Terpolymer (EPT) Ring Pack U-Cups.
107. Valves shall have a maximum leakage specification of 0.1% of maximum flow per ANSI/FCI 70-2, Class 3.
108. Flow Characteristics shall be equal modified linear.
109. Valves shall be serviceable without being removed from the pipe.
110. Valves shall be provided with a 3 year equipment warranty.
111. Valve electric actuators shall be UL-recognized or CSA-certified.
112. Valves shall be Johnson Controls VG2000 Series globe valves or approved equal.

G. Electric Zone Valves, 1/2 through 1-1/4 in.

113. Valves shall have bodies manufactured from Forged Brass.
114. Valves stems shall be brass (Hard Chrome Plated.)
115. Valve Actuator shall be UL, cUL listed or CSA certified.
116. Valves shall be rated for service with hot water, chilled water and 50% glycol solutions.

117. Two Position valves shall have models available rated for use with 15 psig saturated steam.

118. Valve Actuator shall be replaceable without removing valve from the pipe.

119. Modulating Valves flow characteristics shall be equal percentage.

120. Valves shall be provided with a 2 year equipment warranty.

121. Valve actuators shall be UL-recognized or CSA-certified.

122. Valves shall be Johnson Controls J Series electric zone valves or approved equal.

H. Pressure Independent Valves, 1/2 through 2 in.

123. Valves bodies shall be manufactured from forged brass and shall be nickel plated.

124. Valves shall have a stem and ball manufactured from chrome plated brass.

125. Valve seat shall be fiberglass reinforced with Teflon®.

126. Characterizing disk shall be brass for 1/2 and 3/4 in. valves, and Tefzel® for sizes 1 through 2 in. valves.

127. Valves shall pressure ratings of 600 psi for 1/2, 3/4 and 1 in. size valves, and pressure rating of 400 psi for 1-1/4, 1-1/2 and 2 in. size valves.

128. Closeoff Pressure rating shall be 200 psi differential pressure.

129. Valves shall have a maximum leakage specification of 0.01% of maximum flow per ANSI/FCI 70-2, Class 4 with a 50 psi differential pressure applied.

130. Valves shall be maintenance free.

131. Valves shall be provided with a 5 year equipment warranty.

132. Valve actuators shall be UL-recognized or CSA-certified.

133. Valves shall be Johnson Controls P1000 Series pressure independent valves or approved equal.

.3 23 09 13.43 Control Dampers

A. The BMS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the drawings.

B. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.

C. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.

D. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with

synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" WC static pressure when tested in accordance with AMCA Std. 500.

E. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" WC, but no more than 4000 FPM or 6" WC.

134. Acceptable manufacturers are Johnson Controls VD-1250, VD1630, or VD-1330, Ruskin CD50 or CD60, and Vent Products 5650.

F. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below.

135. Acceptable manufacturers: Johnson Controls VD-1620, VD-1320, Ruskin CD36, and Vent Products 5800.

G. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

1.1.2. 23 09 23 Direct-Digital Control System for HVAC/Building Management System

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.2 Part 1 – General

1.A Related Documents

136. All work of this Division shall be coordinated and provided by the single BMS Contractor.

137. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the applicable sections for details.

138. The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.

139. If the BMS Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

1.B Definitions

140. Analog: A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values.

141. Binary: A two-state system where an "on" condition is represented by one discrete signal level and an "Off" condition is represented by a second discrete signal level.

142. BMS: The total integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this Division BMS Contractor and to be interfaced to the associated work of other related trades.

143. BMS Contractor: The single Contractor to provide the work of this Division. This Contractor shall be the primary manufacturer, installer, commissioner and ongoing service provider for the BMS work.

144. Control Sequence: A BMS pre-programmed arrangement of software algorithms, logical computation, target values and limits as required to attain the defined operational control objectives.

145. Direct Digital Control: The digital algorithms and pre-defined arrangements included in the BMS software to provide direct closed-loop control for the designated equipment and controlled variables. Inclusive of Proportional, Derivative and Integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like.

146. BMS Network: The total digital on-line real-time interconnected configuration of BMS digital processing units, workstations, panels, sub-panels, controllers, devices and associated elements individually known as network nodes. May exist as one or more fully interfaced and integrated sub-networks, LAN, WAN or the like.

147. Node: A digitally programmable entity existing on the BMS network.

148. BMS Integration: The complete functional and operational interconnection and interfacing of all BMS work elements and nodes in compliance with all applicable codes, standards and ordinances to provide a single coherent BMS as required by this Division.

149. Provide: The term "Provide" and its derivatives when used in this Division shall mean to furnish, install in place, connect, calibrate, test, commission, warrant, document and supply the associated required services ready for operation.

150. PC: Personal Computer from a recognized major manufacturer or a virtual equivalent provided by, or with the consent of the owner.

151. Furnish: The term "Furnish" and its derivatives when used in this Division shall mean supply at the BMS Contractor's expense to the designated third party trade contractor for installation. BMS Contractor shall connect furnished items to the BMS, calibrate, test, commission, warrant and document.

152. Wiring: The term "Wiring" and its derivatives when used in this Division shall mean provide the BMS wiring and terminations.

153. Install: The term "Install" and its derivatives when used in this Division shall mean receive at the jobsite and mount.

154. Protocol: The term "protocol" and its derivatives when used in this Division shall mean a defined set of rules and standards governing the on-line exchange of data between BMS network nodes.

155. Software: The term "software" and its derivatives when used in this Division shall mean all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in the BMS industry for real-time, on-line, integrated BMS configurations.

156. The use of words in the singular in these Division documents shall not be considered as limiting when other indications in these documents denote that more than one such item is being referenced.

157. Headings, paragraph numbers, titles, shading, bolding, underscores, clouds and other symbolic interpretation aids included in the Division documents are for general information only and are to assist in the reading and interpretation of these Documents.

158. The following abbreviations and acronyms may be used in describing the work of this Division:

AHJ	Authority Having Jurisdiction
AI	Analog Input
AO	Analog Output
AWG	American Wire Gauge
BTL	BACnet® Testing Laboratories
CPU	Central Processing Unit
DDC	Direct Digital Control
DI	Digital Input
DO	Digital Output
EEPROM	Electronically Erasable Programmable Read Only Memory

EMI	Electromagnetic Interference
HD	High Definition
HOA	Hand-Off-Auto
I/O	Input/Output
IT	Information Technology
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MCC	Motor Control Center
NC	Normally Closed
NO	Normally Open
OAT	Outdoor Air Temperature
OEM	Original Equipment Manufacturer (Private label)
OWS	Operator Workstation
PC	Personal Computer
ppm	parts per million
RAM	Random Access Memory
RF	Radio Frequency
RFI	Radio Frequency Interference
RH	Relative Humidity
ROM	Read Only Memory
RTD	Resistance Temperature Device
TCP/IP	Transmission Control Protocol/Internet Protocol
UPS	Uninterruptible Power Supply
VAC	Volts, Alternating Current
VAV	Variable Air Volume
VDC	Volts, Direct Current
VPN	Virtual Private Network
VSD	Variable Speed Drive
WAN	Wide Area Network

1.C BMS System Description [existing]

159. The BMS shall be a complete system designed for use with the enterprise IT systems. This functionality shall extend into the equipment rooms. Devices residing on the automation

network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the owner's IT staff to ensure that the BMS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN.

160. Any and all components of the BMS that are connected via field bus or IP network, including the network controllers, field controllers, application specific controllers, server and user interface software, system and controller programming tools and software applications shall be designed, engineered, and tested to work together as a complete building management system, and shall be manufactured by the same BMS manufacturer. Systems that use or require network controllers, field controllers, application specific controllers, server and user interface software, programming tools and software from more than one BMS manufacturer shall not be accepted.

161. All points of user interface shall be on standard computing devices that do not require the purchase of any special software from the BMS manufacturer for use as a building operations terminal. The primary point of interface on these devices will be a standard Web Browser.

162. Where necessary and as dictated elsewhere in these Specifications, Servers shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft SQL Server Express or Microsoft SQL Server as dictated elsewhere in this specification.

163. The work of the single BMS Contractor shall be as defined individually and collectively in all Sections of this Division specification together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.

164. The BMS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.

165. Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.

166. Manage and coordinate the BMS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as not to impede or delay the work of associated trades.

167. The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:

a. Operator information, alarm management and control functions.

b. Information management including monitoring, transmission, archiving, retrieval, and reporting functions.

c. Diagnostic monitoring and reporting of BMS functions.

d. Energy management.

e. Standard applications for terminal HVAC systems.

f. Enterprise-wide information and control access.

g. Offsite monitoring and management access.

h. [Indoor Air Quality monitoring and control].

1.D Quality Assurance

168. General

a. The BMS Contractor shall be the primary manufacturer-owned branch office of Johnson Controls.

b. The BMS Contractor shall be a recognized national manufacturer, installer and service provider of BMS.

c. The BMS Contractor shall have a branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis. The BMS Contractor shall have, at this facility, a trained, directly employed and full time technical staff, spare parts inventory, and all necessary test and diagnostic equipment.

d. The BMS architecture shall consist of the products of a manufacturer regularly engaged in the production of BMS, and shall be the manufacturer's latest standard of design at the time of bid.

169. Workplace Safety and Hazardous Materials

a. Provide a safety program in compliance with the Contract Documents.

b. The BMS Contractor shall have a corporately certified comprehensive Safety Certification Manual and a designated Safety Supervisor for the Project.

c. The Contractor and its employees and subtrades shall comply with federal, state and local safety regulations.

d. The Contractor shall ensure that all subcontractors and employees have written safety programs in place that covers their scope of work, and that their employees receive the training required by the OSHA rules that have jurisdiction for at least each topic listed in the Safety Certification Manual.

e. Hazards created by the Contractor or its subcontractors shall be eliminated before any further work proceeds.

f. Hazards observed but not created by the Contractor or its subcontractors shall be reported to either the General Contractor or the Owner within the same day. The Contractor shall be required to avoid the hazard area until the hazard has been eliminated.

g. The Contractor shall sign and date a safety certification form prior to any work being performed, stating that the Contractor's company is in full compliance with the Project safety requirements.

h. The Contractor's safety program shall include written policy and arrangements for the handling, storage and management of all hazardous materials to be used in the work in compliance with the requirements of the AHJ at the Project site.

lxxii. The Contractor's employees and subcontractor's staff shall have received training as applicable in the use of hazardous materials and shall govern their actions accordingly.

170. Quality Management Program

a. Designate a competent and experienced employee to provide BMS Project Management. The designated Project Manager shall be empowered to make technical, scheduling and related decisions on behalf of the BMS Contractor. At minimum, the Project Manager shall:

- Manage the scheduling of the work to ensure that adequate materials, labor and other resources are available as needed.
- Manage the financial aspects of the BMS Contract.
- Coordinate as necessary with other trades.
- Be responsible for the work and actions of the BMS workforce on site.

1.E References

171. All work shall conform to the following Codes and Standards, as applicable:

a. National Fire Protection Association (NFPA) Standards.

b. National Electric Code (NEC) and applicable local Electric Code.

c. UL listing and labels.

d. UL 864 UUKL Smoke Control.

e. UL 268 Smoke Detectors.

f. UL 916 Energy Management.

g. NFPA 70 – National Electrical Code.

h. NFPA 90A – Standard For The Installation Of Air Conditioning And Ventilating Systems.

i. NFPA 92A and 92B Smoke Purge/Control Equipment.

j. Factory Mutual (FM).

k. American National Standards Institute (ANSI).

l. National Electric Manufacturer's Association (NEMA).

m. American Society of Mechanical Engineers (ASME).

n. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

o. Air Movement and Control Association (AMCA).

p. Institute of Electrical and Electronic Engineers (IEEE).

q. American Standard Code for Information Interchange (ASCII).

r. Electronics Industries Association (EIA).

s. Occupational Safety and Health Administration (OSHA).

t. American Society for Testing and Materials (ASTM).

u. Federal Communications Commission (FCC) including Part 15, RF Devices.

v. Americans Disability Act (ADA).

w. ANSI/EIA 909.1-A-1999 (LonWorks®).

x. ANSI/ASHRAE Standard 195 (BACnet).

172. In the case of conflicts or discrepancies, the more stringent regulation shall apply.

173. All work shall meet the approval of the Authorities Having Jurisdiction at the project site.

1.F Work By Others

174. The demarcation of work and responsibilities between the BMS Contractor and other related trades shall be as outlined in the BMS RESPONSIBILITY MATRIX.

BMS Responsibility Matrix

Work	Furnish	Install	Low Volt. Wiring/Tube	Line Power
BMS low voltage and communication wiring	BMS	BMS	BMS	N/A
BMS conduits and raceway	BMS	BMS	BMS	BMS
Automatic dampers (non factory)	BMS	23	N/A	N/A
Automatic valves	BMS	23	BMS	N/A
Pipe insertion devices and taps including thermowells, flow and pressure stations.	BMS	23	BMS	BMS
BMS Current Switches.	BMS	BMS	BMS	N/A
BMS Control Relays	BMS	BMS	BMS	N/A
All BMS Nodes, equipment, housings, enclosures and panels.	BMS	BMS	BMS	BMS
Smoke Detectors	26	26	26	26
Fire/Smoke Dampers	23	23	26	26
Fire Dampers	23	23	N/A	N/A
VSDs	BMS	26	BMS	26
Refrigerant monitors	BMS	BMS	BMS	26
Fire Alarm shutdown relay interlock wiring	26	26	26	26

Work	Furnish	Install	Low Volt. Wiring/Tube	Line Power
Fire Alarm smoke control relay interlock wiring	26	26	26	26
Fireman's Smoke Control Override Panel	26	26	26	26
Starters, HOA switches	26	26	N/A	26
Control damper actuators (non factory)	BMS	BMS	BMS	26

1.G Submittals

175. Shop Drawings, Product Data, and Samples

a. The BMS contractor shall submit a list of all shop drawings with submittals dates within 30 days of contract award.

b. Submittals shall be in defined packages. Each package shall be complete, shall only reference itself, and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.

c. Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BMS work.

d. Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BMS Contractor where filing is necessary. Provide a copy of all related correspondence and permits to the Owner.

e. Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.

f. The BMS Contractor shall correct any errors or omissions noted in the first review.

g. At a minimum, submit the following:

- BMS network architecture diagrams including all nodes and interconnections.
- Systems schematics, sequences, and flow diagrams.
- Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
- Samples of Graphic Display screen types and associated menus.
- Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.
- Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.
- Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address.
- Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.
- Details of all BMS interfaces and connections to the work of other trades.
- Product data sheets or marked catalog pages including part number, photo and description for all products including software.

176. Existing Systems Inventory

a. Where applicable, provide a complete and current BMS site inventory for all existing field and supervisory controllers to be integrated into the new BMS including manufacturer, model number, firmware version, available updates, battery condition, integrations, controlled equipment, and point counts.

b. Site inventory shall be provided on a separate, new USB compatible flash drive.

1.H Record Documentation

177. Operation and Maintenance Manuals.

a. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media or USB Flash Drive, and include the following for the BMS provided:

- Table of contents.
- As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
- Manufacturer's product data sheets or catalog pages for all products including software.
- System Operator's manuals.
- Archive copy of all site-specific databases and sequences.
- BMS network diagrams.
- Interfaces to all third party products and work by other trades.

b. The Operation and Maintenance Manual shall be self-contained, and include all necessary software required to access the product data sheets. Include a logically organized table of contents. Viewer software shall provide the ability to display, zoom, print, and search all documents.

178. On-Line documentation: After completion of all tests and adjustments the contractor shall provide a copy of all as-built information and product data to be installed on a customer designated computer workstation or server.

1.I Warranty

179. Standard Material and Labor Warranty:

a. Provide a one-year labor and material warranty on the BMS.

b. If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor.

c. Maintain an adequate supply of materials within 100 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during BMS Contractor's normal business hours.

.3 Part 2 – Products

2.A General Description

180. The BMS shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.

181. The BMS shall consist of the following:

a. Network Engine(s)

b. Field Equipment Controller(s)

c. Input/Output Module(s)

d. Local Display Device(s)

e. Portable Operator's Terminal(s)

f. Distributed User Interface(s)

g. Network processing, data storage and communications equipment

h. Other components required for a complete and working BMS

182. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

183. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

a. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

b. The System shall maintain all settings and overrides through a system reboot.

184. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

185. The System shall comply with the following International Code Council (ICC) Codes:

a. Building Officials and code Administrators International (BOMA) model code.

b. International Conference of Building Officials (ICBO) model code.

c. Southern Building Code Congress International (SBCCI) regulations.

186. Acceptable Manufacturers

a. Johnson Controls, Metasys.

a. Iain Hill; iain.d.hill@jci.com; 647-688-0702

2.B BMS System Architecture

187. Automation Network

a. The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.

b. The BMS shall network multiple user interface clients, application and data servers, automation engines, system controllers and application-specific controllers including but not limited to:

lxxiii. Network Automation Engines

lxxiv. Network Integration Engines

lxxv. Network Control Engines

c. Select Field Equipment Controllers

d. Select VAV Modular Assemblies

e. Third Party BACnet controllers and peripheral devices with compatibility listed by BACnet International

f. Application and Data Server.

g. All BMS devices on the automation network shall be capable of operating at a minimum communication speed of 100 Mbps, with full peer-to-peer network communication.

h. Network Security – To protect the BMS from unauthorized users and computer hackers the Automation Network shall support HTTPS with TLS 1.2 between components, including the Application and Data Server(s), Network Engines, Mobile User Interface and Site Management Portal. Self-signed certificates are installed on supported products, with the option of configuring trusted certificates. Computing devices supplied by the BMS vendor will automatically shut down unused ports to deter unauthorized access.

i. The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

188. Control Network

a. Network Engines (NAE, NIE, NCE) shall provide supervisory control over the control network and shall selectively support the following communication protocols:

lxxvi. BACnet Standard Master-Slave/Token-Passing (MS/TP) Bus Protocol ASHRAE SSPC-135:

a) The NAE shall be BTL certified and carry the BTL Label.

b) The NAE shall be tested and certified as a BACnet Building Controller (B-BC).

lxxvii. LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).

lxxviii. The Johnson Controls N2 Field Bus.

lxxix. Modbus® TCP and RTU.

b. Control networks shall provide either "Peer-to-Peer", Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.

c. Control network shall support digital controllers as indicated in plans and specifications.

d. Default control network communication protocol for this project shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.

e. A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.

f. The PICS shall be submitted 10 days prior to bidding.

189. Integration

a. Hardwired

lxxx. Analog and digital signal values shall be passed from one system to another via hardwired connections.

lxxxi. There will be one separate physical point on each system for each point to be integrated between the systems.

b. Direct Protocol (Integrator Panel)

lxxxii. The BMS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BMS system and third party manufacturers' control panels. The BMS shall have the ability to receive, react to, and return information from multiple building systems, including but not limited to the chillers, boilers, variable frequency drives, power monitoring system, and medical gas.

lxxxiii. All data required by the application shall be mapped into the Automation Engine's database, and shall be transparent to the operator.

lxxxiv. Point inputs and outputs from the third party controllers shall have real-time interoperability with BMS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and LAN Communications.

c. BACnet Protocol Integration – BACnet

lxxxv. The neutral protocol used between systems will be BACnet IP and comply with the ASHRAE BACnet standard 135.

lxxxvi. A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.

lxxxvii. The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

2.C User Interface

190. Dedicated Web Based User Interface [existing]

2.D Network Automation Engines

191. General

a. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers,

provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Engines.

b. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.

c. User Interface – Each NAE shall have the ability to deliver a web based User Interface using the Site Management Portal functionality previously described. All computers connected physically or virtually to the automation network shall have access to the web based user interface.

lxxxviii. The web based user interface software shall be embedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.

lxxxix. The NAE shall support a minimum of two (2) concurrent users.

xc. The web-based user shall have the capability to access all system data through a single NAE.

xci. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.

xcii. Systems that require the user to address more than one NAE to access all system information are not acceptable.

xciii. The NAE shall have the capability of generating web based user interface graphics. The graphics capability shall be embedded in the NAE.

xciv. Systems that only support user interface graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.

xcv. The web based user interface shall support the following functions using a standard version of Microsoft Internet Explorer:

- Configuration
- Commissioning
- Data Archiving
- Monitoring
- Commanding
- System Diagnostics

xcvi. Systems that require workstation software or modified web browsers for system queries are not acceptable.

xcvii. The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

d. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.

e. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

f. User Authentication – The NAE shall support local users, Active Directory users, Microsoft Office 365 users and Remote Authentication Dial-in User Service (RADIUS).

g. Password Security – Access to the embedded user interface shall require a password of 8 to 50 characters including a minimum of one lower case letter, one upper case letter, one number, and one special character. An alarm shall be generated after three unsuccessful attempts within 15 minutes and the user shall be denied access until permission is renewed by a system administrator.

h. Network Security – Communication between the NAE and other system networked devices including additional Network Engines, Application and Data Servers, Open Data Servers (BACnet listed OWS), and user interface clients shall be encrypted and support HTTPS with Transport Level Security (TLS) Version 1.2. Self-signed certificates are to be provided with the option of configuring trusted certificates.

i. Hardware Real Time Clock – The NAE shall include an integrated, hardware-Based, real-time clock.

j. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

k. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

   xcviii. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.

   xcix. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

l. Certification – The NAE shall be listed by UL.

m. Controller network – The NAE shall selectively support the following communication protocols on the controller network:

   c. The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135 on the controller network.

      - The NAE shall support Remote field bus integration via a BACnet IP to MS/TP router.
      - The NAE shall be BTL certified and carry the BTL Label.
      - The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
      - A BACnet Protocol Implementation Conformance Statement shall be provided for the NAE.

- The Conformance Statements shall be submitted 10 days prior to bidding.

ci. The NAE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10.

- All LonWorks controls devices shall be LonMark® certified.

2.E Network Control Engines

192. Network Control Engines

a. The Network Control Engine (NCE) shall be a fully user-programmable, supervisory controller. The NCE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.

b. The NCE shall be a fully user-programmable, digital controller that includes a minimum of 33 I/O points.

c. Automation Network – The NCE shall reside on the automation network and shall support a subnet of 32 Field controllers.

d. User Interface – Each NCE shall have the ability to deliver a web based user interface as previously described. All computers connected physically or virtually to the automation network shall have access to the web based user interface.

cii. The web based user interface software shall be embedded in the NCE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.

ciii. The NCE shall support a minimum of two (2) concurrent users.

civ. The NCE shall have the capability of generating web based user interface graphics. The graphics capability shall be embedded in the NCE.

cv. Systems that only support user interface graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.

cvi. The web based user interface shall support the following functions using a standard version of Microsoft Internet Explorer:

- Configuration
- Commissioning
- Data Archiving
- Monitoring
- Commanding
- System Diagnostics

cvii. Systems that require workstation software or modified web browsers are not acceptable.

cviii. The NCE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

e. User Authentication – The NCE shall support local users, Active Directory users, Microsoft Office 365 users and Remote Authentication Dial-in User Service (RADIUS).

f. Password Security – Access to the embedded user interface shall require a password of 8 to 50 characters including a minimum of one lower case letter, one upper case letter, one number, and one special character. An alarm shall be generated after three unsuccessful attempts within 15 minutes and the user shall be denied access until permission is renewed by a system administrator.

g. Network Security – Communication between the NCE and other system networked devices including additional Network Engines, Application and Data Servers, Open Data Servers (BACnet listed OWS), and user interface clients shall be encrypted and support HTTPS with Transport Level Security (TLS) Version 1.2. Self-signed certificates are to be provided with the option of configuring trusted certificates.

h. The NCE shall employ a finite state programming to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

i. The NCE shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only, shall not be acceptable.

j. The NCE shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

k. The NCE shall support the following number and types of inputs and outputs:

cix. Ten Universal Inputs – shall be configured to monitor any of the following:

- Analog Input, Voltage Mode
- Analog Input, Current Mode
- Analog Input, Resistive Mode
- Binary Input, Dry Contact Maintained Mode
- Binary Input, Pulse Counter Mode

cx. Eight Binary Inputs – shall be configured to monitor either of the following:

- Dry Contact Maintained Mode
- Pulse Counter Mode

cxi. Four Analog Outputs – shall be configured to output either of the following:

- Analog Output, Voltage Mode
- Analog Output, Current Mode

cxii. Seven Binary Outputs – shall output the following:

- 24 VAC Triac

cxiii. Four Configurable Outputs – shall be configured to output either of the following:

- Analog Output, Voltage Mode
- Binary Output, 24 VAC Triac Mode

l. The NCE shall have the ability to monitor and control a network of sensors and actuators over a SA Bus.

cxiv. The SA Bus shall be a MS/TP Bus supporting BACnet Standard protocol SSPC-135.

cxv. The SA Bus shall support a minimum of 10 devices.

cxvi. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the NCE and the furthest connected device.

m. The NCE shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the Field Trunk or the SA Bus.

n. The NCE shall support, but not be limited to, the following applications:

cxvii. Central heating plant applications.

cxviii. Lighting and electrical distribution.

cxix. Built-up air handling units for special applications.

cxx. Power generation and energy monitoring equipment.

cxxi. Interfaces to security and fire detection systems.

o. The NCE shall support a Local Controller Display either as an integral part of the NCE or as a remote device communicating over the SA Bus.

cxxii. The Display shall use a BACnet Standard SSPC-135 MS/TP protocol.

cxxiii. The Display shall allow the user to view monitored points without logging into the system.

cxxiv. The Display shall allow the user to view and change setpoints, modes of operation, and parameters.

cxxv. The Display shall provide password protection with user adjustable password timeout.

cxxvi. The Display shall be menu driven with separate paths for:

- Input/Output
- Parameter/Setpoint
- Overrides

cxxvii. The Display shall use easy-to-read English text messages.

cxxviii. The Display shall allow the user to select the points to be shown and in what order.

cxxix. The Display shall support a back lit LCD with adjustable contrast and brightens and automatic backlight brightening during user interaction.

cxxx. The display shall be a minimum of 4 lines and a minimum of 20 characters per line.

cxxxi. The Display shall have a keypad with no more than 6 keys.

cxxxii. The Display shall be panel mountable.

p. The NCE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NCE size and capability shall be sufficient to fully meet the requirements of this Specification.

q. The NCE shall employ an industrial single board computer.

r. Each NCE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

s. The NCE shall include an integrated, hardware-based, real-time clock.

t. The NCE shall employ nonvolatile Flash memory to store all programs and data. The NCE shall employ a data protection battery to save data and power the real time clock when primary power is interrupted.

u. The NCE shall provide removable, color coded, screw terminal blocks for 24 VAC power, communication bus and I/O point field wiring.

v. The NCE shall include troubleshooting LED indicators to identify the following conditions:

- Power
- Fault
- SA Bus
- FC Bus
- Modem TX
- Modem RX
- Battery Fault
- Ethernet
- 10 LNK
- 100 LNK
- Run
- Peer Com

w. Communications Ports – The NCE shall provide the following ports for operation of operator I/O devices, such as industry-standard computers, modems, and portable operator's terminals.

cxxxiii. USB port

cxxxiv. RS-232 serial data communication port

cxxxv. RS-485 port

cxxxvi. RJ-45 Ethernet port

cxxxvii. RJ-12 jack

x. Diagnostics – The NCE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Control Engine shall

provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

y. Power Failure – In the event of the loss of normal power, The NCE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

cxxxviii. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.

cxxxix. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

z. Certification – The NCE shall be listed by UL. File E107041, CCN PAZX, UL 916, Energy Management Equipment. FCC Compliant to CFR47, Part 15, Subpart B, Class A.

aa. Field Controller Bus – The NCE shall support the following selectable communication protocols on the optional Field Controller Bus:

cxl. The NCE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135 on the controller network.

- The NCE shall be BTL certified and carry the BTL Label.
- The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
- A BACnet Protocol Implementation Conformance Statement shall be provided for the NCE.
- The Conformance Statements shall be submitted 10 days prior to bidding.
- The NCE shall support a minimum of 32 control devices.

cxli. The NCE shall support the N2 devices on the Field Controller Bus (Johnson Controls N2 Bus).

bb. Provide Johnson Controls NCE25 or approved equal as shown on plans.

2.F Application and Data Servers [existing]

2.G DDC System Controllers

193. Advanced Application Field Equipment Controller

a. The Advanced Application Field Equipment Controller (FAC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.

cxlii. The FAC shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.

- The FAC shall be BTL certified and carry the BTL Label.
- The FAC shall be tested and certified as a BACnet Advanced Application Controller (B-AAC).
- A BACnet Protocol Implementation Conformance Statement shall be provided for the FAC.
- The Conformance Statement shall be submitted 10 days prior to bidding.

b. The FAC shall employ finite state programming to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

c. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable. The FAC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

d. The FAC shall include an integral real-time clock and support time-based tasks which enables these field controllers to monitor and control:

cxliii. Schedules.

cxliv. Calendars.

cxlv. Alarms.

cxlvi. Trends.

e. The FAC can continue time-based monitoring when offline for extended periods of time from a network.

f. The FAC can operate as a stand-alone controller in applications that do not require a networked supervisory device or for network applications where it is preferred to have the scheduling, alarming, and/or trending performed locally in the field controllers.

g. The FAC shall include troubleshooting LED indicators to identify the following conditions (*dependent on connection option):

cxlvii. Power On.

cxlviii. Power Off.

cxlix. Download or Startup in progress, not ready for normal operation.

cl. No Faults.

cli. Device Fault.

clii. Field Controller Bus – Normal Data Transmission*.

cliii. Field Controller Bus – No Data Transmission*.

cliv. Field Controller Bus – No Communication*.

clv. SA Bus – Normal Data Transmission.

clvi. SA Bus – No Data Transmission.

clvii. SA Bus – No Communication.

clviii. Ethernet*.

h. The FAC shall accommodate the direct wiring of analog and binary I/O field points with the following minimum Analog to Digital (A/D) and Digital to Analog (D/A) conversion resolution.

clix. Provide a minimum 15 bit A/D resolution for analog inputs.

clx. Provide a minimum 15 bit D/A resolution for analog outputs.

i. The FAC shall support the following types of inputs and outputs supplied in the amounts required for the specified applications:

clxi. Universal Inputs – shall be configured to monitor any of the following:

- Analog Input, Voltage Mode.
- Analog Input, Current Mode.
- Analog Input, Resistive Mode.
- Binary Input, Dry Contact Maintained Mode.
- Binary Input, Pulse Counter Mode.

clxii. Binary Inputs – shall be configured to monitor either of the following:

- Dry Contact Maintained Mode.
- Pulse Counter Mode.

clxiii. Analog Outputs – shall be configured to output either of the following:

- Analog Output, Voltage Mode.
- Analog Output, Current Mode.

clxiv. Binary Outputs – shall output the following:

- Line-voltage relay outputs.
- 24 VAC Triac.

clxv. Configurable Outputs – shall be capable of the following:

- Analog Output, Voltage Mode.
- Binary Output Mode.

j. The FAC shall have the ability to reside on a Field Controller Bus (FC Bus).

2.H Field Devices

194. Input/Output Module

a. The Input/Output Module (IOM) provides additional inputs and outputs for use in digital controllers.

b. The IOM shall communicate with controllers over the FC Bus or the SA Bus.

c. The IOM shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.

clxvi. The IOM shall be BTL certified and carry the BTL Label.

clxvii. The IOM shall be tested and certified as a BACnet Application Specific Controller (B-ASC).

clxviii. A BACnet Protocol Implementation Conformance Statement shall be provided for the IOM.

clxix. The Conformance Statement shall be submitted 10 days prior to bidding.

d. The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

e. The IOM shall have a minimum of 4 points to a maximum of 17 points.

f. The IOM shall support the following types of inputs and outputs:

clxx. Universal Inputs – shall be configured to monitor any of the following:

- Analog Input, Voltage Mode.
- Analog Input, Current Mode.
- Analog Input, Resistive Mode.
- The IOM shall provide minimum 15 bit A/D resolution of analog inputs.
- Binary Input, Dry Contact Maintained Mode.
- Binary Input, Pulse Counter Mode.

clxxi. Binary Inputs – shall be configured to monitor either of the following:

- Dry Contact Maintained Mode.
- Pulse Counter Mode.

clxxii. Analog Outputs – shall be configured to output either of the following:

- Analog Output, Voltage Mode.
- Analog Output, current Mode.
- The IOM shall provide minimum 15 bit D/A resolution of analog outputs.

clxxiii. Binary Outputs – shall output the following:

- 24 VAC Triac.

clxxiv. Configurable Outputs – shall be capable of the following:

- Analog Output, Voltage Mode.
- Binary Output Mode.

g. The IOM shall include troubleshooting LED indicators to identify the following conditions:

clxxv. Power On.

clxxvi. Power Off.

clxxvii. Download or Startup in progress, not ready for normal operation.

clxxviii. No Faults.

clxxix. Device Fault.

clxxx. Normal Data Transmission.

clxxxi. No Data Transmission.

clxxxii. No Communication.

h. Provide Johnson Controls IOM or approved equal as shown on plans.

195. Network Sensors

a. The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:

clxxxiii. Zone Temperature.

clxxxiv. Zone Humidity.

clxxxv. Zone Setpoint.

clxxxvi. Discharge Air Temperature.

clxxxvii. Zone CO_2.

b. The NS shall transmit the information back to the controller on the SA Bus using BACnet Standard protocol SSPC-135.

c. The NS shall be BTL certified and carry the BTL Label.

clxxxviii. The NS shall be tested and certified as a BACnet Smart Sensors (B-SS).

clxxxix. A BACnet Protocol Implementation Conformance Statement shall be provided for the NS.

cxc. The Conformance Statement shall be submitted 10 days prior to bidding.

d. The Network Zone Temperature Sensors shall include the following items:

cxci. A backlit LCD to indicate the temperature, humidity and setpoint.

cxcii. An LED to indicate the status of the Override feature.

cxciii. A button to toggle the temperature display between Fahrenheit and Celsius.

cxciv. A button to program the display for temperature or humidity.

cxcv. A button to initiate a timed override command.

cxcvi. Available in either surface mount, wall mount, or flush mount.

cxcvii. Available with either screw terminals or phone jack.

e. The Network Discharge Air Sensors shall include the following:

cxcviii. 4 inch or 8 inch duct insertion probe.

cxcix. Ten foot pigtail lead.

cc. Dip Switches for programmable address selection.

cci. Ability to provide an averaging temperature from multiple locations.

ccii. Ability to provide a selectable temperature from multiple locations.

f. The Network CO_2 Zone Sensors shall include the following:

cciii. Available in either surface mount or wall mount.

cciv. Available with screw terminals or phone jack.

ccv. Measurement range of 0-2000 ppm

ccvi. Sensing resolution of 1 ppm.

ccvii. Sensing accuracy of +/- 2% of the reading plus 40 ppm.

g. Provide Johnson Controls NS series or approved equal where indicated on plans.

2.I System Tools

196. System Configuration Tool [existing]

197. Controller Configuration Tool [existing]

2.J Computing Hardware and Software

198. General

a. Computing hardware, software and operating systems shall be provided at the revision level or model number as specified or at the latest release of the vendor if not specified.

b. In order to provide a consistent level of performance, all PCs shall be provided with Operating Systems and Processors by the manufacturer specified.

199. Dedicated Web Based User Interface [existing]

2.K Miscellaneous Devices

200. Variable Frequency Motor Speed Control Drives

a. The VSD and all components shall be designed, manufactured and tested in accordance with the latest applicable standards.

ccviii. Institute of Electrical and Electronic Engineers (IEEE)

- IEEE 519-1992: Guide for harmonic content and control.

ccix. Underwriters Laboratories (UL508C: Power Conversion Equipment)

- UL
- cUL

ccx. National Electrical Manufacturer's Association (NEMA)

- ICS 7.0: Industrial Controls & Systems for VSDs.

ccxi. EN 61000-3-12, EN 61800-3 (1996) +A11 (2000) Category C2

- Fulfill all EMC immunity requirements.

b. VSD through 250 HP shall have the following features:

ccxii. The VSD may be designed in a NEMA Type 1, NEMA 12, or NEMA 3R enclosure.

ccxiii. Incoming Power: Three-phase, 208 / 240 / 480 (+10% to -10%) and 50/60 Hz (+10 to -5%). The VSD shall provide microprocessor-based control for three-phase induction motors. The controller's full load output current rating shall be based on a low overload application at 40°C ambient and 1.5 - 10 kHz switching frequency with automatic switching frequency de-rating in case of overload.

ccxiv. Humidity: 0 to 95% (non-condensing and non-corrosive).

ccxv. Altitude: 0 to 3,300 feet (1000 meters) above sea level.

ccxvi. Ambient Temperature: -10 to 40°C (VT).

ccxvii. Storage Temperature: -40 to 70°C.

ccxviii. The VSDs shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation.

ccxix. The VSDs shall have an efficiency at full load and speed that exceeds 97%. The efficiency shall exceed 90% at 50% speed.

ccxx. The VSDs shall maintain a minimum line side displacement power factor of 0.96, regardless of speed and load for VFDs less than 75 HP. The VSDs shall maintain a minimum line side displacement power factor of .99, regardless of speed and load for motors greater than 75 HP.

ccxxi. The VSDs shall have a one (1) minute overload current rating of 110% for low overload applications.

ccxxii. The current withstand rating of the drive shall be 100,000 AIC.

ccxxiii. The VSDs shall be capable of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VSD.

ccxxiv. The VSDs shall have an integral EMI/RFI filter as standard.

ccxxv. VFD must contain a circuit breaker or fused disconnect as an option.

ccxxvi. Total harmonic distortion shall be calculated based on total demand distortion conditions as defined in IEEE 519-1992. Any harmonic calculations shall be done based on the kVA capacity, X/R ratio and the impedance of the utility transformer feeding the installation, as noted on the drawings, and the total system load.

ccxxvii. Provide built in Communication capability for interface with RS-485 (ModBus RTU) (Johnson Controls Metasys N2) (MS/TP BACnet) or Ethernet (BACnet/IP) (Modbus/TCP).

- Communication capability via expansion card to support RS-485 shall include Johnson Controls Metasys – SA Bus or LonWorks.

c. Provide Johnson Controls VSD Series II or equal as indicated on plans.

201. Local Control Panels

a. All control panels shall be factory constructed, incorporating the BMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508A label listing compliance. Control panels shall be fully enclosed, with sub-panel, hinged door, and flush latch.

b. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.

c. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.

d. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.

e. All wiring shall be neatly installed in plastic trays or tie-wrapped.

f. Control panels for use in seismic areas shall be built in an approved facility and carry the appropriate label.

g. Except where otherwise noted, all standard and custom control panels shall be built in an ISO9002 certified facility.

202. Power Supplies

a. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.

b. Input: 120 VAC +10%, 60Hz.

c. Output: 24 VDC.

d. Line Regulation: +0.05% for 10% line change.

e. Load Regulation: +0.05% for 50% load change.

f. Ripple and Noise: 1 mV rms, 5 mV peak to peak.

g. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.

h. A power disconnect switch shall be provided next to the power supply.

.4 Part 3 – Performance/Execution

3.A BMS Specific Requirements

203. Graphic Displays – to match existing

a. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.

b. User shall access the various system schematics via a graphical penetration scheme and/or menu selection.

204. Actuation / Control Type

a. Primary Equipment

ccxxviii. Controls shall be provided by equipment manufacturer as specified herein.

ccxxix. All damper and valve actuation shall be electric.

b. Air Handling Equipment

ccxxx. All air handlers shall be controlled with a HVAC-DDC Controller.

ccxxxi. All damper and valve actuation shall be electric.

c. Terminal Equipment:

ccxxxii. Terminal Units (VAV, UV, etc.) shall have electric damper and valve actuation.

ccxxxiii. All Terminal Units shall be controlled with HVAC-DDC Controller.

3.B Installation Practices

205. BMS Wiring

a. All conduit, wiring, accessories and wiring connections required for the installation of the BMS, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 24 Electrical. All wiring shall comply with the requirements of applicable portions of Division 24 and all local and national electric codes, unless specified otherwise in this section.

b. All BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations.

c. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.

d. Class 2 Wiring

ccxxxiv. All Class 2 (24 VAC or less) wiring shall be installed in conduit unless otherwise specified.

ccxxxv. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.

e. Class 2 signal wiring and 24 VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.

f. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

206. BMS Line Voltage Power Source

a. 120-volt AC circuits used for the BMS shall be taken from panel boards and circuit breakers provided by Division 24.

b. Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.

c. DDC terminal unit controllers may use AC power from motor power circuits.

207. BMS Raceway

a. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2".

b. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.

c. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.

d. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

208. Penetrations

a. Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.

b. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.

c. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.

d. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

209. BMS Identification Standards

a. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.

b. Cable types specified in Item A shall be color coded for easy identification and troubleshooting.

210. BMS Panel Installation

a. The BMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.

b. The BMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

211. Input Devices

a. All Input devices shall be installed per the manufacturer recommendation.

b. Locate components of the BMS in accessible local control panels wherever possible.

212. HVAC Input Devices – General

a. All Input devices shall be installed per the manufacturer recommendation.

b. Locate components of the BMS in accessible local control panels wherever possible.

c. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.

d. Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.

e. Building Differential Air Pressure Applications (-1" to +1" WC)

ccxxxvi. Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.

ccxxxvii. The interior tip shall be inconspicuous and located as shown on the drawings.

f. Air Flow Measuring Stations

ccxxxviii. Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct.

ccxxxix. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.

g. Duct Temperature Sensors

ccxl. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.

ccxli. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.

ccxlii. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.

ccxliii. The sensor shall be mounted to suitable supports using factory approved element holders.

h. Space Sensors

ccxliv. Shall be mounted per ADA requirements.

ccxlv. Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.

i. Low Temperature Limit Switches

ccxlvi. Install on the discharge side of the first water or steam coil in the air stream.

ccxlvii. Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.

ccxlviii. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.

j. Air Differential Pressure Status Switches

ccxlix. Install with static pressure tips, tubing, fittings, and air filter.

k. HVAC Output Devices

ccl. All output devices shall be installed per the manufacturers' recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.

ccli. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.

cclii. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.

ccliii. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.

3.C Training

213. The BMS contractor shall provide the following training services:

a. One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

3.D Commissioning Requirements

214. Fully commission all aspects of the BMS work.

215. Acceptance Check Sheet

a. Prepare a check sheet that includes all points for all functions of the BMS as indicated on the point list included in this specification.

b. Submit the check sheet to the Engineer for approval.

c. The Engineer will use the check sheet as the basis for acceptance with the BMS Contractor.

3.E Performance Verification

216. The installing contractor shall perform a complete Performance Validation (PV) of the Building management system:

a. At project turnover to customer.

217. Performance Verification shall include a complete and current Building Automation System site inventory including the following information at a minimum: a listing of all field and supervisory controllers with the following key attribute data; corresponding model numbers, firmware versions, available security updates, CPU and memory performance data, battery conditions, integrations, controlled equipment, and device and point counts.

218. Performance Verification shall include a complete written evaluation of system configuration and performance in the following categories:

a. Security – The Security evaluation shall include information about controllers that require security updates and conformance of user accounts to latest security rules and best practices.

b. Energy Performance – The Energy Performance and Savings evaluation shall identify opportunities through schedule and nightly setbacks, economizers, eliminating simultaneous heating and cooling and adding VSD to equipment.

c. Comfort and Health – The Comfort and Health evaluation shall identify temperature, pressure, and carbon dioxide values that deviate from desired set points that could lead to occupant discomfort.

d. Reliability – The Reliability evaluation shall identify overridden control points, control points creating excessive alarms, and opportunities to adding control points and trends to further enable system functionality.

e. Standards – The Standards evaluation shall identify conformance to published standards for point count, network performance and protocol standards.

219. Provide all reports as specified on a new, USB compatible flash drive.

1.1.3. 23 09 93 Sequence of Operation for HVAC Controls

.1 Part 1 – Sequence of Operation

1.A Sequence of Operation

SEPARATE ATTACHMENT

.2 Part 2 – Points list

2.A Point Lists

SEPARATE ATTACHMENT

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

.1 Pipe and pipe fittings for:
- .1 Heating water piping system.
- .2 Glycol/water piping system.
- .3 Chilled water piping system.
- .4 Condenser water piping system.
- .5 Equipment drains and overflows.

.2 Valves:
- .1 Gate valves.
- .2 Globe or angle valves.
- .3 Ball valves.
- .4 Butterfly valves.
- .5 Check valves.
- .6 Circuit balancing valves
- .7 Drain valves.

1.3 REFERENCES

.1 ASME - Welding and Brazing Qualifications.
.2 ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.
.3 ASME B16.5 Pipe Pumps & Fittings.
.4 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
.5 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
.6 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
.7 ASME B31.1 - Code for Power Piping.
.8 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
.9 A183 Carbon Steel Track Bolts and Nuts.
.10 ASTM A234/A234M - Piping Fittings of Wrought-Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
.11 ASTM B32 - Solder Metal.
.12 ASTM B88 - Seamless Copper Water Tube.
.13 ASTM D1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
.14 ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
.15 ASTM D2241 - Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).
.16 ASTM D2310 - Machine-Made Fibreglass' (Glass Fibre-Reinforced Thermosetting Resin) Pipe.

.17 ASTM D2466 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
.18 ASTM D2467 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
.19 ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.
.20 ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
.21 ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
.22 ASTM D2855 - Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
.23 ASTM D3309 - Polybutylene (PB) Plastic Hot-and Cold-Water Distribution Systems.
.24 ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
.25 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
.26 ASTM F876 - Crosslinked Polyethylene (PEX) Tubing.
.27 ASTM F877 - Crosslinked Polyethylene (PEX) Plastic Hot - and Cold - Water Distribution Systems.
.28 AWS A5.8 - Filler Metals for Brazing and Braze Welding.
.29 AWS D1.1 - Structural Welding Code - Steel.
.30 AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
.31 AWWA C110 - Ductile - Iron and Grey -Iron Fittings 3 inch - 48 inch (76 mm - 1219 mm), for Water and Other Liquids.
.32 AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Pressure Pipe and Fittings.
.33 AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water.
.34 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
.35 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
.36 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.4 SUBMITTALS

.1 Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
.2 Welders Certificate: Include welders certification of compliance with ASME SEC 9.
.3 Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
.4 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.5 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
.2 Installer: Company specializing in performing the work of this section with minimum 3 years documented experience.
.3 Welders: Certify to ASME SEC 9.

1.6 REGULATORY REQUIREMENTS

.1 Conform to ASME B31.1 code for installation of piping system.
.2 Welding Materials and Procedures: Conform to ASME SEC 9 and applicable provincial labour regulations.
.3 Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Accept valves on site in shipping containers with labeling in place. Inspect for damage.
.2 Provide temporary protective coating on cast iron and steel valves.
.3 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
.4 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.8 ENVIRONMENTAL REQUIREMENTS

.1 Do not install underground piping when bedding is wet or frozen.

1.9 EXTRA MATERIALS

.1 Provide two repacking kits for each size and valve type.

2 PRODUCTS

2.1 VALVES - GENERAL

.1 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
.2 Provide valves of the same manufacturer where possible.
.3 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
.4 Valid CRN (Canadian Registration Number) required for each valve.
.5 Materials:
  .1 Bronze: ASTM B62 or B61 as applicable
  .2 Brass: ASTM B283 C3770
  .3 Cast Iron: ASTM A126 Class B
.6 End Connections:
  .1 Threaded ends: ANSI B1.20.1
  .2 Flanged ends: ANSI B16.1 (Class 125), ANSI B16.5
  .3 Face-to-face dimensions: ANSI B16.10
.7 Design and Testing:
  .1 Bronze Gate & Check valves: MSS-SP-80
  .2 Ball Valves: MSS-SP-110
  .3 Cast Iron Gate Valves: MSS-SP-70
  .4 Cast Iron Globe Valves: MSS-SP-85
  .5 Cast Iron Check: MSS-SP-71

.6 Butterfly Valves: MSS-SP-67

.8 First named product as indicated in paragraphs below; other acceptable manufacturers, subject to equivalent products include:

.1 Kitz.
.2 Crane
.3 Conbraco.
.4 Nibco
.5 Jenkins

2.2 HYDRONIC SYSTEMS TO 150 PSIG, ABOVE GROUND

.1	Nominal Operating Pressure	125 psig
.2	Design Pressure	150 psig
.3	Test Pressure	225 psig
.4	Design Temperature	350°F
.5	Corrosion Allowance	0.0625 in.
.6	Steel Pipe	ASTM A53 Gr.B ERW or ASTM A106 Gr.B SMLS, sch 40,
.7	Joints, 2" and smaller	screwed
.8	Screwed Fittings	150 Lb. malleable iron
.9	Unions	Cl.150, ASTM A-47 malleable iron, ASTM A-153 galvanized, ANSI B2.1 threads.
.10	Joints, 2-1/2" and larger	welded, with flanges at connections to equipment
.11	Butt weld fittings	ASTM A234 Gr. WFB
.12	Flanges	ASTM A105, Class 150, raised face, weld neck or slip on
.13	Bolts	ASTM A307 C.S. bolts, sq. head; ASTM A563 nuts, hex head
.14	Gaskets	1/16" (1.6 mm) thick preformed non-asbestos graphite fibre.
.15	Copper Tubing, 2" and Smaller	ASTM B88, Type L, hard drawn.
.16	Joints:	Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 220°C to 280°C.
.17	Fittings:	ASME B16.18, cast brass, or ASME B16.22, solder wrought copper
.18	Dielectric Unions copper	Union with galvanized or plated steel threaded end, solder end, water impervious isolation barrier.
.19	Valves, 2" and smaller	ASTM A105
	Gate Valves (Isolating)	300 psig non-shock WOG, ASTM B62 bronze body, solid wedge disc, rising stem, bronze trim, threaded ends, Kitz #25
	Globe Valves (Throttling)	300 psig non-shock WOG, ASTM B62 bronze body, composition (Teflon) disc, rising stem, bronze trim, threaded ends, Kitz #09
	Check Valves (Backflow)	300 psig non-shock WOG, ASTM B62 bronze body, Y-pattern horizontal, swing type disc, threaded ends, Kitz

		#29
	Ball Valves (Drain) ball and handle,	600 psig non-shock WOG, forged brass, 2-piece, chrome stem, full port, blow-out proof PTFE seats & stem, lever threaded ends, Kitz #68AC.
.20	Valves, 2-1/2" and larger	ASTM A216 WCB
	Gate Valves (Isolating)	200 psig non-shock WOG, ASTM A126 Class B cast iron body, bolted bonnet, bronze mounted, solid wedge disc, OS&Y, non-asbestos packing, flanged ends, Kitz #72.
	Globe Valves (Throttling)	200 psig non-shock WOG, ASTM A126 Class B cast iron body, bolted bonnet, bronze mounted, bevelled wedge disc, OS&Y, non-asbestos packing, flanged ends, Kitz #76.
	Check (Backflow)	200 psig non-shock WOG, ASTM 126 Class B cast iron body, bolted cover, bronze mounted, swing type disc, flanged ends, Kitz #78
.21	Provide stem extensions for insulated piping.	
.22	Provide gear operator and chain on valves installed above 10-ft AFF.	
.23	Strainers, 2" and smaller screwed cap	Class 250, 400 psig WOG, cast iron body, Y-pattern, and ends, A167 304 stainless steel screen with 1/32" perforations. Mueller Steam 11M.
.24	Strainers, 2-1/2" and larger bolted steel screen Steam 752 .	Class 250 psig non-shock WOG, cast iron, Y-pattern, flange cover, blow-out plug, A167 304 stainless with 1/32" perforations, flanged ends, Mueller

2.3 HYDRONIC SYSTEMS TO 300 PSIG, ABOVE GROUND

.1	Nominal Operating Pressure	250 psig
.2	Design Pressure	300 psig
.3	Test Pressure	450 psig
.4	Design Temperature	450°F
.5	Corrosion Allowance	0.0625 in.
.6	Pipe	ASTM A106 Gr. B, seamless, schedule 80, black.
.7	Joints, 2" and smaller	screwed
.8	Screwed Fittings	300 Lb., ASTM A-47 malleable iron
.9	Unions galvanized,	Class 300, ASTM A-47 malleable iron, ASTM A-153 ANSI B2.1 threads.
.10	Dielectric Unions copper	Union with galvanized or plated steel threaded end, solder end, water impervious isolation barrier.
.11	Joints, 2-1/2" and larger	welded, with flanges at connections to equipment
.12	Butt weld fittings	ASTM A234 Gr. WFB
.13	Flanges slip on	ASTM A105, Class 300, raised face, weld neck or
.14	Bolts	ASTM A193 Gr. B7 studs, ASTM A194 Gr. 2H nuts.

.15	Gaskets	1/16" (1.6 mm) thick preformed non-asbestos graphite fibre.
.16	Valves, 2" and smaller	ASTM A105N
	Gate Valves (Isolating)	Class 800, ASME B16.34 forged steel body, conventional port, outside screw & yoke, bolted bonnet, 1/2 Stellite trim (#8), graphite packing, threaded ends. Bonney Forge HL-11-T.
	Globe Valves (Throttling)	Class 800, ASME B16.34 forged steel body, outside screw & yoke, bolted bonnet, 1/2 Stellite trim (#8), graphite packing, threaded ends. Bonney Forge HL-31-T.
	Check Valves (Backflow)	Class 800, ASME B16.34 forged steel body, bolted bonnet, 1/2 Stellite trim (#8), graphite gasket, swing check, threaded ends. Bonney Forge HL-61-T.
.17	Valves, 2-1/2" and larger	ASTM A216 WCB
	Gate Valves (Isolating)	600 psi non-shock WOG, cast carbon steel body, solid wedge disc (2-1/2" to 4") or flexible wedge disc (6" and over), OS&Y rising stem, non-asbestos packing, flanged ends, Kitz #300 SCLS.
	Globe Valves (Throttling)	600 psi non-shock WOG, ASTM A126 Class B cast carbon steel body, bolted bonnet, swivel disc, OS&Y rising stem, non-asbestos packing, flanged ends, Kitz #300 SCJS.
	Check (Backflow)	600 psi non-shock WOG, cast carbon steel body, bolted cover, swing .type disc, flanged ends, Kitz #300SCOS.
.18	Provide stem extensions for insulated piping.	
.19	Provide gear operator and chain on valves installed above 10-ft AFF.	
.20	Strainers, 1/2" to 24"	Class 300 WSP @ 838°F, cast steel body, Y-pattern, flanged ends, bolted flange cover, A167 304 stainless steel screen with 1/32" perforations. Mueller Steam 782.

2.4 GROOVED PIPING SYSTEMS TO 150 PSIG, ABOVE GROUND

.1	Acceptable Manufacturers:	Victaulic Company, Anvil International, Gruvlok
.2	Permitted Applications: where	grooved joints are permitted in HVAC piping systems operating temperatures do not exceed 140°F, including; .1 chilled water .2 condenser water, open .3 condenser water, closed
.3	Nominal Operating Pressure	125 psig
.4	Design Pressure	150 psig
.5	Test Pressure	225 psig
.6	Design Temperature	350°F
.7	Corrosion Allowance	0.0625 in.
.8	Pipe	ASTM A53 Gr. B or ASTM A106 Gr. B, schedule 40, black
.9	Fittings:	Roll Grooved, malleable iron to ASTM A 47/A47M

.10 Joints, 2-1/2" and larger roll grooved to CSA B242, in accordance with manufacturers instructions and recommendations, with flanges at connections to equipment

.11 Gaskets EPDM

2.5 EQUIPMENT DRAINS AND OVERFLOWS

.1 Copper Tubing: ASTM B88, Type M and DWV, hard drawn.
  .1 Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
  .2 Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 4428°F to 536°F (220°C to 280°C).

2.6 CIRCUIT BALANCING VALVES

.1 Circuit Balancing Valves; 2" (50 mm) and smaller)
  .1 Screwed connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy. Each valve shall be such that when installed in any direction, it will not affect flow measurement.
  .2 Valves shall provide the following functions:
    .1 Precise flow measurement.
    .2 Precision flow balancing.
    .3 Positive shut off with no drip seat and teflon disc.
    .4 Drain connection with protective cap.
  .3 Valves shall have four 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.
  .4 Valves shall be shipped in a 4.5 R factor polyurethane container that shall be used as insulation after valve in installed.
  .5 Provide valves suitable for maximum working pressure of 250 psi (1720 kPa) and maximum operating temperature of 250°F (121°C).
  .6 Acceptable Products: S.A. Armstrong CRV I indicated or Tour & Anderson STA-D or Newman Hattersley.
.2 Circuit Balancing Valves 2 1/2" (65 mm) and larger
  .1 Flanged, line size connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy.
  .2 Valves, shall provide the following functions:
    .1 Precise flow measurement.
    .2 Precision flow balancing.
    .3 Positive shut off with no drip seat and teflon disc.
  .3 Valves shall have twelve 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.
  .4 Valves shall be suitable for maximum working pressure of 250 psi (1720 kPa) and maximum operating temperature of 250°F (120°C).
  .5 Acceptable Products: S.A. Armstrong CBV II indicated or Tour & Anderson STA-

F or Newman Hattersley.

3 EXECUTION

3.1 PREPARATION

.1 Ream pipe and tube ends, remove burrs and bevel plain end ferrous pipe.
.2 Remove scale and dirt on inside and outside before assembly.
.3 Prepare piping connections to equipment with flanges or unions.
.4 Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
.5 After completion, fill, clean, and treat systems.

3.2 APPLICATIONS

.1 Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
.2 Where permitted, install grooved mechanical couplings and fasteners in accessible locations.
.3 Install unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
.4 Provide non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
.5 Provide pipe hangers and supports to CSA B51 unless indicated otherwise.
.6 Use gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
.7 Use globe valves for throttling, bypass, manual flow control services, for balancing & in bypass around control valves.
.8 Use spring loaded check valves on discharge of condenser water pumps.
.9 Use wafer check valves where required to suit space and or weight limitations
.10 Use 3/4 inch (20 mm) gate or ball valves with cap and chain for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.
.11 Use lug end butterfly valves to isolate equipment.
.12 Butterfly valves may be used isolation and throttling duty for large pipe sizes 2-1/2" (65 mm) and above.
.13 Gasket material shall be Grade 'E' EPDM compound conforming of ASTM D2-2000 and suitable for an operating temperature range of -34°C to 110°C.
.14 Small runouts, size 3/4" (20 mm) and less for extension of domestic make-up piping may be constructed using hand drawn copper tube type 'K' or "L" and comply to ASTM B88.

3.3 INSTALLATION

.1 Install to manufacturer's instructions.
.2 Install heating water, glycol, chilled water, condenser water piping to CSA B51.
.3 Route piping in orderly manner, parallel to building structure, and maintain gradient.
.4 Install piping to conserve building space, and not interfere with use of space.
.5 Group piping whenever practical at common elevations.
.6 Sleeve pipe passing through partitions, walls and floors.
.7 Slope piping and arrange to drain at low points.
.8 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
.9 Inserts:
  .1 Provide inserts for placement in concrete formwork.
  .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
  .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
.10 Pipe Hangers and Supports:
  .1 Install to CSA B51.
  .2 Support horizontal piping as scheduled.
  .3 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.
  .4 Place hangers within 12" (300 mm) of each horizontal elbow.
  .5 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
  .6 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
  .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
  .8 Provide copper plated hangers and supports for copper piping.
  .9 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
.11 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
.12 Provide access where valves and fittings are not exposed.
.13 Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
.14 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer (VOC content not to exceed 250

g/L) to welds.

.15 Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

.16 Install valves with stems upright or horizontal, not inverted.

.17 Air vents shall be selected to suit the system operating pressures and shall be automatic and complete with isolating vavles.

.18 All strainers 1-1/2" (38mm) & larger shall be fitted with chain valves.

.19 Unless specified otherwise, drain piping shall be sloped down in the direction of flow not less than 1" in 40 feet.

.20 Eccentric reducers shall be provided to keep the bottom of sloped piping aligned in order to minimize risk of water hammer and to facilitate drainage.

.21 Valves shall be installed with stems upright or angled 45 deg. above horizontal unless instructed otherwise.

.22 Pipe all discharge from temperature & pressure safety relief valves to a point of safe discharge directly into a floor drain, hub drain or safe outdoor location.

3.4 EQUIPMENT CONNECTIONS

.1 Install unions or flanges at connections to all equipment and specialty components.

.2 Arrange piping connections to allow ease of access and removal of equipment.

.3 Align and independently support piping adjacent to equipment connections in order to prevent piping stresses from being transferred to equipment.

.4 Piping reducers shall be used where equipment connections differ from pipe sizes indicated. The use of bushings will not be permitted.

.5 Install removable sections of pipe 12" (300 mm) spool pieces on the suction side of pumps and where needed for ease of maintenance.

3.5 VALVES, COCKS AND FAUCETS

.1 Use valves of line size unless noted otherwise.

.2 Provide isolating valves in each branch from the main line and where indicated.

.3 Provide isolating valves at all equipment connections.

.4 Provide globe valves or ball valves complete with memory stop at the discharge of each pump and where valves are used for regulating or throttling purposes.

.5 Provide 1/2" (13 mm) brass hose bibbs at all low points of each system, where the system cannot be drained through the main floor or return piping.

.6 Where new valves are installed to replace existing valves and it is impractical to shut-down and drain the entire system, valves shall be replaced using pipe freezing techniques.

3.6 HYDRONIC SPECIALTIES

.1 Air Vents

.1 Provide 1" (25 mm) diameter air vent chamber at each riser feeding terminal units. Install chambers as high as possible within unit, and provide manual air vent connected to air chamber by flexible tubing.

.2 Provide a float type automatic air vent at any high points of hot water supply and return piping not vented through a convector etc. and at high point of piping for each hot water coil. The discharge of air vent shall terminate over a floor drain in mechanical rooms or over a sink in service rooms. A shut-off valve shall be provided on each automatic air vent and an access door and frame shall be provided for air vents located above ceilings.

.2 Automatic Feed Valves: provide automatic feed valve on the cold water make-up line to each new hot water heating system.

.3 Air Cushion Tanks
- .1 Provide air cushion tanks of size noted where indicated.
- .2 Provide housekeeping pad for floor mounting of tank.
- .3 Terminate drainout line at nearest funnel floor drain, or service sink.
- .4 Adjust charge to system static pressure at point of connection plus 5 psi (35 kPa).

.4 Air Eliminators: provide an air eliminator at each new air cushion (expansion) tank.

.5 Circuit Balancing Valve (CBV): provide a CBV in each branch serving a heating and/or cooling terminal unit and where indicated on drawings. Installation shall be in accordance with manufacturer's installation instructions. Ensure that manufacturer's recommended clearances are maintained to minimize turbulence and to promote accuracy.

.6 Supply and install threaded couplings or half coupling for flow switches that are supplied under Section 25

.7 Install flow switches as supplied under Section 25

3.7 CONTROLS DEVICES

.1 Install pipe wells for various remote sensors such as temperature, pressure and flow sensors. Supply of sensors and controls wiring will be under Section 25.

.2 Install control valves for fluid flow control. Supply of valves, valve actuators and controls wiring will be under Section 25.

3.8 TESTING AND INSPECTION

.1 Test liquid heat transfer piping hydrostatically at not less than 150% of operating pressure or not less than 125 psi (860 kPa) whichever is the greater. Test period shall be not less than six (6) hours duration during which time each joint shall be inspected, given a sharp tap with a hammer and checked for leaks.

.2 Arrange and pay for inspection by authorities having jurisdiction.

3.9 ADJUSTING AND BALANCING

.1 Instruments used for this work shall be accurately calibrated and maintained in good working order, and shall include:
- .1 one set of pressure gauges and fittings.
- .2 dry bulb thermometer.

.3 wet bulb thermometer.
.4 thermocouple unit and thermocouple.
.5 set of balancing cock adjustment wrenches.
.6 portable field flow meter.

.2 Prepare the liquid heat transfer systems as follows:
.1 Install any additional devices required for effective balancing as advised by the Systems Verification Agency.
.2 Open all valves, and return line balancing cocks.
.3 Remove and clean all strainers.
.4 Check pump rotation.
.5 Check expansion tanks to make sure they are not air bound and that the system is full of water.
.6 Check all air vents at high points of water systems to make sure they are installed properly and are operating freely. Make certain all air is removed from circulating system.
.7 Set all temperature controls so that all coils are calling for full cooling. This should close all automatic bypass valves at coil and chillers. To balance hot water coils, set systems to call for full heating.
.8 Check operation of automatic bypass valve.
.9 Check and set operating temperature of heat exchangers to design requirements.

.3 Balance the liquid heat transfer systems as follows:
.1 Complete air balance must have been accomplished before water balance is begun.
.2 Set chilled water, hot water and glycol pumps to proper gpm delivery.
.3 Adjust flow of hot water through heat exchangers.
.4 Check leaving water temperatures and return water temperatures, and pressure drop through heat exchangers. Reset to correct design temperatures.
.5 Check water temperature at inlet side of cooling and heating coils. Note rise or drop of temperatures from source.
.6 Balance each chilled water and hot water coil.
.7 Upon completion of flow readings and coil adjustments, mark all settings and record all data.
.8 After making adjustments to coils, recheck settings at pumps, and heat exchangers. Readjust if required.
.9 Install pressure gauges on each coil, then read pressure drop through coil at set flow rate on call for full cooling and full heating. Set pressure drop across bypass valve to match coil full flow pressure drop. This prevents unbalanced flow conditions when coils are on full bypass.
.10 Check and record the following items at each cooling and heating element:
.1 Inlet water and air temperature.
.2 Leaving water and air temperature.
.3 Pressure drop of each coil.

.4 Pump operating suction and discharge pressures and final t.d.h.
.5 Pressure drop across bypass valve.
.6 All mechanical specifications of pumps.
.7 Rated and actual running amperage of pump motor.

.4 After completion of adjusting and balancing and submittal of records notify the Systems Verification Agency and the Consultant and assist in verifications. If systems fail verification, readjust and balance systems to the satisfaction of the Consultant.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

.1 Steam piping system.
.2 Condensate piping system.

1.3 REFERENCES

.1 The Technical Standards and Safety Act and Regulations
.2 CSA B51 - Boiler, Pressure Vessel and Pressure Piping Code, as ammended
.3 ASME B31.1 - Code for Power Piping.
.4 ASME B31.3 - Process Piping.
.5 ASME - SEC 9 - Welding and Brazing Qualifications.
.6 ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.
.7 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
.8 ASTM A234/A234M - Piping Fittings of Wrought-Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
.9 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
.10 AWS A5.8 - Filler Metals for Brazing and Braze Welding.
.11 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
.12 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
.13 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.4 SYSTEM DESCRIPTION

.1 When more than one piping system material is selected, ensure systems components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.
.2 System components shall conform to Component Standards and Specifications as listed in ASME B31.1 or B31.3.
.3 Use unions, flanges, and downstream of valves and at equipment or apparatus connections. Use dielectric unions where joining dissimilar materials. Do not use direct welded or threaded connections.
.4 Provide pipe hangers and supports to MSS SP69 unless indicated otherwise.
.5 Use gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
.6 Use globe valves for throttling, bypass, or manual flow control services.

1.5 SUBMITTALS

.1 Section 15010: Procedures for submittals.
.2 Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
.3 Welders Certificate: Include welders certification of compliance with ASME/SEC 9.
.4 Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
.5 Submittals for project closeout, Division 1.

1.6 PROJECT RECORD DOCUMENTS

.1 Section 23 01 01: Submittals for project closeout.
.2 Record actual locations of valves.

1.7 OPERATION AND MAINTENANCE DATA

.1 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
.2 Installer: Company specializing in performing the work of this section with minimum three years documented experience. Registered with TSSA for ASTM B31.1 and ASTM B31.3 procedures.
.3 Welders: Certified to CSA B51 and ASME SEC 9.

1.9 REGULATORY REQUIREMENTS

.1 Conform to ASME B31.1 and CSA B51 standards for installation of piping system.
.2 Provide certificate of compliance from authority having jurisdiction indicating approval of welders.
.3 Welding Materials and Procedures: Conform to ASME SEC 9 and applicable provincial labour regulations.

1.10 DELIVERY, STORAGE, AND HANDLING

.1 Accept valves on site in shipping containers with labelling in place. Inspect for damage.
.2 Provide temporary protective coating on cast iron and steel valves.
.3 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
.4 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.11 EXTRA MATERIALS

.1 Provide two of repacking kits for each size and valve type.

2 PRODUCTS

2.1 VALVES - GENERAL

.1 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
.2 Provide valves of the same manufacturer where possible. Use Piston values for all steam applications with Class 6 shut-off
.3 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
.4 Valid CRN (Canadian Registration Number) required for each valve.
.5 Materials:
  .1 Bronze: ASTM B62 or B61 as applicable
  .2 Brass: ASTM B283 C3770
  .3 Cast Iron: ASTM A126 Grade B
  .4 Cast Carbon Steel: ASTM A 216 Grade WCB
  .5 Forged Steel: ASTM A105N
.6 End Connections:
  .1 Threaded ends: ANSI B1.20.1
  .2 Flanged ends: ANSI B16.1 (Class 125), ANSI B16.5
  .3 Face-to-face dimensions: ANSI B16.10
.7 Design and Testing:
  .1 Bronze Gate & Check valves: MSS-SP-80
  .2 Ball Valves: MSS-SP-110
  .3 Cast Iron Gate Valves: MSS-SP-70
  .4 Cast Iron Globe Valves: MSS-SP-85
  .5 Cast Iron Check: MSS-SP-71
.8 First named product as indicated, other acceptable manufacturers subject to equivalent products include:
  .1 Kitz
  .2 Crane
  .3 Conbraco.
  .4 Jenkins
  .5 Forbes-Marshall
  .6 Nibco

2.2 LOW PRESSURE STEAM

.1 Nominal Operating Pressure 15 psig
.2 Design Pressure 125 psig
.3 Test Pressure 188 psig
.4 Design Temperature 350°F
.5 Corrosion Allowance 0.0625 in.
.6 Pipe ASTM A53 Gr. B ERW or ASTM A106 Gr. B, sch 40, black
.7 Joints, 2" and smaller screwed

.8	Screwed Fittings	125 Lb. cast steel
.9	Unions	Cl.150, ASTM A-47 malleable iron, ASTM A-153 galvanized, ANSI B2.1 threads.
.10	Dielectric Unions	Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
.11	Joints, 2-1/2" and larger	welded, with flanges at connections to equipment
.12	Butt weld fittings	ASTM A234 Gr. WFB
.13	Flanges	ASTM A105, Class 150, raised face, weld neck or slip on
.14	Bolts	ASTM A307 C.S. bolts, sq. head; ASTM A563 nuts, hex head
.15	Gaskets	1/16" (1.6 mm) thick preformed non-asbestos graphite fibre.
.16	Valves, 2" and smaller	ASTM A105
	Gate Valves (Isolating)	125 psig WSP, ASTM B62 bronze body, solid wedge disc, rising stem, bronze trim, threaded ends, Kitz model 24
	Globe Valves (Throttling) (Teflon)	125 psig WSP, ASTM B62 bronze body, composition disc, rising stem, bronze trim, threaded ends, Kitz model 03
	Check Valves (Backflow)	125 psig WSP, ASTM B62 bronze body, Y-pattern horizontal, swing type disc, threaded ends, Kitz model 22T
	Gate Valves (Drain)	125 psig WSP, ASTM B62 bronze body, solid wedge disc, rising stem, bronze trim, threaded ends, cap and chain. Kitz # 24 piston type
.17	Valves, 2-1/2" and larger	ASTM A216 WCB
	Gate Valves (Isolating) bolted	125 psig WSP, ASTM A126 Class B cast iron body, bonnet, bronze mounted, solid wedge disc, OS&Y, non-asbestos packing, flanged ends, Kitz model 72.
	Globe Valves (Throttling)	125 psig WSP, ASTM A126 Class B cast iron body, bolted bonnet, bronze mounted, bevelled wedge disc, OS&Y, non-asbestos packing, flanged ends, Kitz model 76.
	Check (Backflow)	125 psig WSP, ASTM 126 Class B cast iron body, bolted cover, bronze mounted, swing type disc, flanged ends, Kitz model 78 piston type for steam flanged 2" (50mm) and above.
.18	Provide stem extensions for insulated piping.	
.19	Provide gear operator and chain on valves installed above 10-ft AFF.	
.20	Strainers, 2" and smaller	150 psig WSP, bronze, Y-pattern, threaded cap and ends, A167 304 stainless steel screen with 1/32" perforations, Kitz model 15.
.21	Strainers, 2-1/2" and larger	150 psig WSP, cast iron, Y-pattern, bolted cover, blow-out

	plug, perforations, flanged	A167 304 stainless steel screen with 1/32" ends, Kitz model 80.

2.3 HIGH PRESSURE STEAM (150 PSI MAXIMUM)

.1	Nominal Operating Pressure	125 psig
.2	Design Pressure	150 psig
.3	Test Pressure	225 psig
.4	Design Temperature	500°F
.5	Corrosion Allowance	0.0625 in.
.6	Pipe	ASTM A106 Gr. B, schedule 40, black
.7	Joints, 2" and smaller	screwed
.8	Screwed Fittings	250 Lb. cast steel
.9	Unions galvanized,	Class 150, ASTM A-47 malleable iron, ASTM A-153 ANSI B2.1 threads.
.10	Dielectric Unions copper barrier.	Union with galvanized or plated steel threaded end, solder end, water impervious isolation
.11	Joints, 2-1/2" and larger	welded with flanges at connections to equipment
.12	Butt weld fittings	ASTM A234 Gr. WFB, seamless
.13	Flanges slip on	ASTM A105, Class 150, raised face, weld neck or
.14	Bolts	ASTM A307 C.S. bolts, sq. head; ASTM A563 nuts, hex head
.15	Gaskets fibre.	1/16" (1.6 mm) thick preformed non-asbestos graphite
.16	Valves, 2" and smaller	ASTM A105
	Gate Valves (Isolating) disc,	150 psig WSP, ASTM B62 bronze body, solid wedge rising stem, bronze trim, threaded ends, Kitz #25.
	Globe Valves (Throttling) Kitz #09.	150 psig WSP, ASTM B62 bronze body, union bonnet, inside screw, G/F PTFE disc, rising stem, threaded ends,
	Check Valves (Backflow)	150 psig WSP, ASTM B62 bronze body, Y-pattern horizontal, swing type disc, threaded ends, Kitz #29.
	Gate Valves (Drain) chain. Kitz #	150 psig WSP, ASTM B62 bronze body, solid wedge disc, rising stem, bronze trim, threaded ends, cap and 25. Piston type
.17	Valves, 2-1/2" and larger	ASTM A216 WCB
	Gate Valves (Isolating) steel wedge disc 96" asbestos packing, flanged	150 psig WSP, ASTM A216 Grade WCB, cast carbon body, solid wedge disc (2-1/2" to 4") or flexible and over), OS&Y rising stem, non- ends, Kitz #150 SCLS.
	Globe Valves (Throttling) asbestos	150 psig WSP, ASTM A126 Class B cast carbon steel body, bolted bonnet, swivel disc, OS&Y rising stem, non- packing, flanged ends, Kitz #150 SCJS.

Check (Backflow) 150 psig WSP, ASTM 216 Grade WC B cast carbon steel body, bolted cover, swing type disc, flanged ends, Kitz #150 SCOS

.18 Provide stem extensions for insulated piping.

.19 Provide gear operator and chain on valves installed above 10-ft AFF.

.20 Strainers, 2" and smaller Class 250 WSP, 400 psig WOG, cast iron body, Y-pattern, screwed cap and ends, A167 304 stainless steel screen with 1/32" perforations. Mueller Steam 11M.

.21 Strainers, 2-1/2" and larger Class 300 psig WSP, cast iron, Y-pattern, bolted flange cover, A167 304 stainless steel screen with 1/32" perforations, flanged ends, Mueller Steam 752 .

2.4 HIGH PRESSURE STEAM (300 PSI MAXIMUM)

.1	Nominal Operating Pressure	250 psig
.2	Design Pressure	300 psig
.3	Test Pressure	450 psig
.4	Design Temperature	420°F
.5	Corrosion Allowance	0.0625 in.
.6	Pipe	ASTM A106 Gr. B, schedule 80, black,
.7	Joints, 2" and smaller	screwed
.8	Screwed Fittings	2000 Lb. ASTM A105 forged steel, ANSI B16.11.
.9	Unions	3000 Lb WOG (1000 psi, 900°F steam), ASTM A105 Gr. 2, forged steel, gound joint.
.10	Joints, 2-1/2" and larger	welded with flanges at connections to equipment
.11	Butt weld fittings	ASTM A234 Gr. WFB, seamless
.12	Flanges	ASTM A105, Class 300, raised face, weld neck or slip on
.13	Bolts	ASTM A193 Gr. B7 studs, ASTM A194 Gr. 2H nuts.
.14	Gaskets	1/16" (1.6 mm) thick preformed non-asbestos graphite fibre.
.15	Valves, 2" and smaller	ASTM A105
	Gate Valves (Isolating)	Class 800, ASME B16.34 forged steel body, conventional port, outside screw & yoke, bolted bonnet, 1/2 Stellite trim (#8), graphite packing, threaded ends. Bonney Forge HL-11-T.
	Globe Valves (Throttling)	Class 800, ASME B16.34 forged steel body, outside screw & yoke, bolted bonnet, 1/2 Stellite trim (#8), graphite packing, threaded ends. Bonney Forge HL-31-T.
	Check Valves (Backflow)	Class 800, ASME B16.34 forged steel body, bolted bonnet, 1/2 Stellite trim (#8), graphite gasket, swing check, threaded ends. Bonney Forge HL-61-T.
	Gate Valves (Drain)	Class 800, ASME B16.34 forged steel body, conventional

port, outside screw & yoke, bolted bonnet, 1/2 Stellite trim (#8), graphite packing, threaded ends, cap & chain. Bonney Forge HL-11-T.

.16 Valves, 2-1/2" and larger ASTM A216 WCB
Gate Valves (Isolating) 300 psig WSP, cast carbon steel body, solid wedge disc (2-1/2" to 4") or flexible wedge disc (6" and over), OS&Y rising stem, non-asbestos packing, flanged ends, Kitz #300 SCLS
Globe Valves (Throttling) 300 psig WSP, ASTM A126 Class B cast carbon steel body, bolted bonnet, swivel disc, OS&Y rising stem, non-asbestos packing, flanged ends, Kitz #300 SCJS.
Check (Backflow) 300 psig WSP, cast carbon steel body, bolted cover, swing type disc, flanged ends, Kitz #300SCOS.

.17 Provide stem extensions for insulated piping.

.18 Provide gear operator and chain on valves installed above 10-ft AFF.

.19 Strainers, 2" and smaller Class 600 WSP, cast steel body, Y-pattern, NPT ends, bolted flange cover, A167 304 stainless steel screen with 1/32" perforations. Mueller Steam 861-BC

.20 Strainers, 2-1/2" and larger Class 300 WSP @ 838°F, cast steel body, Y-pattern, flanged ends, bolted flange cover, A167 304 stainless steel screen with 1/32" perforations. Mueller Steam 782.

2.5 CONDENSATE & FEEDWATER (150 PSI MAXIMUM)

.1 Nominal Operating Pressure 125 psig

.2 Design Pressure 150 psig

.3 Test Pressure 225 psig

.4 Design Temperature 500°F

.5 Pipe ASTM A106 Gr. B, schedule 80, black, seamless

.6 Joints, 2" and smaller screwed

.7 Screwed Fittings 250 Lb. cast steel

.8 Flanged Fittings 2" and above ANSI 150

.9 Unions Class 300, ASTM A-47 malleable iron, ASTM A-153 galvanized, ANSI B2.1 threads.

.10 Dielectric Unions Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

.11 Joints, 2-1/2" and larger welded with flanges at connections to equipment

.12 Butt weld fittings ASTM A234 Gr. WFB, seamless

.13 Flanges ASTM A105, Class 150, raised face, weld neck or slip on

.14 Bolts ASTM A307 C.S. bolts, sq. head; ASTM A563 nuts, hex head

.15 Gaskets 1/16" (1.6 mm) thick preformed non-asbestos graphite

fibre.

.16 Valves, 2" and smaller — ASTM A105
Gate Valves (Isolating) — 150 psig WSP, ASTM B62 bronze body, solid wedge disc, rising stem, bronze trim, threaded ends, Kitz #25.
Globe Valves (Throttling) — 150 psig WSP, ASTM B62 bronze body, union bonnet, inside screw, G/F PTFE disc, rising stem, threaded ends, Kitz #09.
Check Valves (Backflow) — 150 psig WSP, ASTM B62 bronze body, Y-pattern horizontal, swing type disc, threaded ends, Kitz #29.
Gate Valves (Drain) — 150 psig WSP, ASTM B62 bronze body, solid wedge disc, rising stem, bronze trim, threaded ends, cap and chain. Kitz # 25

.17 Valves, 2-1/2" and larger — ASTM A216 WCB
Gate Valves (Isolating) — 150 psig WSP, ASTM A216 Grade WCB, cast carbon steel body, solid wedge disc (2-1/2" to 4") or flexible wedge disc 96" and over), OS&Y rising stem, non-asbestos packing, flanged ends, Kitz #150 SCLS.
Globe Valves (Throttling) — 150 psig WSP, ASTM A126 Class B cast carbon steel body, bolted bonnet, swivel disc, OS&Y rising stem, non-asbestos packing, flanged ends, Kitz #150 SCJS.
Check (Backflow) — 150 psig WSP, ASTM 216 Grade WC B cast carbon steel body, bolted cover, swing type disc, flanged ends, Kitz #150 SCOS

.18 Provide stem extensions for insulated piping.

.19 Provide gear operator and chain on valves installed above 10-ft AFF.

.20 Strainers, 2" and smaller — 150 psig WSP, bronze, Y-pattern, threaded cap and ends, A167 304 stainless steel screen with 1/32" perforations, Kitz model 15.

.21 Strainers, 2-1/2" and larger — 150 psig WSP, cast iron, Y-pattern, bolted cover, blow-out plug, A167 304 stainless steel screen with 1/32" perforations, flanged ends, Kitz model 80.

2.6 CONDENSATE & FEEDWATER (300 PSI MAXIMUM)

.1 Nominal Operating Pressure — 250 psig
.2 Design Pressure — 300 psig
.3 Test Pressure — 450 psig
.4 Design Temperature — 420°F
.5 Corrosion Allowance — 0.0625 in.
.6 Pipe — ASTM A106 Gr. B, schedule 80, black,
.7 Joints, 2" and smaller — screwed
.8 Screwed Fittings — 2000 Lb. ASTM A105 forged steel, ANSI B16.11.
.9 Unions — 3000 Lb WOG (1000 psi, 900°F steam), ASTM A105 Gr. 2, forged steel, gound joint.

.10 Joints, 2-1/2" and larger welded with flanges at connections to equipment
.11 Butt weld fittings ASTM A234 Gr. WFB, seamless
.12 Flanges ASTM A105, Class 300, raised face, weld neck or slip on
.13 Bolts ASTM A193 Gr. B7 studs, ASTM A194 Gr. 2H nuts.
.14 Gaskets 1/16" (1.6 mm) thick preformed non-asbestos graphite fibre.
.15 Valves, 2" and smaller ASTM A105
Gate Valves (Isolating) Class 800, ASME B16.34 forged steel body, conventional port, outside screw & yoke, bolted bonnet, 1/2 Stellite trim (#8), graphite packing, threaded ends. Bonney Forge HL-11-T.
Globe Valves (Throttling) Class 800, ASME B16.34 forged steel body, outside screw & yoke, bolted bonnet, 1/2 Stellite trim (#8), graphite packing, threaded ends. Bonney Forge HL-31-T.
Check Valves (Backflow) Class 800, ASME B16.34 forged steel body, bolted bonnet, 1/2 Stellite trim (#8), graphite gasket, swing check, threaded ends. Bonney Forge HL-61-T.
Gate Valves (Drain) Class 800, ASME B16.34 forged steel body, conventional port, outside screw & yoke, bolted bonnet, 1/2 Stellite trim (#8), graphite packing, threaded ends, cap & chain. Bonney Forge HL-11-T.
.16 Valves, 2-1/2" and larger ASTM A216 WCB
Gate Valves (Isolating) 300 psig WSP, cast carbon steel body, solid wedge disc (2-1/2" to 4") or flexible wedge disc (6" and over), OS&Y rising stem, non-asbestos packing, flanged ends, Kitz #300 SCLS
Globe Valves (Throttling) 300 psig WSP, ASTM A126 Class B cast carbon steel body, bolted bonnet, swivel disc, OS&Y rising stem, non-asbestos packing, flanged ends, Kitz #300 SCJS.
Check (Backflow) swing 300 psig WSP, cast carbon steel body, bolted cover, type disc, flanged ends, Kitz #300SCOS.
.17 Provide stem extensions for insulated piping.
.18 Provide gear operator and chain on valves installed above 10-ft AFF.

3 EXECUTION

3.1 PREPARATION

.1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
.2 Remove scale and dirt on inside and outside before assembly.
.3 Prepare piping connections to equipment with flanges or unions.
.4 Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.

.5 After completion, fill, clean, and treat systems. Refer to Section 23 25 00.

3.2 INSTALLATION

.1 Install to manufacturer's instructions.
.2 Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
.3 Install piping to conserve building space and not interfere with use of space.
.4 Sleeve pipe passing through partitions, walls, and floors.
.5 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
.6 Inserts:
  .1 Provide inserts for placement in concrete formwork.
  .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
  .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
.7 Pipe Hangers and Supports:
  .1 Install to ASTM B31.9.
  .2 Support horizontal piping as scheduled.
  .3 Place hangers within 12" (300 mm) of each horizontal elbow.
  .4 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
  .5 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
  .6 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
  .7 Provide copper plated hangers and supports for copper piping.
  .8 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
.8 Provide clearance for installation of insulation and access to valves and fittings.
.9 Provide access where valves and fittings are not exposed.
.10 Slope steam piping 0.25 percent in direction of flow. Use eccentric reducers to maintain bottom of pipe level.
.11 Slope steam condensate piping 0.25 percent. Provide drip trap assembly at low points and before control valves. Run condensate lines from trap to nearest condensate receiver. Provide loop vents over trapped sections.
.12 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer (VOC content not to exceed 250

g/L) to welds.

.13 Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting.

.14 Install valves with stems upright or horizontal, not inverted.

3.3 CONTROLS DEVICES

.1 Install pipe wells for various remote sensors such as temperature and pressure sensors. Supply of sensors and controls wiring will be under Section 26.

.2 Install control valves for fluid flow control. Supply of valves, valve actuators and controls wiring will be under Section 26.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

.1 Steam traps.
.2 Steam air vents.
.3 Pressure reducing valves.
.4 Steam safety valves.

1.3 REFERENCES

.1 CSA B51 Boiler, Pressure Vessel and Pressure Piping Code
.2 ASME - Boiler and Pressure Vessel Codes, SEC 8-D - Rules for Construction of Pressure Vessels.
.3 ASTM A105/A105M - Carbon Steel Forgings for Piping Applications.
.4 ASTM A126 - Grey Iron Castings for Valves, Flanges, and Pipe Fittings.
.5 ASTM A216/A216M - Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
.6 NEMA 250 - Enclosures for Electrical Equipment (1000 Volt Maximum).

1.4 PERFORMANCE REQUIREMENTS

.1 Steam Traps:
  .1 Select to handle minimum of two times maximum condensate load of apparatus served.
  .2 Pressure Differentials:
    .1 Low Pressure Systems (34 kPa and less): 3.4 kPa
    .2 Low Pressure Systems (103 kPa maximum): 13.8 kPa.
    .3 Medium Pressure Steam (172 kPa maximum): 34 kPa.
    .4 Medium Pressure Steam (276 kPa maximum): 69 kPa.
    .5 Medium Pressure Steam (414 kPa maximum): 103 kPa.
    .6 High Pressure Steam (689 kPa maximum): 206 kPa.
    .7 High Pressure Steam (1034 kPa maximum): 276 kPa.
    .8 High Pressure Steam (2068 kPa maximum): 345 kPa.

1.5 SUBMITTALS

.1 Section 25 01 01: Procedures for submittals.
.2 Product Data:
  .1 Provide for manufactured products and assemblies required for this project.
  .2 Include product description, model, dimensions, component sizes, rough-in

requirements, service sizes, and finishes.

.3 Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each specialty.

.4 Include electrical characteristics and connection requirements.

.3 Manufacturer's Installation Instructions: Indicate application, selection, and hookup configuration. Include pipe and accessory elevations.

1.6 OPERATION AND MAINTENANCE DATA

.1 Division 25 01 01: Submittals for project closeout.

.2 Operation and Maintenance Data: Include installation instructions, servicing requirements, and recommended spare parts lists.

1.7 REGULATORY REQUIREMENTS

.1 Conform to CSA B51 Boilers, Pressure Vessels and Pressure Piping Code and to ASME B31.1 Power Piping Code for installation of steam and steam condensate piping and specialties.

.2 Products Requiring Electrical Connection: Listed and classified by CSA, ULC, cUL or Special Inspection as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

.1 Section 25 01 01: Transport, handle, store, and protect products.

.2 Accept valves on site in shipping containers with labeling in place. Inspect for damage.

.3 Provide temporary protective coating on cast iron and steel valves.

.4 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

.5 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 EXTRA MATERIALS

.1 Section 25 01 01: Submittals for project closeout.

.2 Provide two service kits for each size and type of steam trap.

.3 Provide one set of mechanical seals for each pumps.

2 PRODUCTS

2.1 INVERTED BUCKET TRAPS

.1 Trap:

.1 Construction: ASTM A126, Cast iron or semi-steel body with bolted cover, brass bucket, stainless steel seats and plungers, and stainless steel lever mechanism with knife edge operating surfaces.

.2 Rating: 65 psi (443 kPa) WSP.
.3 Features: Access to internal parts without disturbing piping, top test plug, bottom drain plugs.
.4 Accessories: Integral inlet strainer of brass.
.5 Manufacturers:
.1 Armstrong International
.2 Spirax Sarco
.3 Colton Industries

2.2 FLOAT AND THERMOSTATIC TRAPS

.1 Trap:
.1 Construction: ASTM A126, cast iron or semi-steel body and bolted cover, stainless steel or bronze bellows type air vent, stainless steel or copper float, stainless steel lever and valve assembly
.2 Rating: 15 psi (103 kPa) WSP.
.3 Features: Access to internal parts without disturbing piping, bottom drain plug.
.4 Manufacturers:
.1 Armstrong International
.2 Spirax Sarco
.3 Colton Industries

2.3 THERMODYNAMIC TRAPS

.1 Trap:
.1 Construction: Stainless steel body, disc, and cap.
.2 Rating: 300 psi (2070 kPa) WSP.
.3 Features: Stainless steel insulating cap.
.4 Manufacturers:
.1 Armstrong International
.2 Spirax Sarco
.3 Colton Industries

2.4 THERMOSTATIC TRAPS

.1 Pressure Balanced:
.1 Trap: ASTM A395 stainless mild steel body and bolted or screwed cover and integral ball joint union for 125 psi (860 kPa) WSP; phosphor bronze bellows, stainless steel valve and seat; integral stainless steel strainer.
.2 Freeze Proof:
.1 Trap: Stainless mild steel body for 300 psi (2070 kPa) WSP, bronze bellows, stainless steel valve and seat, external adjustment.
.3 Bi-metallic:
.1 Trap: ASTM A105 forged steel body and cover, for 300 psi (2070 kPa) WSP, bi-metal element with stainless steel components, integral Type 304 stainless steel

strainer screen, 1/4" (6 mm) blow down valve.

.4 Manufacturers:
- .1 Armstrong International
- .2 Spirax Sarco
- .3 Colton Industries

2.5 STEAM AIR VENTS

.1 125 psi (860 kPa) WSP:
- .1 Balanced Pressure Type: Cast brass body and cover; access to internal parts without disturbing piping; stainless steel bellows, stainless steel valve and seat.

.2 225 psi (1550 kPa) WSP:
- .1 Balanced Pressure Type: ASTM A126 cast iron body and cover; access to internal parts without disturbing piping; phosphor bronze bellows, stainless steel valve and seat.

.3 Manufacturers:
- .1 Armstrong International
- .2 Spirax Sarco
- .3 Colton Industries

2.6 FLASH TANKS

.1 Tank:
- .1 Closed type, tested and stamped to ASME SEC 8-D, welded steel construction, cleaned, prime coated, and supplied with steel support legs.
- .2 Working Pressure: 690] 860 kPa.
- .3 Construct with nozzles and tappings for installation of accessories and piping connections.

.2 Manufacturers:
- .1 Armstrong International
- .2 Spirax Sarco
- .3 Colton Industries

2.7 PRESSURE POWERED CONDENSATE RETURN UNITS

.1 Condensate Return Units: Consist of receiver, inlet strainer, pumps, float switches, control panel and accessories.

.2 Condensate Receiver: Cast iron, equipped with externally adjustable float switches, water level gauge, dial thermometer, pressure gauges on pump discharge, bronze isolation valves and strainer between pumps and receiver, and lifting eye bolts.

.3 Inlet Strainer: Cast iron with vertical self-cleaning bronze screen and large dirt pocket, mounted on receiver. Screen to be easily removable for cleaning.

.4 Pumps: One stage, vertical design, bronze fitted with stainless steel shaft, bronze impeller, renewable bronze case ring, mechanical shaft seal, close coupled to 1750 rpm motor.

.5 Control Cabinet:
  .1 NEMA 250 enclosure, UL listed, with piano hinged door, grounding lug, terminal strip, and fusible control circuit transformer.
  .2 Combination magnetic starters with overload relays, circuit breakers and cover interlock.
  .3 Electric alternator.
    .1 Operate pumps on high level, alternating after each cycle.
    .2 Operate second pump upon failure of first pump and alarm.
  .4 'Auto-Off' switch
  .5 Test button, high level alarm light, acknowledge button, alarm horn.
.6 Unit Capacity: as scheduled on drawings.

2.8 PRESSURE REGULATING VALVES

.1 Pilot Operated Pressure Regulator shall be of the pilot-actuated diaphragm type. The main valve shall be single-seated with hardened stainless steel trim; the regulator body shall be cast iron (cast steel). The pilot shall be bolted directly to the regulator body. The regulator shall be capable of dead-end shut-off. Spirax Sarco model 25P, Spence BD

2.9 SAFETY RELIEF VALVES

.1 Valve: Bronze or cast iron body, stainless steel valve spring, stem, and trim, direct pressure actuated, capacities ASME certified and labelled.
.2 Accessories: Drip pan elbow.
.3 Manufacturers:
  .1 Conbraco
  .2 Spirax Sarco

2.10 STEAM SEPARATORS

.1 Cast steel body, rated to 2100 kPa (300 psi), flanged (ANSI 300) end connections, screwed bottom drain connection.
.2 Spirax Sarco, Armstrong, or approved equal, Colton MSF-300

2.11 STEAM FLASH VESSEL

.1 Fabricated steel construction to ANSI/ASTM specifications for "unfired fusion welded pressure vessels" certified and registered, with flanged condensate inlet and flash outlet connections, pressure gauge with siphon and cock, float and thermostatic trap with wye strainer, safety relief valve. Spirax Sarco model FV, Docal, Colton Industries.

2.12 CONDENSATE COOLERS

.1 Condensate coolers shall be installed at humidifiers to accept drain, manifold, and

distribution piping steam traps, all in one cooler. Each humidifier unit shall have its own cooler. Outlet of warm water and condensate discharge shall be twined and piped to nearest floor drain.

.2 Condensate cooler shall be Forbes Marshall 2 gallon or 4 gallon capacity of all stainless steel construction. Cooler shall be of non contact type and shall have its own stainless steel condensate/steam cooling coil. No external vent connections are required or allowed.

.3 Direct injection type condensate coolers into a storage unit vented or not shall not be allowed.

.4 Provide each cooler with a reverse acting cooling control valve by Danfoss Industries or similar manufacturer.

.5 Approved Equal Dri-Steam (Non contact models only), Nortec, Armstrong International.

3 EXECUTION

3.1 INSTALLATION

.1 Install specialties to manufacturer's instructions.

.2 Steam Traps:

.1 Use Float and Thermostatic Traps for:

.1 Direct steam injected equipment.

.2 Process equipment.

.3 Main headers.

.4 Branch lines.

.2 Use Inverted Bucket Steam Traps for:

.1 Main headers.

.2 Branch lines.

.3 Direct steam injected equipment.

.3 Provide minimum 20 mm size on steam mains and branches.

.4 Install with union or flanged connections at both ends.

.5 Provide gate valve and strainer at inlet, and gate valve and check valve at discharge.

.6 Provide minimum 250 mm long, line size dirt pocket between apparatus and trap.

.7 Provide parallel steam traps on coils where entering air temperature is less than 4°C. Each trap shall be capable of handling the full condensing capacity of the coil.

.3 Remove thermostatic elements from steam traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.

.4 In high pressure and medium pressure mains, provide 3/4" (20 mm) nipple in bottom of main, extending 3/4" (20 mm) into and above bottom of pipe. Provide dirt pocket with 1/2" (13 mm) high pressure thermostatic trap.

.5 Provide pressure reducing stations with pressure reducing valve, valved bypass, strainer and pressure gauge on upstream side, safety relief valve and pressure gauge on downstream side of pressure reducing valve.

.6 Pressure reducing station to be one or two stages as required, to produce flat reduced pressure curve over range of capacity. Locate pilot operator control minimum 78" (2000 mm) downstream of valve.

.7 Rate relief valves for pressure upstream of pressure reducing station, for full operating capacity. Set relief at maximum 20 percent above reduced pressure.

.8 Terminate relief valves to a safe location outdoors 84" (2100mm) above roof. Provide drip pan elbow with drain connection to nearest floor drain. Size vent riser to suit drip pan elbow.

.9 When several relief valve vents are connected to a common header, header cross section area to equal sum of individual vent outlet areas.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 REFERENCES

.1 ASHRAE HANDBOOK, HVAC SYSTEMS & EQUIPMENT, Duct Construction Recommendations

.2 Sheet Metal And Air Conditioning Contractors' National Association (SMACNA)

- .1 HVAC Duct Construction Standards - Metal and Flexible
- .2 HVAC Duct Systems Design
- .3 Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
- .4 Accepted Industry Practice for Industrial Duct Design
- .5 HVAC Systems - Testing, Adjusting and Balancing
- .6 Round Industrial Duct Construction Standards
- .7 Rectangular Industrial Duct Construction Standards
- .8 HVAC Air Duct Leakage Test Manual.
- .9 Guide for Steel Stack Construction

.3 National Fire Protection Association (NFPA)

- .1 80 Standard for Fire Doors and Windows
- .2 90A Standard for Installation of AC and Ventilation Systems
- .3 90B Standard for Installation of Warm Air Heating and AC Systems
- .4 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .5 255 Building Materials, Test of Burning Characteristics (same as ASTM E84)

.4 American Society for Testing and Materials (ASTM)

- .1 A90/A90M - Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc- Alloy Coatings.
- .2 A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- .3 A480/A480M - General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
- .4 A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .5 A1011/A1011M - Standard Specification for Steel, Sheet, and Strip Hot-Rolled, Carbon, Structural, High-Strength, Low-Alloy with Improved Formability.
- .6 B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- .7 A240 - Standard Specification for Heat-Resisting Chromium and Chromium- Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels
- .8 A480 - Standard Specification for General Requirements for Flat Rolled Stainless Heat-Resisting Steel Plate, Sheet

and Strip
.9 A653 - Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated by the Hot Dip Process
.10 E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
.11 E477 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Material and Prefabricated Silencers
.12 E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops

.5 American Welding Society (AWS)
.1 B2.2 Brazing Procedures and Performance Qualifications
.2 D9.1 Sheet Metal Welding Code

.6 Underwriter's Laboratories (UL)
.1 181 Factory Made Air Ducts and Air Connectors
.2 555 Standard for Safety Fire Dampers
.3 555S Leakage Rated Dampers for Use in Smoke Control Systems
.4 723 Test for Surface Burning Characteristics of Burning Materials (ASTM E84)

1.3 PERFORMANCE REQUIREMENTS

.1 No variation of duct configuration or sizes permitted except by written permission.
.2 Size round ducts installed in place of rectangular ducts to ASHRAE table of equivalent rectangular and round ducts.
.3 Sizes indicated on drawings are clear inside dimensions and do not include for duct linings.

1.4 SUBMITTALS

.1 Division 23 01 01: Procedures for submittals.
.2 Product Data: Provide data for duct materials.
.3 Shop Drawings:
.1 Plenums and plenum related items showing physical dimensions, joints, sealants, door construction and hardware.
.2 Factory fabricated ducts, fittings and joining systems.
.3 Firewall duct penetrations; fire and smoke dampers; louvers and access doors.
.4 Duct fitting particulars such as gauges, sizes, welds, reinforcements and configuration for 4" wg. (1000 kPa) pressure class and higher systems.
.4 Submit changes or alterations in ductwork layout, with supporting calculations showing that the modified design will not increase total pressure, before work commences. Submittals for proposed changes shall be stamped for acceptance prior to commencement of work.
.5 Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

.6 Material Safety Data Sheets (MSDS) for sealants, adhesives and coatings.

1.5 PROJECT RECORD DOCUMENTS

.1 Division 1: Submittals for project closeout.
.2 Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 QUALITY ASSURANCE

.1 Perform Work to SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
.2 Perform Duct Leakage Testing to SMACNA "HVAC Air Duct Leakage Testing Manual"
.3 Maintain one copy of document on site.
.4 Asbestos Free: Insulating and sealing materials must be certified to be free of asbestos.
.5 Brazing: Certify brazing procedures, brazers, and operators in accordance with AWS B2.2 Brazing Procedures and Performance Qualifications
.6 Welding: Certify welding procedures, welding equipment and welders in accordance with AWS D9.1 Sheet Metal Welding Code.

1.7 REGULATORY REQUIREMENTS

.1 Ontario Building Code (OBC)
.2 Ontario Fire Code (OFC)
.3 Construct ductwork to NFPA 90A standards.

1.8 ENVIRONMENTAL REQUIREMENTS

.1 Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
.2 Maintain temperatures during and after installation of duct sealants.

2 PRODUCTS

2.1 MATERIALS

.1 Table of Materials

APPLICATIONS	MATERIALS
Rigid HVAC ducts, casings and fittings	ASTM A653 galvanized steel sheet, lock form quality, G90 zinc coating (0.90 oz/ft2) to ASTM A90. Sheets free of pits, blisters, slivers, and ungalvanized spots.

Rigid HVAC ducts, casings and fittings installed underground (below slabs on grade). Rigid HVAC ducts, casings and fittings installed in swimming pools (natatorium).	PVC coated, galvanized steel sheets, lock form quality to ASTM A653, G90 zinc coating (0.90 oz/ft2 both sides) and factory applied 4-mil PVC coating. Ductwork shall be UL-181, Class 1 listed.

.2 Hanger Rod: continuously threaded, ASTM A36 galvanized steel in general, stainless steel for stainless steel ducts.

.3 Sealant: Non-hardening, water resistant, fire resitive, low VOC (VOC content not to exceed 250 g/L), compatible with mating materials; liquid used alone or with tape, or heavy mastic.

.4 Supports: Angle iron, channels, rods and related supporting materials shall be galvanized or red oxide coated.

.5 Fasteners: Use galvanized rivets, screws and bolts throughout, except on stainless steel ductwork, use SS fasteners.

.6 Reinforcements: Provide galvanized steel or stainless steel reinforcement shapes and plates to match ductwork.

.7 Tie Rods: Use galvanized steel, 1/4 inch minimum diameter fasteners for ductwork 36 inch or less in length; use 3/8 inch minimum diameter for lengths longer than 36 in.

2.2 DUCT CONSTRUCTION

Duct Construction Schedule

Duct Application	Duct Pressure	Pressure Class (in.wg.)	Seal Class	Leakage Class
Rectangular high pressure, high velocity ductwork	Positive	10	A	6
Round high pressure, high velocity ductwork	Positive	10	A	3`
Rectangular HVAC Supply from AHU to terminal unit or reheat coil	Positive	4	A	6
Round HVAC Supply from AHU to terminal unit or reheat coil	Positive	4	A	3
Rectangular HVAC Supply from terminal unit or reheat coil to HEPA filter in OR air outlet	Positive	4	A	6
Round HVAC Supply from terminal unit or reheat coil to HEPA filter in OR air outlet	Positive	4	A	3
Rectangular HVAC Supply from terminal unit or reheat coil to air outlet	Positive	2	A	6
Round HVAC Supply from terminal unit or reheat coil to air outlet	Positive	2	A	3
Rectangular HVAC Single zone supply from	Positive	2	A	6

AC Unit to air outlet				
Round HVAC Single zone supply from AC Unit to air outlet	Positive	2	A	3
Rectangular HVAC Return from air outlet to AHU	Negative	2	A	6
Round HVAC Return from air outlet to AHU	Negative	2	A	3
Rectangular Sanitary exhaust ductwork	Negative	2	A	6
Round Sanitary exhaust ductwork	Negative	2	A	3
Rectangular General HVAC exhaust ductwork	Negative	2	A	6
Round General HVAC exhaust ductwork	Negative	2	A	3
Notes: 1. Pressure class shall be the lower of exhaust fan shut-off pressure or value shown				

2.3 DUCT SEALING

.1 Duct Sealing Requirements

SEAL CLASS	SEALING REQUIREMENTS
A	All tranverse joints, longitudinal seams and duct wall penetrations
B	All tranverse joints and longitudinal seams a
C	All tranverse joints

2.4 DUCT LEAKAGE

.1 Leakage Class is defined as

$CL = F / (P)^{0.65}$

where: CL = Leakage Class
F = Leakage Factor (cfm/100-ft2 of duct surface)
P = Static pressure in the duct (in.wg.)

.2 Table

LEAKAGE FACTOR (F) CFM/100 –sq.ft. of DUCT SURFACE					
LEAK CLASS	**PRESSURE CLASS (in.wg.) (+ve or –ve)**				
C_L	**1**	**2**	**4**	**6**	**10**

48	48	75	118	154	214
24	24	38	59	77	107
12	12	19	30	38	54
6	6	9	15	19	27
3	3	5	7	10	13
0	0	0	0	0	0

2.5 DUCTWORK FABRICATION

.1 All Ductwork shall be constructed to withstand 1-1/2 times fan pressure at shut-off and 2" (500 Pa) minimum.

.2 Fabricate and support to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated in accordance with recommendations of ASHRAE and SMACNA.

.3 Joints and reinforcements:

- .1 to SMACNA and ASHRAE
- .2 may be made with the Ductmate System or Nexus System. System components shall be made of standard catalogue manufacture as supplied by Ductmate Industries, Inc. or Nexus Inc.

.4 Construct Tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centreline. Where not possible and where rectangular elbows are used, provide air foil turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fibre insulation.

.5 Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

.6 Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints: minimum 100 mm cemented slip joint, brazed or electric welded. Prime coat welded joints.

.7 Provide standard 45-degree lateral wye takeoffs. Alternative 90-degree conical tee connections may be used only where specifically indicated.

2.6 INSULATED PANELS

.1 Double-wall insulated panels, 4" (100 mm) thick with solid galvanized steel exterior and interior shells. Outer and inner shells shall be tack or spot welded to perimeter and internal longitudinal steel channels and box-end internal closures in such a manner and spacing that the panel assembly will withstand a wind loading of 20 pounds per square foot with no panel joint deflections in excess of L/200.

.2 Outer shell shall be minimum 20 gauge (1.0 mm) thickness and inner shell shall be minimum 22 gauge (0.86 mm) thickness.

.3 All perimeter and internal longitudinal steel channel members shall be constructed of ASTM Type A-446 structural quality galvanized steel with a minimum 18 gauge (1.32 mm) thickness or ASTM Type A-526 commercial-quality galvanized steel with a minimum 16 gauge (1.62 mm) thickness.

.4 All steel panel surfaces, internal channels, and trim items shall be fabricated from zinc-coated steel with a hot-dipped galvanized coating (minimum G-90 coating class as determined by ASTM A-525) and shall meet all requirements of ASTM A-526 for commercial-quality galvanized carbon steel.

.5 Insulating materials used in all prefabricated panel assemblies shall have the following maximum thermal conductances at a mean temperature of 75°F (24°C): 0.06 Btu per hour per square foot per degree Fahrenheit. (0.34 W per square metre per degree Celsius)

.6 Each panel assembly shall be completely filled with acoustical/thermal insulating material that is noncombustible, inert, mildew-resistant, and vermin-proof. Insulation shall not settle within the panel assembly. No insulating materials shall be used that have a flame spread greater than 25 or a smoke developed greater than 50.

.7 Panels shall be of "snap-lock" construction, such that adjacent panels are held together rigidly with an integral, continuous self-locking joint on both inside and outside panel surfaces. These joints should not require screws, H-connectors, tape, or any other type of additional fasteners or connectors.

.8 Acceptable Manufacturer: United McGill "Uni-Housing", Vibro-Acoustics, Kinetics (Virbon) Price, VAN

2.7 INSTALLATION OF STACKS

.1 Stacks shall be designed under the supervision of a professional engineer licensed in the province of Ontario and experienced in the design of these works.

.2 Submitted shop drawings, signed, sealed and dated by the professional engineer to indicate details of design, fabrication, assembly and support including seismic restraints as required for installation on a "post disaster" facility.

.3 Install stacks with minimum of joints. Align accurately at connections, with internal surfaces smooth.

.4 Support stacks from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Refer to OBC, NFPA Standards and SMACNA Guide for Steel Stack Construction.

.5 Level and plumb stacks.

.6 Clean stacks during installation, removing dust and debris.

3 EXECUTION

3.1 INSTALLATION

.1 Install and seal ducts to SMACNA HVAC Duct Construction Standards - Metal and Flexible.

.2 Install ductwork parallel to building lines.

.3 Support all ductwork from structural members. Where structural bearings do not exist, suspend strapping or hangers from steel channels or angles. Provide supplementary structural members. Do not suspend from metal deck.

.4 Do not break continuity of insulation vapour barrier by hangers or rods.

.5 Hangers shall be steel angles with supporting rods, locking nuts and washers to following table; [Except for Fire Rated Ventilation Ductwork or Fire Rated Kitchen Exhaust Grease Duct which shall comply with ULC Listing and manufacturers instructions]

DUCT HANGERS - IP			
Duct Sizes (Largest side)	**Angle Size**	**Rod Size**	**Spacing**
Up to 30"	1" x 1" x 1/8"	1/4" diameter	10 ft
31" to 42"	1-1/2" x 1-1/2" x 1/8"	1/4" diameter	10 ft
43" to 60"	1-1/2" x 1-1/2" x 1/8"	3/8" diameter	10 ft
61" to 84"	2" x 2" 1/8"	3/8" diameter	8 ft

DUCT HANGERS - SI			
Duct Sizes (Largest side)	**Angle Size**	**Rod Size**	**Spacing**
Up to 30"	25 x 25 x 3 mm	6mm diameter	3 m
31" to 42"	40 x 40 x 3 mm	6mm diameter	3 m
43" to 60"	40 x 40 x 3 mm	10mm diameter	3 m
61" to 84"	50 x 50 x 3 mm	10mm diameter	2.5 m

.6 Anchor all risers at bottom and support from building structure at each floor level.

.7 Vertical ducts passing through floors shall be supported on angles secured to duct bearing on the floor.

.8 Where ducts pass through walls, floors, openings requied to have a fire resistance rating the opening in the construction around the duct shall be filled with an approved fire stop material as per NFPA 90A and fire damper shall also be installed with access doors as per the code.

.9 Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.

.10 Provide openings in duct work where required to accommodate thermometers and

controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

.11 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

.12 Use crimp joints with or without bead for joining round duct sizes 8" (200 mm) and smaller with crimp in direction of air flow.

.13 Use double nuts and lock washers on threaded rod supports.

.14 Connect terminal units to supply ducts directly or with 12" (300 mm) maximum length of flexible duct. Do not use flexible duct to change direction.

.15 Connect diffusers or light troffer boots to low pressure ducts directly or with 60" (1.5 m) maximum length of flexible duct held in place with strap or clamp.

.16 Connect flexible ducts to metal ducts with adhesive and metal or nylon straps.

.17 Ground across flexible connector with No. 2/0 braided copper strap.

.18 Set plenum doors 6" to 12" (150 to 300 mm) above floor. Arrange door swings so that fan static pressure holds door in closed position.

.19 During construction provide temporary closures of metal or taped polyethylene on open duct work to prevent construction dust from entering duct work system.

.20 Install HTL ductwork between duct silencer and mechanical room wall.

.21 Balancing dampers shall be installed on branches as per locations shown on the drawings and as per the requirements of NEBB and AABC listing/measuring standards.

.22 Perform duct leakage testing for all ductwork installed ubnder this contract.

3.2 WATERTIGHT DUCTWORK

.1 Spiral ducts and elbows shall not be used for watertight exhaust systems.

.2 Provide watertight ductwork for:

- .1 Dishwasher exhaust
- .2 Cartwasher exhaust
- .3 "Wet" air exhaust
- .4 Humidifiers for 10 ft. (3 metres) in all directions
- .5 Fresh air intake ducts and plena
- .6 Fume hood exhaust

.3 Form bottom of duct without longitudinal seams.

.4 All seams and joints welded. Connections to equipment and accessories flanged and gasketted.

.5 Slope horizontal branch ductwork down toward hood or equipment served.

.6 Slope header ducts down toward risers.

.7 Fit base of risers with 6" (150 mm) deep drain and 1-1/4" (32 mm) drain connection, with deep seal trap and valved drain line to open funnel drain.

.8 Provide drain in every fresh air intake and exhaust plenum.

3.3 CORRIDOR PENETRATION DUCTWORK

.1 Site measurement shall be taken before fabrication in the factory shall begin.

.2 The ductwork, joints, hangers, access doors and all other accessories shall be manufactured and installed as per manufacturer's instructions and in accordance with the ULC listing, meeting the requirements of NFPA 96.

.3 The final installation shall be inspected and approved by the duct manufacturer. Contractor to submit letters from manufacturer to authority having jurisdiction verifying undertaking to inspect and final approval.

3.4 INSULATED PLENUMS

.1 Insulated panels shall be installed on a level concrete curb. Spacing of base channel attachments shall be as outlined in the manufacturer's standard details of assembly.

.2 All assembly trim items shall be constructed of hot-dipped galvanized steel (minimum 18-gauge (1.32 mm) thickness) and furnished in standard lengths to be field cut to the required dimensions. Spacing of sheet metal screws, application of duct sealant, and positioning of trim shall be in accordance with the plenum manufacturer's published erection and installation details.

.3 All mechanical joints and external trim items shall be sealed with a UL-Classified duct sealant as follows. In order to show that joints have been sealed properly, enough sealant shall be used so that excess sealant is extruded from all completed external joints. Joints and trim shall be sealed with a solvent-based duct sealant that is a neoprene-phenolic mastic formulated to withstand temperatures from -20 to +300 degrees Fahrenheit (-29 to 149°C). Sealant shall be formulated such that surface preparation or solvent cleaning is not necessary. Sealant shall have a UL Classification marking with flame spread of 5 and smoke developed of 0 when applied to 18-gauge (1.32 mm) galvanized steel and a flame spread of 5 and smoke developed of 5 when applied to inorganic reinforced cement board, both at a coverage of 53 sq. ft. per gallon (1.3 m2 per litre). Sealant shall exceed 1,000 hours under ASTM-D572 test conditions (oxygen bomb) without becoming brittle and 500 hours in QUV accelerated-exterior-aging apparatus without degradation (under ASTM-C732 test conditions).

.4 One personnel access door shall be provided and shall be 24" wide by 60" high (600 mm wide by 1500 mm high). Door shall be the same nominal thickness as the prefabricated standard door panel in which they are mounted and shall be constructed with a solid inner and outer shell (minimum 20-gauge (1.0 mm) thickness). Each door shall be installed in the door panel at the factory and shall have a minimum of two ball-bearing hinges and two wedge-lever door latches. All levers shall be operable from the interior and exterior sides of the door panels. Door shall be installed to open against the air pressure differential.

.5 Door shall seat against neoprene gasket materials, installed around the entire perimeter of the door frame in such a manner that door operation will provide direct compression with no sliding action between the door and gasket.

.6 Openings for pipe and conduits shall be field cut to ensure proper positioning. All

framing members, collars, and bellmouth fittings shall be insulated, welded, and sealed according to the plenum manufacturer's published installation details.

.7 Entire wall shall be designed to be removable for equipment access purposes.

.8 Provide drain in every fresh air intake and exhaust plenum.

3.5 DUCT CLEANLINESS

.1 All ductwork shall be handled and installed in accordance with the advanced level described in SMACNA Duct Cleanliness for New Construction Guidelines.

.2 Ductwork leaving the premises of the manufacturer may include some or all of the following:

- .1 self-adhesive labels or marking for part(s) identification shall be applied to external surfaces only;
- .2 exposed mastic sealant;
- .3 light zinc oxide coating on the metal surface;
- .4 a light coating of oil on machine formed ductwork;
- .5 minor protrusions into the airway of rivets, screws, bolts and other jointing devices;
- .6 internal insulation and associated fasteners;
- .7 discoloration marks from plasma cutting process.
- .8 to maintain cleanliness during transportation, all ductwork shall be sealed either by blanking or capping duct ends, bagging small fittings, surface wrapping or shrink wrapping. Care must be taken to prevent damage during transportation and off loading.

.3 A clean and dry environment where the ductwork is protected from dust must be provided for the storage of ductwork prior to installation. All sealed ends shall be visually examined and if damaged resealed with an appropriate material.

.4 During installation, the working area shall be clean, dry and the ductwork protected from dust.

.5 The internal surfaces of the uninsulated ductwork shall be wiped to remove excess dust immediately prior to installation.

.6 Open ends on completed ductwork and overnight work-in-progress shall be sealed.

.7 Access covers shall be firmly fitted in position on completion of each section of the work.

.8 Protective coverings shall only be removed immediately before installation and inspected to determine if additional wipe down is necessary.

3.6 HVAC SYSTEM CLEANING

.1 Qualifications of HVAC Systems Cleaning Contractor

- .1 Member of National Air Duct Cleaners Association (NADCA)
- .2 Supervisor: Air System Cleaning Specialist certified by NADCA
- .3 Firm: regularily engaged in HVAC system cleaning with minimum 3-years experience
- .4 Employees: trained in safe use of equipment and individual health protection

measures

.2 Maintain a copy of all current MSDS documentation and safety certifications for products employed in the cleaning operations at the site at all times. Submit a copy of all MSDS sheets to Owner.

.3 Standards: Conform to NADCA Standard ACR 2006, Assessment, Cleaning and Restoration of HVAC Systems and NADCA Guidelines.

.4 Scope of HVAC System Cleaning Work;

.1 clean each HVAC System and component as follows;

.1 interior surfaces of all new ductwork and accessories installed as part of this project

.2 interior surfaces of all existing ductwork and accessories that are to remain in service on completion of this project,

.3 interior surfaces of all new and existing HVAC System components that are to remain in service on completion of this project, including; air handling units, fans, fan housings, air coils, drain pans, humidifiers, filters, filter frames, intake and exhaust and mixing plenums, air blenders, air outlets and inlets, air terminal units, power ventilators, sound attenuators, reheat coils, turning vanes, dampers, and sensors

.2 Verify the cleanliness of each HVAC System and component through visual inspection, video recording and testing indicated hereinafter.

.5 Cleaning & Disinfection Requirements;

.1 conduct visual/video inspections of HVAC Systems and components without disruption of settled dust or debris and without microbial amplification. Record and submit video inspections before and after cleaning as follows;

.1 ducts serving Class 1 areas (critical care): 100%

.2 ducts serving Class 2 areas (patient care): 25%

.3 ducts serving Class 3 areas (admin, office):10%

Area classifications per CSA Standard Z-317.1.

.2 mark and record position of any and all adjustable devices and ensure that they are re-set to their original position on completion of cleaning and verification work,

.3 document and report any and all damage to HVAC Systems and components discovered during inspections to Consultant and to Owner,

.4 Cleaning: remove all visible surface contaminants and deposits from each HVAC System and component

.5 Disinfection: disinfect all internal surfaces of ductwork, equipment and accessories that serve one or more Class 1 areas.

.6 Containment: ensure that dust and debris collected during the cleaning process is contained within the HVAC System and not otherwise dispersed outside of the system.

.7 Particulate Collection: high power vacuums with HEPA filtration to 99.97% efficiency on particles greater than 0.3-micron size

.8 Odours and Mist control: ensure that odours and mist vapours arising from cleaning operations are contained within the HVAC System and are

prevented from escaping to and dispersing outside of the system.

.9 Provide adequate access into ductwork for cleaning purposes. Provide access doors conforming to project specifications.

.10 Flexible ducts shall be disconnected to provide access for cleaning.

.11 Protect components which may be harmed by excessive dirt with filters, or bypass during cleaning.

.12 Where mechanical brushing and vacuuming is not appropriate or is not sufficient to clean a component of the system, dismantle and remove the component and clean or replace as appropriate.

.13 Ensure that appropriate liquid collection and drainage measures are in place prior to undertaking any washdown procedures.

.14 Anti-microbial Agents and Coatings: apply anti-microbial agents where active fungal growth is suspected or where unacceptable levels of fungal contamination exist. Apply anti-microbial treatments and coatings in strict adherence to the manufacturer's written recommendations and registration listings. Application of anti-microbial agents and coatings may be performed only after removal of surface deposits and debris.

.6 Cleanliness Verification:

.1 Visual Inspection: no visible contaminants present when examined under a bright light (equivalent to 100w incandescent bulb). Maximum 0.75mg/100cm2 with no significant local accumulations.

.2 Air Coils and reheat coils: restored to within 10% of original design pressure drop

.3 In Class 1 areas (critical care) test supply ducts for each room as follows;

.1 Microbial Samples: rose bengal agar Hycon contact plates, incubated for 3 days at 37°C with number of micro-organisms counted and reported in both per plate and per cm2 concentration levels. Maximum 1 cfu per cm2.

.2 Bacterial Samples: tryptic soy agar contact plates, incubated for 3 days at 37°C with number of micro-organisms counted and reported in both per plate and per cm2 concentration levels. Maximum 1 cfu per cm2.

.4 Particle Profiling Procedures: In the event of a dispute between Contractor and Owner regarding cleanliness, Contractor shall perform NADCA PP procedures in accordance with Chapter 2 of NADCA Guideline to ACR 2006; Particle Measurement, Air Sampling and Surface Sampling for each supply air system at representative locations selected by Owner and in the discharge plenum of each air handling unit.

.7 Report:

.1 submit three (3) copies of cleaning report

.2 report shall include;

.1 certificate of cleanliness from third party inspection service with following minimum qualifications;

.1 Environmental Engineer licensed in the province of Ontario or

.2 Certified Industrial Hygenist, and
.3 minimum 3 years experience in duct cleaning

.2 photographic/video record of cleaned surfaces and components

.3 comparative record of damage discovered on initial inspection and of remedial measures implemented by others

3.7 DUCT LEAKAGE TESTING

.1 Ductwork shall be leak tested in accordance with the SMACNA "HVAC Air Duct Leakage Test Manual". The maximum permitted duct leakage shall be determined by multiplying the leakage factor from paragraph 2.4 above by the surface area of the ductwork in the test zone.

.2 Ductwork that exceeds the maximum permitted leakage shall be re-sealed and re-tested.

.3 Duct leakage test shall be witnessed and certified by the Systems Verification Agency of section 23 01 05.

.4 Record and submit three (3) copies of test results to the Consultant for review prior to application of duct insulation or concealment of ductwork.

3.8 CONTROLS DEVICES

.1 Install remote sensors such as temperature, pressure and airflow sensors. Supply of sensors and controls wiring will be under Section 25.

.2 Install remote mounted control dampers for airflow control. Supply of dampers, damper actuators and controls wiring will be under Section 25.

.3 Install duct type smoke detectors in accordance with manufacturer's instructions. Supply of detectors and fire alarm wiring will be under Division 26.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

.1 Air turning devices/extractors
.2 Backdraft dampers
.3 Volume Control dampers
.4 Fire Dampers
.5 Fire Dampers (Dynamic)
.6 Combination Smoke/Fire dampers
.7 Duct access doors.
.8 Duct test holes.
.9 Hangers and Supports
.10 Fire Protection Duct Wrap
.11 Duct Sealants
.12 Heat Shrink Duct Bands
.13 Motorized dampers
.14 Actuators

1.3 REFERENCES

.1 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
.2 NFPA 92A - Smoke-Control Systems.
.3 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
.4 UL 33 - Heat Responsive Links for Fire-Protection Service.
.5 UL 555 - Fire Dampers.
.6 UL 555S - Smoke Dampers.

1.4 SUBMITTALS

.1 Section 23 01 01: Submittals.
.2 Shop Drawings for shop fabricated assemblies including balancing dampers, volume control dampers, duct access doors and duct test holes.
.3 Product Data for shop fabricated assemblies including volume control dampers, duct access doors, duct test holes and hardware used. Include electrical characteristics and connection requirements.
.4 Manufacturer's Installation Instructions for fire dampers and combination fire and smoke dampers.

1.5 PROJECT RECORD DOCUMENTS

.1 Section 23 01 01: Submittals for project closeout.

.2 Record actual locations of access doors.

1.6 REGULATORY REQUIREMENTS

.1 Products Requiring Electrical Connection: CSA Listed as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Transport, handle, store, and protect products.
.2 Protect dampers from damage to operating linkages and blades.

1.8 EXTRA MATERIALS

.1 Section 23 01 01: Submittals for project closeout.
.2 Provide two of each size and type of fusible link.

2 PRODUCTS

2.1 AIR TURNING DEVICES / EXTRACTORS

.1 Turning vanes in rectangular duct elbows shall be double walled, multi-blade vanes with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps. Acceptable Products: Duro-Dyne "Duro Vane Rail", Hart & Cooley "Ducturn", Dyn-Air or Tuttle and Baily.
.2 Volume extractors: gang operated curved blades, adjustable from full open to full closed positions. Units shall be factory assembled, fabricated from 14 ga. and 22 ga. (2 and .9 mm) steel, with blades on 1" (25 mm) centres, and No. 2 or No. 3 operators to suit application.
.3 Acceptable Manufacturers: EH Price Model AE1 indicated. Krueger model EX-8, Duro-Dyne, Dyn-Air.

2.2 BACKDRAFT DAMPERS.

.1 Gravity Backdraft Dampers, Size 18" x 18" (450 x 450 mm) or Smaller, Provided with Air Moving Equipment: Air moving equipment manufacturers standard construction.
.2 Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: 1/16" (1.5 mm) thick galvanized steel, or, with centre pivoted blades of maximum 6" (150 mm) width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.
.3 Acceptable Manufacturers: EH Price.

2.3 VOLUME CONTROL DAMPERS

.1 Fabricate to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

.2 Splitter Dampers:
  .1 Material: Same gauge as duct to 24" (600 mm) size in either direction, and two gauges heavier for sizes over 24" (600 mm).
  .2 Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
  .3 Operator: Minimum 24" (600 mm) diameter rod in self aligning, universal joint action, flanged bushing with set screw.

.3 Single Leaf Dampers: fabricated from minimum 20 gauge (1.0 mm) galvanized steel, suitably reinforced to prevent vibration and fitted with indicating regulator. Duro-Dyne, Lawson & Taylor, Dyn-Air.

.4 Multi-Blade Opposed Action Dampers: fabricated from 16 gauge (1.6 mm) galvanized steel, mounted in separate channel frames, reinforced to prevent vibration, and fitted with opposed action linkage hardware. Duro-Dyne "Opax" blade kit, Lawson & Taylor, Dyn-Air

.5 End Bearings: Except in round ductwork 12" (300 mm) and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

.6 Quadrants:
  .1 Provide locking, indicating quadrant regulators on single and multi-blade dampers.
  .2 On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
  .3 Where rod lengths exceed 30" (750 mm) provide regulator at both ends.

.7 Acceptable Manufacturers: Duro-Dyne, Dyn-Air, Price, Lawson & Taylor

2.4 FIRE DAMPERS

.1 Manufacturers:
  .1 Price
  .2 Ruskin
  .3 Nailor
  .4 Ventex
  .5 Controller Air
  .6 NCA

.2 Fire dampers shall be ULC listed, labelled, or Warnock-Hersey label, meet all requirements of NFPA 90A, and constructed and rated in conformance with:
  .1 CAN4-S112-M82, "Standard for Fire Dampers", when used in a fire separation of not more than 2 hours, and which is not a firewall.
  .2 CAN4-S104-M80, "Standard Method for Fire Tests of Door Assemblies", when used in a fire separation of more than 2 hours, or used in a firewall.
  .3 CAN4-S112.2-M84, "Fire Test of Ceiling Firestop Flap Assemblies", when used in a ceiling fire separation.

.3 Fire dampers shall be galvanized steel channel frame curtain type galvanized steel interlocking blades, minimum 22 gauge (0.9 mm) galvanized steel enclosure, and

160°F (71°C) fusible link standard.

.4 Fire dampers for horizontal installation in vertical ductwork shall be operated by a stainless steel closure spring and latch.

.5 Fire damper configuration shall be low resistance type B with blades located outside of the air stream for rectangular ductwork, and type C for round or oval ductwork.

.6 Ceiling fire dampers shall be ULC labelled, for fire rated membrane type ceilings, galvanized steel construction with heat retardant blanket (non-asbestos) with standard 160°F (71°C) fusible link.

.7 Thermal blanket shall be ULC labelled, for fire rated membrane type ceilings, to completely enshroud ceiling penetration.

.8 Fire dampers in stainless steel ductwork shall be of all stainless steel construction.

.9 Fusible Links: UL 33, separate at 160°F (71°C) with adjustable link straps for combination fire/balancing dampers.

2.5 FIRE DAMPERS (DYNAMIC)

.1 Dynamic fire dampers tested, constructed and labeled in accordance with the latest edition of UL Standard 555. Dampers shall have a fire rating of 1-1/2 hours or 3 hours and shall meet the requirements of the latest edition of NFPA90A.

.2 Each damper shall include a 165ºF (74ºC) fusible link and shall be labeled for use in dynamic systems. The damper shall be rated for dynamic closure at 2000fpm (10.16m/s) and 4 inches w.g. (1 kPa) static pressure and shall be rated to close with airflow in either direction.

.3 Each dynamic fire damper shall include a steel sleeve and mounting angles furnished by the damper manufacturer to ensure appropriate installation. Submittals information shall include the fire protection rating, maximum velocity/pressure ratings and the manufacturer's UL installation instructions. The dampers shall be installed in accordance with the manufacturer's UL installation instructions.

.4 Acceptable Product: Ruskin DIBD2/DIBD23, NCA, Ventex, Price, Controlled Air.

2.6 COMBINATION FIRE/SMOKE DAMPERS

.1 Manufacturer: Ruskin Model FSD60

.2 Other acceptable manufacturers, subject to requirements;

- .1 NCA Mfg. Inc.
- .2 Nailor
- .3 Greenheck
- .4 Price
- .5 Controlled Air
- .6 AlumaVent/Ventex

.3 Combination fire/smoke dampers, complete with sleeves and operators, designed and tested to meet both UL555 requirements for fire dampers and UL555S for leakage Class 1 rated smoke dampers. Provide with end switches. Construct frame from 1.6mm (16 gauge) galvanized steel. Construct single piece construction air foil blades from 2.0mm (14 gauge) galvanized steel, with stainless steel sleeve bearings,

square plated steel axles and concealed linkages. Use stainless steel spring. Design for operator mounted out of the air stream. Equip with 120 degrees C (250 degree F) snap disc. Design for operator mounted out of air stream. Provide damper actuators for complete cUL listed and tested damper assembly.

.4 Use only fire damper assemblies tested in accordance with CAN4 S112 M "Standard Method of Fire Test of Fire Damper Assemblies" and listed in most recent ULC "List of Equipment and Materials" or by another recognized independent testing and certification agency acceptance to the Consultant. Label each damper to indicate compliance with these requirements.

.5 Links shall comply with ULC S505 "Standard for Fusible Links for Fire Protection Service".

.6 Fabricate all dampers from galvanized steel except in copper, stainless steel or aluminum duct systems. In these systems, use all stainless steel construction.

.7 Fire protection ratings of damper assemblies shall comply with Ontario Building Code requirements for fire resistance ratings of the fire separations through which the protected openings pass. Provide an approval label, stating the fire rating, from a recognized independent testing laboratory acceptable to the Consultant, on each assembly.

.8 Provide with each damper, detailed installation instructions. Include illustrations and adequate information to attain proper and safe installation of the smoke/fire damper assembly.

2.7 DUCT ACCESS DOORS

.1 Fabricate to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

.2 Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated duct work, install minimum 1" (25 mm) thick insulation with sheet metal cover.

- .1 Less Than 12" (300 mm) Square: Secure with sash locks.
- .2 Up to 18" (450 mm) Square: Provide two hinges and two sash locks.
- .3 Up to 24" x 48" (600 x 1200 mm): Three hinges and two compression latches with outside and inside handles.
- .4 Larger Sizes: Provide an additional hinge.

.3 Access doors with sheet metal screw fasteners are not acceptable.

.4 Acceptable Manufacturer: Acudoor, Duro-Dyne, Dyn-Air, Nailor, Kreuger

2.8 DUCT TEST HOLES

.1 Provide test ports to suit intended application, (ie. insulated/uninsulated duct, round/rectangular duct).

.2 Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

.3 Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.9 HANGERS AND SUPPORTS

.1 Fabricate strap hangers to same material as duct. Hanger configuration to SMACNA details. 20" (500 mm) is maximum duct size to be supported by strap hanger.
.2 Rod and angle hangers: galvanized steel to SMACNA details.
.3 Hanger attachments: manufactured concrete inserts, expansion shields and bolted steel clamps. Do not weld rods to steel decks or use powder actuated fasteners.

2.10 FIRE PROTECTION DUCT WRAP

.1 Ductwork required to be fire-rated shall be wrapped with 3M Fire Master Duct Wrap consisting of a 38 mm (1-1/2") thick non-combustible, flexible fireproof blanket, fully encapsulated in a foil scrim and supplied in roll form. The wrap material shall be aplied directly onto the installed ductwork Guide No. 40 U21, 'Fire Resistant Ducts', as tested to ISO Standard 6944. Royal Quickstop and CL4 Fire Protection Thermal Insulation Quickwrap also acceptable.

2.11 DUCT SEALANT

.1 General: Low VOC, water based sealant, non-toxic, non-combustible, non-flammable, and tested in accordance with CAN4/ULC-S102. Flame spread shall not exceed 25 and smoke developed shall not exceed 50.
.2 Acceptable Products: Multi-Purpose Duct Sealant as manufactured by Trans Continental Equipment, Duro Dyne SWB Duct Sealer, Iron Grip 601 as supplied by Alpha Sheet Metal Co., or Uni-Grip Duct Sealer from United McGill Corporation.

2.12 HEAT SHRINK DUCT BANDS

.1 Thermofit Wrap around Duct Band duct-joint sealing tape (band).
.2 Construction: two-layer system
  .1 first layer: copolymer adhesive
  .2 second layer: thick-walled, radiation-cross-linked, high-density polyethylene.
.3 Hot applied duct sealing tape composed of heat-shrinkable backing with heat resistant pressure sensitive, non-drip adhesive and closure patch.
.4 Standard size: 4" wide x 100 LF rolls, with 30 closure strips
.5 Available from RB, L.L.C., PO Box 23781, New Orleans, La 70183
phone: 504-841-0035, fax: 504-841-0036, e-mail: sales@rbllc.com through
Claremont Sales Corp. Durham, CT 06422, Contact: Dean Williams 800-222-4448.

2.13 MOTORIZED DAMPERS-EXPOSED TO OUTDOOR AIR

.1 Tamco series 9000 thermally insulated damper as manufactured by T. A. Morrison & Co or equivalent by Ruskin, Nailor, Alumavent/Ventex.
.2 Extruded aluminum (6063T5) damper frame shall not be less than .080" (2.03mm) in thickness. Damper frame to be 4" (101.6mm).
.3 Blades to be extruded aluminum (6063T5) profiles, internally insulated with expanded

polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55.

.4 Blade seals shall be of extruded EPDM. Frame seals shall be of extruded silicone. Seals to be secured in an integral slot within the aluminum extrusions.

.5 Maintenance-free bearings are to be composed of a Celcon inner bearing fixed to a 7/16" (11.11mm) aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.

.6 Linkage hardware shall be installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.

.7 Dampers are to be designed for operation in temperatures ranging between -72°F (-58°C) and 185°F (85°C).

.8 Dampers shall be available with either opposed blade action or parallel blade action.

.9 Leakage shall not exceed 3 cfm/ft² (15.2 l/s/m²) against 1" (.25 kPa) w.g. differential static pressure.

.10 Pressure drop of a fully open 48" x 48" (1220mm x 1220mm) damper shall not exceed .03" (.007kPa) w.g. at 1000 fpm (5.08 m/s).

.11 Dampers shall be made to size required without blanking off free area.

.12 Dampers shall be available in two mounting types: i.e., "Installed in Duct" or "Flanged to Duct".

2.14 MOTORIZED DAMPERS-EXPOSED TO TEMPERED AIR

.1 Tamco series 1500 enhanced air-foil damper as manufactured by T. A. Morrison & Co or equivalent by Ruskin, Nailor, Alumavent/Ventex.

.2 Extruded aluminum (6063T5) damper frame shall not be less than .080" (2.03mm) in thickness. Damper frame to be 4" deep.

.3 Blades to be extruded aluminum (6063T5) profiles. Aluminum end caps are to be press fitted to blade ends,in order to seal hollow interior and reduce air leakage rate.

.4 Blade and frame seals shall be of extruded silicone. Seals are to be secured in an integral slot within the aluminum extrusions.

.5 Maintenance-free bearings are to be composed of a Celcon inner bearing fixed to a 7/16" (11.11mm) aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.

.6 Linkage hardware shall be installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.

.7 Dampers are to be designed for operation in temperatures ranging between -72°F (-58°C) and 212°F (100°C).

.8 Dampers shall be available with either opposed blade action or parallel blade action.

.9 Leakage shall meet Class 1A at 1" w.g. static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.
.10 Pressure drop of a fully open 48" x 48" (1220mm x 1220mm) damper shall not exceed .02" (.004kPa) w.g. at 1000 fpm (5.08 m/s).
.11 Dampers shall be made to size required without blanking off free area.
.12 Dampers shall be available in two mounting types: i.e., "Installed in Duct" or "Flanged to Duct".

2.15 ELECTRONIC DAMPER ACTUATORS

.1 Manufactured, brand labeled or distributed by BELIMO or approved equivalent.
.2 Size for torque required for damper seal at load conditions.
.3 Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
.4 Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
.5 Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to prevent any damage to the actuator during a stall condition.
.6 Fail-Safe Operation: Mechanical, spring-return mechanism.
.7 Power Requirements (Spring Return): 120 V ac, maximum 10 VA at 24-V ac or 8 W at 24-V dc.
.8 Proportional Actuators shall be fully programmable. Control input, position feedback and running time shall be factory or field programmable by use of external computer software Diagnostic feedback shall provide indications of hunting or oscillation, mechanical overload and mechanical travel. Programming shall be through an EEPROM without the use of actuator mounted switches.
.9 Temperature Rating: -22 to +122°F (-30 to +50°C)
.10 Housing: Minimum requirement NEMA type 2 mounted in any orientation.
.11 Agency Listing: ISO 9001, cULus, and CSA C22.2 No. 24-93.
.12 The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.

3 EXECUTION

3.1 PREPARATION

.1 Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

.1 Install accessories to manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.
.2 Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

.3 Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide minimum 8" x 8" (200 x 200mm) size for hand access, 18" x 18" (450 x 450 mm) size for shoulder access, and as indicated. Provide 4" x 4" (100 x 100 mm) for balancing dampers only. Review locations prior to fabrication.

.4 Provide duct test holes where indicated and required for testing and balancing purposes.

.5 Provide fire dampers, combination fire and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

.6 Install smoke dampers and combination smoke and fire dampers to NFPA 92A.

.7 Demonstrate re-setting of fire dampers to Owner's representative.

.8 Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and supported by vibration isolators. For fans developing static pressures of 1250 Pa and over, cover connections with loaded vinyl sheet, held in place with metal straps.

.9 Use splitter dampers only where indicated.

.10 Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

.11 Install control dampers supplied under Section 25 ducts or plena as indicated.

.12 Install duct type smoke detectors in accordance with manufacturers instructions where required in Section 25 Controls and Instrumentation and in Fire Alarm and Emergency Voice Communication.

.13 Provide turning vanes where space restrictions prohibit the use of elbows having a minimum inside radius equal to the duct width for horizontal elbows or the duct depth for vertical elbows.

.14 Provide test ports as required by Balancing Agency to completely test and balance the system. No temporary holes will be permitted in ductwork or flexible connections.

3.3 FIRE DAMPERS

.1 Provide fire dampers where shown on drawings. In general, fire dampers are required where ducts pass through fire rated assemblies, floors and roofs and ducts entering and leaving duct shafts and mechanical rooms.

.2 Install fire dampers in strict accordance with manufacturer's installation instructions and in conformance with NFPA 90A.

.3 Install type A fire dampers anywhere there are extreme space limitations and then only where dimension of duct exceeds 12" (300 mm) in direction of blade closing, and is specifically approved by Consultant.

.4 Install type B fire dampers for rectangular ductwork.

.5 Install type C fire dampers for round or oval ductwork.

.6 Openings for fire dampers must be properly prepared and the fire dampers installed, and secured prior to field review by the Consultant. Notify the Consultant when ready for review. Do not make any duct connections to fire dampers until review is complete and work found correct.

.7 Support fire dampers from building structure. Submit erection Drawings, approved by all authorities, showing the locations and construction details of all fire dampers before proceeding with any work.

.8 Install Ceiling Fire Dampers where ducts serve grilles and diffusers in rated ceilings. Support from building structure.

.9 Install thermal blanket in all fire rated membrane type ceilings. Thermal blanket shall be wrapped and stapled around the unexposed perimeter of diffuser after installation of ceiling damper following manufacturer's installation instructions.

.10 Use Dynamic Fire Dampers for Systems expected to be Operational during a Fire.

3.4 COMBINATION FIRE/SMOKE DAMPERS

.1 Provide fire/smoke dampers where indicated and where required by building authorities under the building code.

.2 Install fire/smoke dampers in accordance with manufacturer's instructions and listing conditions.

.3 Integrate operation of the fire/smoke dampers with the fire alarm and the building control systems.

3.5 DUCT ACCESS DOORS

.1 Provide duct access doors of suitable size in ductwork in the following locations:

- .1 Suction inlet of all fans
- .2 At not more than 12m intervals
- .3 At not more than 6m intervals on the ductwork installed after a high efficiency filter
- .4 At the base of all main risers
- .5 In front of and behind all turning vanes and coils
- .6 At all fire, smoke, and motorized dampers
- .7 At all locations having an internally mounted piece of equipment or device. Provide a section of transparent plexiglass to permit viewing without opening the access doors.
- .8 Where required for duct cleaning.

.2 Wherever possible, doors shall be mounted to close in direction of air flow.

3.6 FIRE PROTECTION DUCT WRAP

.1 Supply and install fire protection duct wrap on ductwork as indicated on drawings in accordance with manufacturer’s recommendations.

3.7 FIRESTATS

.1 Provide 135°F (57°C) firestats in return air ductwork of all supply units greater than 2000 CFM capacity.
.2 Provide 135°F (57°C) firestats in all exhaust systems greater than 2000 CFM capacity.
.3 Provide 235°F (112°C) firestats in discharge of all supply air units greater than 2000 CFM capacity.
.4 Wire firestats under this Section unless indicated otherwise in Mechanical-Electrical Schedule.
.5 Provide firestats in accordance with NFPA 90A.

3.8 HEAT SHRINK DUCT BANDS

.1 Install in accordance with manufacturer's installation instructions.
.2 Join duct sections using internal sleeves. Two screws 180° apart are usually sufficient for initial securement.
.3 Wipe joint area to remove foreign materials, and pre-heat to remove moisture and surface oil that may be present.
.4 Cut TDAB III duct band to allow a loose fit plus approx. 2" overlap.
.5 Using supplied high temperature tape, secure the loose TDAB III end by taping in place.
.6 Using a standard propane torch, heat TDAB III on all sides until it has shrunk uniformly and adhesive is showing at each side.
.7 Smooth down overlap with gloved hand to ensure proper contact with duct.

3.9 MOTORIZED DAMPERS

.1 Installation of dampers must be in accordance with current manufacturer's installation guidelines provided with each shipment of dampers.
.2 Intermediate or tubular steel structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width. See manufacturer's installation guidelines.

3.10 ELECTRONIC DAMPER ACTUATORS

.1 Provide electronic damper actuators for each motorized damper.
.2 Power wiring and interconnections to associated fan control will be under Division 26.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

.1 Diffusers.
.2 Linear Diffusers and Grilles
.3 Grilles and Registers
.4 Critical Environments

1.3 REFERENCES

.1 ADC 1062 - Air Distribution and Control Device Test Code.
.2 AMCA 500 - Method of Testing Louvres for Ratings.
.3 AMCA 5000 - Method of Testing Dampers for Ratings.
.4 AHRI 650 - Air Outlets and Inlets.
.5 ASHRAE 70 - Method of Testing for Rating the Performance of Outlets and Inlets.
.6 SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
.7 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.4 SUBMITTALS

.1 Section 23 01 01: Procedures for submittals.
.2 Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
.3 As built record drawings to record actual locations of air outlets and inlets.

1.5 QUALITY ASSURANCE

.1 Test and rate air outlet and inlet performance to ADC Equipment Test Code 1062 and ASHRAE 70.
.2 Test and rate louvre performance to AMCA 500.

1.6 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Diffusers, grilles and registers shall be Price model indicated or equivalent products

by;

.1 Titus

.2 Nailor

2.2 SQUARE CONE DIFFUSERS, FIXED PATTERN

.1 Manufacturer's Reference: Price Model SCD/31/3C/B12

.2 Type: Square, fixed pattern, stamped, multi-core diffuser to discharge air in 360 degree pattern with sectorizing baffles where indicated.

.3 Frame: Inverted T-bar type. In plaster ceilings, provide plaster frame and ceiling frame.

.4 Fabrication: Steel with baked enamel off-white finish.

.5 Accessories: Radial opposed blade damper and multi-louvred equalizing grid with damper adjustable from diffuser face.

2.3 SQUARE CONE DIFFUSERS, ADJUSTABLE PATTERN

.1 Manufacturer's Reference: Price Model SCDA/3/3C/B12

.2 Type: Square, adjustable pattern, stamped, multi-core diffuser to discharge air in 360 degree pattern with sectorizing baffles where indicated.

.3 Frame: Surface mount type. In plaster ceilings, provide plaster frame and ceiling frame.

.4 Fabrication: Steel with baked enamel off-white finish.

.5 Accessories: Radial opposed blade damper and multi-louvred equalizing grid with damper adjustable from diffuser face.

2.4 SQUARE PLAQUE DIFFUSERS

.1 Manufacturer's Reference: Price Model SPD/31/B12

.2 Type: Square face plaque and back cone, fixed 360° horizontal pattern with sectorizing baffles where indicated.

.3 Frame: Inverted T-bar type.

.4 Fabrication: Steel with baked enamel off-white finish.

.5 Accessories: butterfly type volume control damper, adjustable from diffuser face.

2.5 LAMINAR FLOW DIFFUSERS (SURGICAL SUITE)

.1 Manufacturer's Reference: Price Model LFDSS (Titus & Nailor as alternate only)

.2 Type: Stainless steel laminar flow, type 304/2B stainless steel construction, continuously welded joints.

.3 Construction: 0.037" thickness face plate and diffuser back pan.

.4 Perforated Face Plate: open easily with spring loaded, quarter-turn fasteners and safety cable for damper adjustment and cleaning. Mounting screws to be same finish as diffuser.

.5 Volume Control Damper: steel construction full flow type damper located in the inlet

collar

.6 Finish: No. 4 polished stainless steel

2.6 LAMINAR FLOW DIFFUSERS

.1 Manufacturer's Reference: Price Model LFD, aluminum

.2 Construction: aluminum and plated steel to inhibit corrosion. The perforated face plate, and the diffuser back pan shall be 0.040 aluminum. The diffuser frame shall be extruded aluminum with staked and welded corners.

.3 Volume control damper: steel construction full flow type damper located in the inlet collar and painted with a sterile white thermal setting finish.

.4 Perforated face plate: open easily with spring loaded, quarter-turn fasteners and safety cable for damper adjustment and cleaning. Use tamper proof screws for mental health areas.

.5 Finish: B12 Sterile White - Thermal Setting finish which will withstand cleaning with high concentration cleaning solutions and agents.

2.7 SIDEWALL RETURN/EXHAUST GRILLES (Model 98)

.1 Manufacturer's Reference: Price Model 98DAL

.2 Type: heavy duty, extruded aluminum border with blades held in place with aluminum mandrel tubes not exceeding 12" (300mm) on centre

.3 Louvres: 45° deflection fixed louvre with blades on 1/2" (13 mm) centres, blades shall run parallel to the floor

.4 Fastening: counter sunk screw

.5 Finish: powder coat, colour as selected by Architect.

.6 Damper: aluminum opposed blade damper

2.8 SIDEWALL RETURN/EXHAUST GRILLES

.1 Manufacturer's Reference: Price Model 530D. Steel return grille with 45 degree deflection fixed louver type, blades spaced ¾ in. (19mm) on center, blades parallel to long dimension, opposed blade volume control.

.2 Mounting type: Flat standard border, no mounting frame, countersunk fastening.

.3 Finish: Finish selection by Architect. Paint finish shall pass 500 hours of salt spray exposure with no measurable creep in accordance with AST M D1654 and 1000 hours with no rusting or blistering as per AST M D610 and AST M D714.

3 EXECUTION

3.1 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

.3 Install diffusers and grilles and connect to ductwork with air tight connections.

.4 Provide balancing dampers in duct take-off to diffusers, grilles and registers, whether or not dampers are included as part of the diffuser, grille or register assembly.
.5 Paint visible ductwork behind air outlets and inlets matte black.
.6 Provide safety chains for ceiling mounted filter units and for diffusers 24" x 48" (600 x 1200mm) and larger.
.7 Install filters in diffusers, grilles and registers after final cleaning of rooms and ductwork has been completed and accepted and when environmental conditions are suitable. Ensure that air tight seal is achieved.

3.2 PROTECTION

.1 Protect each diffuser, grille and register from damage during construction.
.2 Protect each diffuser, grille, register and ductwork from contamination and entry of dust and debris during construction.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

.2 Air Handling Units shall be built to the level of quality as herein specified and to the description of the Air Handling Unit Schedule.

.3 Substitution of any product other than that specified, must ensure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded. Applications for "equal" or "alternate" must address these factors.

.4 Unless stated otherwise, air-handling units are to be shipped to the job in one piece, factory assembled. Modular units assembled to achieve a close proximation to the intent of this specification will not be considered equal. All equipment shall where specified and applicable, be pre-wired, and factory certified by an approved testing agency such as CETL, ETLUS, UL, CSA prior to shipment.

.5 Pre-wired air handling units shall bear an approved label with all the necessary identification marks, electrical data.

.6

.7 All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.

.8 The air handling units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifteen continuous years of proven production experience.

.9 Air Handling Units shall be as manufactured by Engineered Air and be base bid. Alternate products must show savings and clearly indicate all areas where they do not meet specified product.

1.2 REFERENCES

.1 AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
.2 AMCA 99—Standards Handbook
.3 AMCA 210—Laboratory Methods of Testing Fans for Rating Purposes
.4 AMCA 500—Test Methods for Louver, Dampers, and Shutters.
.5 AHRI 340/360 - Unitary Large Equipment
.6 NEMA MG1—Motors and Generators
.7 National Electrical Code.
.8 NFPA 70—National Fire Protection Agency.
.9 SMACNA—HVAC Duct Construction Standards—Metal and Flexible.

.10 UL 900—Test Performance of Air Filter Units.

1.3 SUBMITTALS

.1 Section 23 01 01: Procedures for submittals.

.2 Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics, and connection requirements.

.3 Product Data:
- .1 Provide literature that indicates dimensions, weights, capacities, ratings, fan performance, and electrical characteristics and connection requirements.
- .2 Provide computer generated fan curves with specified operating point clearly plotted.
- .3 Manufacturer's Installation Instructions.

1.4 OPERATION AND MAINTENANCE DATA

.1 Section 23 01 01: Submittals for project closeout.
.2 Maintenance Data: Provide instructions for installation, maintenance and service.

1.5 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience, who issues complete catalog data on total product.

.2 Startup must be done by trained personnel experienced with rooftop equipment.

.3 Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters and remote controls are in place, bearings lubricated, and manufacturers' installation instructions have been followed.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Section 23 0101: Transport, handle, store, and protect products.
.2 Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
.3 Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.7 ENVIRONMENTAL REQUIREMENTS

.1 Do not operate units for any purpose, temporary or permanent, until ductwork is

clean, filters are in place, bearings lubricated, and fan has been test run under observation.

2 PRODUCTS

2.1 MANUFACTURERS

.1 Base bid manufacturer shall be Daikin. For considerations of alternates, cost savings must be shown on the tender form at time of closing. Should nothing be noted on the submitted tender form at time of closing the contractor must supply the base bid manufacturer. Contractors shall be responsible for all cost for all trades associated with any substitutions.

2.2 GENERAL DESCRIPTION

.1 Furnish as shown on plans, Daikin Applied Rebel Single Zone Heating and Cooling Unit(s) model DPS. Unit performance and electrical characteristics shall be per the job schedule.

.2 Configuration: Fabricate as detailed on prints and drawings:

- .1 Return plenum / economizer section
- .2 Energy recovery section
- .3 Filter section
- .4 ASHP coil section w condenser reheat
- .5 Supply fan section
- .6 Glycol heating section
- .7 Condensing unit section

.3 The complete unit shall be cETLus listed.

.4 The unit shall be ASHRAE 90.1-2019 compliant and labeled.

.5 Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-32 Refrigerant and oil.

.6 The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.

.7 All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.

.8 Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.

.9 Warranty: The manufacturer shall provide 12-month parts only warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence at startup or six months after shipment, whichever occurs first.

2.3 CABINET, CASING AND FRAME

.1 Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 1" thick with an R-value of 7.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.

.2 Unit construction for all walls, doors, ceiling and floor shall be double wall with a solid stainless-steel liner that provides a cleanable, corrosion resistant. interior.

.3 Exterior surfaces shall be constructed of painted galvanized steel, for aesthetics and long-term durability. Paint finish will include a base primer with a high-quality polyester resin topcoat. Finished, unabraded panel surfaces shall be exposed to an ASTM B117 salt spray environment and exhibit no visible red rust at a minimum of 3,000 hours exposure. Finished, abraded surfaces shall be tested per ASTM D1654, having a mean scribe creepage not exceeding 1/16" at 1,000 hours minimum exposure to an ASTM B117 salt spray environment. Measurements of results shall be quantified using ASTM D1654 in conjunction with ASTM D610 and ASTM D714 to evaluate blister and rust ratings.

.4 Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless-steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.

.5 The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal.

2.4 OUTDOOR/RETURN AIR SECTIONS

.1 Daikin Applied UltraSeal low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged vertically in the hood. Damper leakage shall be less than 1.5 CFM/Sq. Ft. of damper area at 1.0 inch static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers. Control of the dampers shall be from a factory installed actuator.

.2 Control of the outdoor dampers shall be by a factory installed actuator. Damper actuator shall be of the modulating type. Damper to open when supply fan starts, and close when supply fan stops.

.3 Provide factory installed and tested, outdoor air monitor that controls outdoor air +/- 15% accuracy down to 40 cfm per ton.

.4 Unit is provided with a factory installed and tested outdoor air monitor, with +/- 15% accuracy down to 40 cfm/ton, and a field installed Duct/Space mounted C02 sensor. Outside air damper position will modulate between the Demand Control Ventilation Limit (minimum position setpoint) and the Ventilation Limit (maximum non-economizer position setpoint) to satisfy the space requirements. Damper position will be controlled to the greater of the two command signals, either minimum outside air flow or space IAQ (CO2).

.5 Provide a field installed Duct/Space mounted C02 sensor. Outside air damper position will modulate between the Demand Control Ventilation Limit (minimum position setpoint) and the Ventilation Limit (maximum non-economizer position setpoint) to satisfy the space requirements. Damper position will be controlled to the greater of the two command signals, either minimum outside air flow or space IAQ (CO2).

2.5 ENERGY RECOVERY

.1 The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction, power supply and controls and does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable. The energy recovery wheels supplied must meet the scheduled capacity, and air pressure drop. The wheel capacity, air pressure drop and effectiveness shall be AHRI certified per AHRI Standard 1060. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060,

Rating Air-to-Air Heat Exchangers For Energy Recovery Ventilation equipment. The rooftop unit shall be designed with a track so the entire energy recovery wheel cassette can slide out from the rooftop unit to facilitate cleaning. The unit shall have 2" Merv 8 filters for the outdoor air before the wheel to help keep the wheel clean and reduce maintenance. A dirty filter switch and alarm shall be provided on the Energy wheel filter rack. The total energy recovery wheel shall have an aluminum substrate and a 3 angstrom desiccant and shall have an adjustable purge for field balancing. The rooftop unit with the energy recovery wheel shall incorporate the economizer operation. Units with economizers and energy recovery wheels shall have a bypass damper. When the unit is in the economizer mode of operation the energy recovery wheel shall stop and the bypass dampers shall be opened. The outdoor air shall be drawn through the bypass dampers to reduce the pressure drop of the outdoor airstream.

.2 The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction and does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable.

.3 The wheel capacity, air pressure drop and effectiveness shall be AHRI certified per AHRI Standard 1060. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Heat Exchangers For Energy Recovery Ventilation Equipment.

.4 The control of the energy recovery wheel shall be an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed at the rooftop units DDC controller LCD display. All of these temperatures shall be made available through the BACnet interface.

.5 The rooftop unit with the energy recovery wheel shall incorporate the economizer operation. The energy recovery wheel shall have a bypass damper. When the unit is in the economizer mode of operation the energy recovery wheel shall stop and the bypass dampers shall be opened. The outdoor air shall be drawn through the bypass dampers to reduce the pressure drop of the outdoor airstream.

.6 The rooftop unit DDC controller shall provide frost control for the energy recovery wheel. When a frost condition is encountered the unit controller shall stop the wheel.

When in the frost control mode the wheel shall be jogged periodically and not be allowed to stay in the stationary position.

2.6 EXHAUST FAN

.1 Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.

.2 The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

.3 The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

2.7 FILTERS

.1 Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" prefilter and a 4" final filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2" MERV 8 and 4" MERV 14 filters.

.2 (APPLICABLE TO UNITS SELECTED WITH MINIHELIC FILTER GAUGES) All units shall be provided with a through the wall minihelic filter gauge that displays filter loading on the exterior of the unit.

2.8 HEAT PUMP DX COIL

.1 The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.

.2 The direct expansion (DX) coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face

active at all load conditions. All coils shall be factory leak tested with high pressure air under water.

.3 The coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.

.4 The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.

.5 The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

.6 A drain pan overflow safety shall shut off the unit and issue a warning before over flow occurs.

2.9 HOT GAS REHEAT

.1 Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser.

.2 Hot gas reheat coil shall be a Micro Channel design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 20°F temperature rise at all operating conditions.

.3 The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.

.4 Each coil shall be factory leak tested with high-pressure air under water.

2.10 SUPPLY FAN

.1 Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.

.2 The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

.3 The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

.4 All Supply Fans shall include a factory installed flow measuring station. Airflow needs to be readable through the unit controller and building automation system.

.5 All Supply and Exhaust Fans shall include a factory installed flow measuring station. Airflow needs to be readable through the unit controller and building automation system.

3 EXECUTION

3.1 INSTALLATION

.1 Install to manufacturer's instructions.

.2 Install to ARI 435.

.3 Assemble high pressure units by bolting sections together. Isolate fan section with flexible duct connections.

.4 Install assembled unit on Mason Super `W' 0.1 Deflection Isolation.

.5 Exact thickness of concrete housekeeping pad to suit depth required for deep seal trap.

3.2 AIR HANDLING UNIT SCHEDULE

.1 Air Handling Unit Scheduled: As scheduled on drawings.

END OF SECTION

1 GENERAL

1.1 GENERAL REQUIREMENTS

.1 Comply with General Requirements of Section 23 01 01.

1.2 SECTION INCLUDES

.1 Ductless Split Air Conditioning Systems.

1.3 REFERENCES

.1 Local and District By-Laws, Regulations and Published Engineering Standards.
.2 CAN/CSA - B52 Mechanical Refrigeration Code.

1.4 SUBMITTALS FOR REVIEW

.1 Product Data: Provide catalogue data indicating rated capacity, dimensions, duct and service connections, electric nameplate data and wiring diagrams.
.2 Shop Drawings: Indicate layout of system and components.
.3 Manufacturer's Instructions: Indicate installation instructions and recommendations.
.4 Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
.5 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owners name and registered with manufacturer.

1.5 QUALITY ASSURANCE

.1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.

.2 The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.

.3 The units shall conform to ANSI/UL STD. 1995 and certified to CAN/CSA C22.2 No. 236-05.

.4 The units shall be rated in accordance with ARI Standard 210/240 and bear the ARI label.

.5 The units shall be line tested for correct operation and coils pressure tested for leaks.

.6 Helium holding charge shall be provided in the evaporator

1.6 WARRANTY

.1 The units shall have a manufacturer's parts warranty for a period of two (2) years

from date of installation. The compressor shall have a warranty of seven (7) years from date of installation.

.2 Manufacturer shall have thirty years experience in the Canadian market.

2 PRODUCTS

2.1 AIR CONDITIONING UNIT - SPLIT SYSTEM

.1 Manufacturer: Mitsubishi

.2 Other Manufacturers meeting specifications and subject to shop drawing review;

.1 LG

.2 Daikin

.3 JCI

.3 General: CSA or Ontario Hydro Inspection approved, UL or ULC tested and ARI rated, and factory assembled with all controls installed, piped and wired. Refer to Mechanical-electrical Schedule for electrical characteristics.

.4 Each system shall perform in accordance to ARI 210/240 confirmed specification ratings shown in the table 1.

.5 Cooling performance shall be based on 67°F (19.4˚C) WB, 80°F (26.7˚C) DB for the indoor unit and 75°F (24˚C) WB, 95°F (35˚C) DB, for the outdoor unit.

.6 The system shall have standard cooling operation to a minimum ambient temperature of -18˚C (0°F).

.7 Ultra low ambient cooling operation at minimum ambient temperatures of -40˚C (-40°F) shall be factory design and pre-installed. Locally modified systems are not acceptable.

.8 Windscreens shall be factory developed for low ambient ≤ -5˚C (23°F) cooling operation.

Table 1

Model No.	Capacity Range Btu/h	TPW	SEER	EER
PKA-A24KA	12 000 - 24 000	2 270	17.0	10.6

TPW = Total Power Watts

.9 Indoor Unit:

.1 The indoor unit shall be factory assembled, wired and tested.

.2 Contained within the unit shall be all factory wiring, internal piping, control circuit board and fan motor.

.3 The indoor unit shall pull room air at the top and dispel conditioned air at the bottom.

.4 There shall be an operation and error indication on the wired controller.

.5 Indoor unit shall have capabilities to be installed at a maximum height of 100ft. (30m) above or below the outdoor unit.

.6 Manual adjustable louvers shall be provided to change the laterally direction of airflow.

.7 A motorized vane shall close the outlet port when operation is stopped.
.1 A motorized vane shall direct air flow in a vertical direction.

.8 Cabinet:
.1 The casing shall be ABS plastic and have a white (munsell 1.0Y 9.2/0.2) finish.

.2 The casing shall have provision for six directions (left side, right side, left side & down, right side & down, right side rear and left side rear) of refrigerant and drain pipe installation.

.3 There shall be a separate back plate which secures the unit firmly to the wall.

.9 Fan:
.1 The evaporator shall have a line flow fan directly driven by a single dc motor.

.2 The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.

.3 The indoor fan shall consist of three speeds, Low, Mid and Hi.

.10 Filter:
.1 Return air shall be filtered by means of an easily removed washable filter with MERV rating of 1- 4.

.11 Coil:
.1 The evaporator coil shall be of nonferrous construction with aluminum strake pre-coated fins on copper tubing.

.2 All tube joints shall be brazed with phoscopper and silver alloy.

.3 A condensate pan and drain shall be provided under the coil.

.12 Electrical:

.1 The unit shall be powered by 208/230Vac, 1 phase, 60 hertz electrical AC power supply.

.2 The system shall operate within voltage limits of 198Vac to 253Vac.

.3 The outdoor unit shall provide 208/230Vac, 1 phase, 60 hertz electrical AC power to the indoor unit.

.13 Fittings:

.1 The indoor unit shall have flare brass fittings and meets ANSI B16.26 standards.

.14 Control:

.1 The unit shall have a wired controller with micro processor controls to perform input functions necessary to operate the system.

.2 There shall be a multi-language large DOT liquid crystal display wired controller.

.3 The controller shall have a built in room temperature sensor with display of room and set temperature both in °F and ˚C.

.4 Set temperature changes shall be by 1° increments.

.1 Temperature range shall be 67°F - 87°F (19˚C -30˚C).

.5 The controller shall have the capability to simultaneously control up to a maximum of sixteen systems at a maximum cable distance of 1,500 feet.

.6 The microprocessor control signal between the indoor and outdoor unit shall be incorporated with the indoor unit's electric supply requiring a minimum of 4 wire (3+gnd.)14AWG cable.

.7 The system shall be capable of automatic restart when power is restored after interruption.

.8 The wired controller shall provide 7 day programmable time schedule with eight settings per day, temperature set back and system ON/OFF operation.

.9 The controller shall provide system error diagnostic and operation data.

.10 The wired controller shall have built in lead lag control (operation rotation between two systems, backup operation on failure of working system) between two systems.

.11 The system shall have the option to be integrated and controlled by BMS (LonWorks, BacNet)

.12 The system shall provide status and error output signals

.13 The system shall have remote (control from remote location) ON/OFF control

.10 5.00 Outdoor Unit:

.1 The outdoor unit shall be compatible with P-series indoor units. The indoor units must be of the same capacity as the outdoor unit.

.2 The outdoor unit shall have a holding charge for a max. refrigerant piping of 70ft. one way (100ft. for model PUY-A24NHA).

.3 The outdoor unit shall have a maximum refrigerant piping of 165ft. (50m)

.4 The outdoor unit shall have a three minute time delay before compressor restart

.5 The outdoor unit shall have provision for optional system operation data display.

.6 The outdoor unit shall have sufficient oil return without the use of refrigerant pipe traps.

.7 Cabinet:

.1 The casing shall be constructed from galvanized steel plate and finished with ivory colour (munsell 3Y 7.8/1.1) acrylic paint.

.2 The fan grille shall be of polypropylene (PP) plastic.

.8 Fan:

.1 The unit shall be furnished with DC fan motors for direct drive propeller fan.

.2 The motor bearings shall be permanently lubricated.

.3 The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front.

.9 Coil:

.1 The L shaped condenser coil shall be of copper tubing with flat aluminum fins.

.2 The coil shall be protected with an integral metal guard.

.10 Compressor:

.1 The compressor shall be hermetic rotary type (PUY-A42NHA, shall be scroll type) with variable compressor speed inverter technology.

.2 The compressor crankcase shall be heated by intermittent low speed compressor motor rotation.

.3 The outdoor unit shall have high pressure and over current protective device.

.11 Electrical:

.1 The unit electrical power shall be 208/230 Vac, 1 phase, 60 hertz.

.2 The unit shall operate within voltage limits of 198Vac to 253Vac.

.3 The unit shall have a power factor of 98%. Start Up: Provide the service of certified manufacturer's representative during start-up and owner's instruction.

3 EXECUTION

3.1 AIR CONDITIONING - SPLIT SYSTEM

.1 Install indoor unit in accordance with manufacturer's installation instructions. Make all duct and piping connections necessary.

.2 Install outdoor unit plumb and level on concrete pad or wall mounted as required, making all necessary piping connections.

.3 Install refrigerant line kits in accordance with manufacturer's installation instructions.

.4 Refrigeration Equipment: prepare system for start-up by having manufacturer's field engineer or factory trained representative supervise testing, and charging of machines.

.5 Testing:

.1 Provide sufficient refrigerant, dry nitrogen and refrigeration oil for pressure and

operational testing under manufacturer's supervision.

.2 Prior to testing ensure that system is complete. Protect relief valves during test procedure. After completion of test, reconnect and make good piping connections and leak test entire system.

.6 Power wiring under Division 26.

.7 Control wiring under this Section.

END OF SECTION

1.0 GENERAL - ELECTRIC STEAM HUMIDIFICATION SYSTEM - MODEL NORTEC RS

1.1 WORK INCLUDED

.1 Nortec RS Series resistive element humidifier[s] as indicated on drawing[s] and as indicated on schedule[s].
.2 Complete and operable humidification system [which meets applicable building codes]
.3 Equipment start-up and project inspection by qualified factory trained representative.

1.2 QUALITY ASSURANCE

.1 Certifications, C-UL US Listed.
.2 ISO 9001.
.3 ANSI/NFPA 70 - National Electrical Code.
.4 AHRI 640, "Standard for Commercial and Industrial Humidifiers."
.5 ASHRAE Standard 135 BACnet

1.3 RELATED SECTIONS

.1 23 Mechanical General
.2 23 Piping Installation
.3 23 Control System

1.4 SUBMITTALS

.1 Submit product data under provisions of Section 23. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes. Include rated capacities, operating weights, furnished specialties, and accessories.
.2 Submit manufacturer's installation instructions.
.3 Submit operation and maintenance data.
.4 Submit coordination drawings. Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, and dispersion tubes. Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, and required clearances.
.5 Submit wiring diagrams including power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
.6 Submit water pressure requirements.

1.5 SCHEDULES

.1 Refer to information contained in schedule[s] attached to this specification.
.2 Humidifiers to be of type, capacity, and arrangement as listed in schedule[s].
.3 Include accessories listed in schedule[s] and those accessories required for type of unit.

2.0 Products

2.1 Provide Nortec RS resistive element humidifier generating mineral-free, sterile steam for use

with potable, De-Ionized (DI), or Reverse Osmosis (RO) water. Packaged unit, wall mounted, atmospheric steam generation using resistive heating element. Electrode technology and boiler steam (pressure steam) technology not acceptable.

2.2 UNIT[S] TO BE COMPLETE WITH

.1 Touchscreen controller with standard building automation and Online connectivity:
- .1 Intuitive touchscreen control with color graphic user interface.
- .2 Standard building automation communication protocols BACnet IP, BACnet MSTP and Modbus. Additional hardware required for building automation communication not acceptable.
- .3 Embedded web interface for easy configuration and remote monitoring from any computer with a web browser over a local area network (LAN) connection.
- .4 USB interface for new software/feature upload and download of operational information.
- .5 Single or dual channel analog signal acceptance, supporting both demand and transducer control. Ability to control setpoint from humidifier control when using transducer controls.

.1 Packaged system with Condair resistive element technology:
- .1 Incoloy based resistive heating element for steam production.
- .2 Modulating output between 4% and 100% of rated capacity.
- .3 Control accuracy of up to +/- 1% RH using optional Precision solid state relay control and high precision humidistat.
- .4 Separate scale collection chamber external from main boiling tank when using optional Scale Management system.
- .5 Dual magnetic electronic float system, located outside of the boiling water to ensure accurate water level control and reduced maintenance. Systems using conductivity probes or floats located within hot reservoir are not acceptable.
- .6 Self-diagnostics during start-up of system to prevent unsafe operation of the unit[s]:
  - .1 Fill valve check.
  - .2 Float level check.
  - .3 Drain pump check.
- .7 Durable powder coated steel cabinet with zero side clearance requirement for minimal footprint.
- .8 Insulating air gap between plumbing and electrical compartment for increased electronic reliability.
- .9 Standard internal drain water tempering to ensure maximum 140°F [60°C] drain water. External drain water cooler not acceptable.
- .10 Integral fill cup with minimum 1-inch [25 mm] air gap to prevent back siphoning.
- .11 Automatic off-season shut-down [after 3 days of "no call"] will completely drain the boiling tank[s] and automatically restart on call for humidity.
- .12 Programmable drain settings too allow cycling small water quantities during operation without interrupting steam production.
- .13 Integral design allowing easy installation and access for servicing.

2.3 OPTIONAL ACCESSORIES

.1 Refer to 'Option schedule'

3.0 EXCECUTION

3.1 INSTALLATION

.1 Install humidifiers per manufacturers' instructions.
.2 Install with required clearance for service and maintenance.

3.2 ACCESSORIES

.1 Install accessories in accordance with manufacturer's recommendations.

3.3 COMMISSIONING

.1 Start-up of humidifier to be by factory trained technician.

1.0 GENERAL - DL (DL)

1.1 Section Includes Low Pressure Nozzle and Evaporative Media Humidifier/Cooler

1.2 RELATED SECTIONS

.1 Section 08310 - Access Doors and Panels.
.2 Section - Common Work Results for HVAC.
.3 Section - Heating, Ventilating, and Air Conditioning Equipment.
.4 Division 26 – Electrical.

1.3 REFERENCES

.1 ANSI/NFPA 70 - National Electrical Code. (North America version only)
.2 ARI 640 - Commercial and Industrial Humidifiers.(North America version only)
.3 UL998 – Standard for Safety Humidifiers. (North America version only)

1.4 SUBMITTALS

.1 Submit under provisions of Section 01300.
.2 Product Data: Including but not limited to product descriptions, models, dimensions, component sizes, rough-in requirements, service sizes, and finishes. Include rated capacities, operating weights, furnished specialties, and accessories.
    .1 Manufacturer's installation instructions.
    .2 Operation and maintenance data.
    .3 Minimum water quality requirements and water pressure requirements.
.3 Shop Drawings: For each type of humidification system specified.
    .1 Details of fabrication, installation of humidifiers.
    .2 Piping details, plans, elevations, sections, details of components, and nozzle and media.
    .3 Detail of humidifiers and adjacent equipment showing support locations, type of support, weight on each support, and required clearances.
    .4 Wiring diagrams including power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

1.5 QUALITY ASSURANCE

.1 Manufacturer:
    .1 Products manufactured in an ISO 9001 certified facility.
    .2 For each product specified, provide components by single manufacturer throughout.
.2 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authority having jurisdiction, and marked for intended use.
.3 Humidifiers: In compliance with ARI 640 - Standard for Commercial and Industrial

Humidifiers and applicable "New Approach" CE Directives.

.4 Certifications, C-UL US Listed. In compliance with UL 998 - UL Standard for Safety for Humidifiers. (North America version only)

1.6 COMMISSIONING

.1 Commissioning of system or systems specified herein is required. Provide personnel and equipment to facilitate commissioning process.

.2 Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Commissioning Authority.

.3 Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Deliver all materials in their original sealed containers bearing manufacturer's name and identification of product.

.2 Do not store products in location with conditions outside manufacturer's absolute limits.

.3 Materials delivered to the site shall be examined for concealed damage or defects in shipping. Defects shall be noted and reported to the Owner's Representative in writing.

1.8 PROJECT CONDITIONS

.1 Coordinate location and installation of humidifiers in ducts and air-handling units in the space it serves with the electrical, mechanical, and plumbing contractors. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

1.9 WARRANTY

.1 Manufacturer's Standard Warranty: Two year warranty covers defects in materials and workmanship, commences on date of shipment.

2.0 PRODUCTS

2.1 MANUFACTURERS

.1 Acceptable Manufacturer: Condair Ltd.

.2 Acceptable Manufacturer: Condair Group AG

.3 Substitutions: Not permitted.

2.2 IN-DUCT LOW PRESSURE NOZZLE AND EVAPORATIVE MEDIA HUMIDIFIER/COOLER

.1 Series: DL Series humidifiers as manufactured by CONDAIR.

The Nortec DL with Variable Frequency Drive (VFD), low pressure nozzle and evaporative

media humidifier system is configured to operate on Reverse Osmosis (RO) or De-ionized (DI) Water supplied by others.

.2 General:

.1 Pre-engineered system, for air handler/duct application, uses low pressure nozzle technology to directly inject fine mist into the airstream with a ceramic evaporative media downstream for additional evaporation and mist elimination.
.2 Humidifier minimum installation length of 23.6" (distance from nozzle grid to ceramic media)
.3 Humidifier accepts reverse osmosis and de-ionized water (0.5-15µS).
.4 Low pressure nozzles to operate between 43.5 and 101.5 psi (3-7 bar).
.5 Evaporative media to be porous ceramic material designed for post evaporation and mist elimination.
.6 Electronic controller, which monitors the operation of the system, controls output levels and initiates self-cleaning and flush cycles to ensure hygiene operation.
.7 Humidifier powered by 200-240 volts single phase power supply.
.8 Hydraulic system to supply water to the low pressure nozzles with 3, 7, 15 or 31 steps of control, depending on humidifier capacity and cross-section.
.9 Duct shall contain nozzle grid, connection hoses, and ceramic media. Pumps, valves, controls, and other mechanical components shall be provided in a separate module for installation external to the air stream.
.10 Control panel includes BTL Certified BACnet IP and BACnet MS/TP, Modbus RTU (RS485 interface), and Modbus TCP (RJ45 Ethernet) as standard. Lonworks available as an option.
.11 Control panel includes IoT connection to Condair Cloud via IoT Ethernet. Connection via IoT mobile module as an option.
.12 Central rack for mounting the control panel and hydraulic unit shall be provided. Located within 10' below AHU in conditioned space. Lines to be heat traced by others and piped through the AHU Pipe Chase.

.3 Nozzle Grid:

.1 Pre-assembled nozzle grid sections with color coded nozzle assemblies for easy connection to staging solenoid valves.
.2 316SS Low pressure nozzles with capacities of: 3.3 lb/hr (1.5 l/hr), 5.5 lb/hr (2.5 l/hr), 6.6 lb/hr (3.0 l/hr), 8.8 lb/hr (4.0 l/hr), 9.9 lb/hr (4.5 L/hr), or 11 lb/hr (5.0 l/hr)
.3 Nozzles spray angle can be adjusted into (4) positions to prevent condensing on AHU walls.
.4 Threaded nozzle connections. All other connections to be push fit quick connections.

.4 Evaporative Media:

.1 Media: Made of porous ceramic material, absolutely free of fiberglass.
.2 Replacement: Individual removable tiles.
.3 No tools required for media removal.
.4 Rate of Evaporation: Dependent on the air volume, air temperature, and installation distance from nozzle grid.

.5 Droplet Separator:

.1 Additional droplet separator required if air velocity exceeds the allowable limit.
.1 DL without additional droplet separator allows velocities operation up to 492 fpm (2.5 m/s).
.2 DL with additional droplet separator allows velocities operation up to 787 fpm (4.0 m/s).

.6 Management System:

.1 Microprocessor control using a proportional or proportional-integral method for interpreting analog signals from a humidity sensor or a demand signal from an external humidity controller.
.2 The controller determines which stages should be activated to meet humidification loads.
.3 The controller activates self-maintenance cycles. This includes controlled flushing of the water supply lines, and drain cycles to maintain cleanliness of the water loop.
.4 Control panel complete with on/off switch and LCD capacitive touch screen for error, maintenance, and operational indication, viewing process and functional data history, and settings manipulation.
.5 Remote operating and fault indication.

.7 Control panel with backlit Capacitive Touch Screen Display to have the following functionality:

.1 Service indicator and LED power on.
.2 Intuitive touch screen back-lit graphic display.
.3 Display of relative humidity and set point.
.4 Display of operating hours.
.5 Capacity output.
.6 Real-time date and time.
.7 Numpad for integer input.
.8 Quick access menu.
.9 Save / reset settings.
.10 Remote fault indication.
.11 Error history indication.
.12 Error analyzer.
.13 Error / warning reset via software
.14 Limited capacity adjustment.
.15 Inlet flush and line purging.
.16 BTL Certified BACnet IP and BACet MS/TP, Modbus RTU (RS485 interface), and Modbus TCP (RJ45 Ethernet) as standard host protocol.
.17 Terminal block installed for easy field connections.

.8 Humidity Control Methods:

.1 Humidity sensor or demand signal from an external controller. BMS control via Modbus or BACnet.
.2 Accepts standard modulating control signals

.3 Enable On/Off, 24 VAC safety loop for On/Off control (air proving, and/or high limit.

.9 Hydraulic Assembly:

.1 Packaged Hydraulic Assembly: Shall be installed external to airstream and include all components required for circulation water including; optional VFD pump, “Hygiene Plus? Silver Ion cartridge, spray valves, pressure and conductivity sensors, and drainage system.
.2 A maximum of 31 stage control shall be available as an option, 7 stage standard and controlled by up to (5) 24Vdc solenoid valves.
.3 Optional VFD controlled pump in DL Type A systems.
.4 Optional sterile filter.
.5 Water jet pump to allow for draining of the nozzle supply lines.
.6 The hydraulic unit shall include a "Hygiene Plus" cartridge to actively does the supply water with silver ions as a means of bacteria control.
.7 Inlet valve, pressure gauge and sensor to ensure correct supply water pressure of 43.5-101.5 psi (3-7 bar).
.8 Standard conductivity sensor to monitor supply water conductivity. Control panel to trigger alarm if conductivity increases above allowable limit.

.10 Aerosol Breakdown and Hygiene Control:

.1 Management System capable of real-time flushing, purging and cleaning cycles via the Management System control panel. In the event of no call for humidity, humidifier shall drain all water from the nozzle supply lines.
.2 Humidifier Operation: Aerosol-free operation guaranteed under maximum air velocity of 787 fpm (4.0 m/s).

.11 Optional Features/Accessories:

.1 Secondary droplet separator.
.2 VFD controlled booster pump.
.3 15 or 31 step control.
.4 Remote fault indication board.
.5 Integrated sterile filter.
.6 External 5µm water filter.
.7 Leak monitoring.
.8 Sensor for water temperature monitoring via integrated controller.
.9 External dosing system connection port (type A systems only).
.10 Relay external dosing contact for control of an external disinfection pump (pump by others).
.11 External valve block with additional auxiliary outlet valve (type A systems only).
.12 Silicone free.
.13 Compressed air flushing connections.
.14 On/Off digital duct high limit humidistat.
.15 Air proving switch.
.16 10V Digital Duct Humidistat package.
.17 0 - 10V Digital Wall Humidistat.
.18 2-10V Digital Wall Humidity Sensor.

.19 2-10V Duct Humidity Sensor.
.20 Gateway board for BMS connectivity via LonWorks.

.12 Model: NORTEC DL Low Pressure Nozzle and Evaporative Media Humidifiers/Coolers.

3.0 EXECUTION

3.1 EXAMINATION

.1 Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
.2 Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation
.3 If preparation is the responsibility of another installer, notify Architect of deviations from manufacturer's recommended installation tolerances and conditions.
.4 Do not proceed with installation until substrates have been properly prepared and deviations are corrected.
.5 Commencement of installation constitutes acceptance of conditions.

3.2 INSTALLATION

.1 Install components plumb and level, in accordance with approved shop drawings, product installation details and manufacturer's recommendations.
  .1 Install humidifiers and components per manufacturers' instructions.
  .2 Seal humidifier duct penetrations with flange.
  .3 Install with required clearance for service and maintenance.

3.3 TESTING AND ADJUSTING

.1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections.
.2 Test Results: Reported in writing to Architect.
  .1 Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  .2 Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
  .3 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 TRAINING

.1 Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers.
  .1 Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and

schedules.
.2 Review data in maintenance manuals.
.3 Schedule training with Owner, through Architect, with at least seven days advance notice.

3.5 PROTECTION AND CLEANING

.1 Protect humidification system components from damage until date of substantial completion.
.2 Repair or replace damaged components that cannot be repaired.
.3 Remove temporary protective coverings, excess materials.

END OF SECTION

1 GENERAL

1.1 GENERAL

.1 Read and conform to:
- .1 The General Conditions of the Contract as amended,
- .2 The General Requirements of Division 1,
- .3 The General Requirements of Section 13010.

1.2 ACRONYMS

.1	AHU	Air Handling Unit
.2	ASC	Application Specific Controller
.3	BAS	Building Automation System
.4	BMS	Building Management System (synonymous with BAS)
.5	CAFV	Controllable Air Flow Venturi
.6	CSR	Current Sensing Relay
.7	EMCS	Energy Management and Control System (synonymous with BAS)
.8	FMS	Facility Management System (synonymous with BAS)
.9	HTML	Hypertext Markup Language
.10	LAN	Local Area Network
.11	IOM	Input / Output Module
.12	IT	Information Technology
.13	OWS	Operator Work Station
.14	PC	Personal Computer(s)
.15	PID	Proportional, Integral, Derivative
.16	TCP/IP	Transmission Control Protocol / Internet Protocol
.17	UI	User Interface
.18	XML	Extensible Markup Language

1.3 BUILDING MANAGEMENT SYSTEM SUBCONTRACTOR

.1 All work of this Section shall be coordinated and provided by a single Building Management System (BMS) subcontractor.

.2 The work of this Section shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 15 Sections for details.

.3 The work of this Section shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, warranties, services, and items which are required for the complete, fully functional and commissioned BMS, even if these are not specifically mentioned or fully described under this Section.

.4 If the BMS subcontractor believes there are conflicts or missing information in the project documents, the subcontractor shall promptly request clarification and instruction from the design team.

1.4 QUALITY ASSURANCE

.1 The existing central building management system (BMS) and local controls at the Hospital are Johnson Controls Metasys. Accordingly, Johnson Controls Metasys components and Metasys compatible devices are required for this project.

.2 The BMS subcontractor shall;

.1 have a locally based branch office within 50 miles of the site with experienced, regularly employed technicians and instrument mechanics and electricians, spare parts inventory and necessary test and diagnostic equipment to install, test, commission and provide warranty service.

.2 be regularly engaged in the installation and maintenance of Metasys systems and shall provide complete maintenance and support services on a 24 hour, 7-day-a-week basis.

.3 have a minimum of ten (10) years of demonstrated technical expertise and experience in the installation and maintenance of BMS systems similar in size and complexity to the existing installation at this site.

.3 The BMS subcontractor shall provide full time, on site, experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the BMS. The BMS system shall be designed and installed, commissioned and serviced by factory trained personnel.

.4 Materials, equipment, software and system architecture shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

.5 The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

.6 This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network. Compatibility shall be further defined as the ability for any existing field panel microprocessor to be connected and directly

communicate with new field panels without bridges, routers or protocol converters.

1.5 ACCEPTABLE BMS SUBCONTRACTORS

.1 The following are acceptable Control System Contractors and Manufacturers:
.1 Delta BAS By EHM Solutions

1.6 BMS DESCRIPTION

.1 The Building Management System (BMS) shall be a complete system designed for use with the facility IT systems. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility.
.2 The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:
.1 Operator information, alarm management and control functions.
.2 Enterprise-level information and control access.
.3 Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
.4 Diagnostic monitoring and reporting of BMS functions.
.5 Offsite monitoring and management access.
.6 Energy management
.7 Standard applications for terminal HVAC systems.
.8 Capability for Indoor Air Quality monitoring and control.
.3 The BMS subcontractor shall be responsible for coordination with the Owner's IT staff to ensure that the BMS will perform in the Owner's environment without disruption to any of the other activities taking place on that LAN.
.4 All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.
.5 Server(s) shall be used for the purpose of providing a location for archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft SQL Server Express or Microsoft SQL Server as required.
.6 The System shall provide a Demand Limiting and Load Rolling program for the purpose of limiting peak energy usage and reducing overall energy consumption. The System shall support three levels of sensitivity in the Sliding Window demand calculations for fine tuning the system. The System shall have both a Shed Mode and a Monitor Only Mode of operation. The Demand Limiting program shall monitor the energy consumption rate and compare it to a user defined Tariff Target. The system shall maintain consumption below the

target by selectively shedding loads based upon a user defined strategy. The Load Rolling program shall sum the loads currently shed and compare it to a user defined Load Rolling Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined Load Priority.

1.7 SYSTEM PERFORMANCE

.1 Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation.

.1 Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec. to match the existing graphics.

.2 Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.

.3 Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 15 sec.

.4 Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.

.5 Performance. Programmable controllers shall be able to completely execute DDC control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.

.6 Multiple Alarm Annunciations. Each workstation on the network shall receive alarms within 5 sec of other workstations.

1.8 SUBMITTALS

.1 Shop Drawings, Product Data, and Samples

.1 Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.

.2 At a minimum, submit the following:

.1 BMS network architecture.

.2 Systems schematics, sequences and flow diagrams.

.3 Points schedule for each point in the BMS.

.4 Detailed Bill of Material list for each system or application.

.5 Control Damper Schedule.

.6 Product data sheets or marked catalog pages including part number, photo and description for all products including software.

.3 Allow 15 working days for the review of each package by the Consultant in the scheduling of the total BMS work.

.2 Record Documents (Refer to Section 15010)

.1 Include the following:

.1 Table of contents.
.2 As-built system record drawings.
.3 Manufacturers product data sheets or catalog pages for all products including software.
.4 Archive copy of all site-specific databases and sequences.

.2 Provide three (3) copies of the Record Documents in print, bound in three-ring binders.

.3 Provide three (3) copies of the Record Documents electronically in .pdf on CD, DVD or USB flash drive.

1.9 WARRANTY

.1 Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Failures on control systems that include all computer equipment, transmission equipment and all sensors and control devices during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.

1.10 OWNERSHIP OF PROPRIETARY MATERIAL

.1 Project specific software and documentation shall become Owner's property. This includes, but is not limited to:
.1 Graphics
.2 Record drawings
.3 Database
.4 Application programming code

2 PRODUCTS

2.1 GENERAL

.1 The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks. The new controls shall be seamlessly integrated into the exiting BMS and Fire Alarm systems and shall be integrated with each other and be serviceable with the same portables as the recently installed Johnson Metasys and Fire Alarm Systems.

.2 The installation of the control system shall be performed under the direct supervision of the Contractor with the shop drawings, flow diagrams, bill of materials, component designation, or identification number and sequence of operation all bearing the name of the manufacturer. The BMS Contractor shall

certify in writing, that the shop drawings have been prepared according to the equipment manufacturer's guidelines.

.3 All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.

.4 The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, and operator devices.

.5 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device. The system shall maintain all settings and overrides through a system re-boot.

.6 DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC Controllers shall also be able to send alarm to multiple operator workstations without dependence upon a central or intermediate processing device.

.7 DDC Controllers shall be able to assign password access and control priorities to each point individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust or control only the points that the operator is authorized for. All other points shall not be displayed at the PC workstation or portable terminal. (e.g. all base building and all tenant points shall be accessible to any base building operators, but only certain base building and tenant points shall be accessible to tenant building operators). Passwords and priority levels for every point shall be fully programmable and adjustable.

.8 All DDC controllers shall be installed with 10% spare points (of each type) and 25% spare memory capacity for connection of floor work.

.9 Controls vendor must supply licensed copies of all software tools so customer can make all future Graphic and programming changes at no additional costs, e.g. Siemens PPCL, Honeywell CARE.

2.2 BMS ARCHITECTURE

.1 The Building Management System shall consist of the following:

.1 Standalone Network Automation Engine(s)

.2 Field Equipment Controller(s)

.3 Input/Output Module(s)

.4 Local Display Device(s)

.5 Portable Operator's Terminal(s)
.6 Distributed User Interface(s)
.7 Network processing, data storage and communications equipment
.8 Other components required for a complete and working BMS

.2 Automation Network

.1 The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.

.2 The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.

.3 All BMS devices on the automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.

.4 Network Automation Engines (NAE) shall reside on the automation network.

.5 The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

.3 Control Network

.1 Network Automation Engines (NAE) shall provide supervisory control over the control network and shall support both of the following communication protocols:

.1 BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9
The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
The NAE shall be tested and certified as a BACnet Building Controller (B-BC).

.2 Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.

.3 DDC Controllers shall reside on the control network.

.4 Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.

.5 A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.

.4 Integration

.1 Direct Protocol (Integrator Panel)

.1 The BMS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BMS system and 3rd party manufacturers' control panels. The BMS shall receive, react to, and return information from multiple building systems, including but not limited to the chillers, boilers, variable frequency

drives, power monitoring system, and medical gas.

.2 All data required by the application shall be mapped into the Automation Engine's database, and shall be transparent to the operator.

.3 Point inputs and outputs from the third party controllers shall have real time interoperability with BMS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications.

.2 BACnet Protocol Integration - BACnet

.1 The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135-2003.

.2 A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.

.3 The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

2.3 USER INTERFACE

.1 Dedicated Web Based User Interface

.1 Where indicated on plans the BMS Contractor shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS Network Automation Engines to facilitate greater fault tolerance and reliability.

.2 Dedicated User Interface Architecture - The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BMS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards.

.1 Microsoft Internet Explorer for user interface functions

.2 Microsoft Office Professional for creation, modification and maintenance of reports, sequences other necessary building management functions

.3 Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports

.4 Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries

.3 PC Hardware - The personal computer(s) shall be configured as follows:

.1 Memory - 1 GB RAM Minimum

.2 CPU- Pentium 4 processor. 2.0 GHz Clock Speed minimum

.3 Hard Drive - 100 GB free hard drive space minimum
.4 Hard drive backup system - CD/RW, DVD/RW or network backup software provided by IT department
.5 CD ROM Drive - 32X performance
.6 Ports - (2) USB ports
.7 Keyboard - 101 Keyboard and 2 Button Mouse
.8 Display configuration as follows:
17" Flat Panel Monitor, SVGA 1280 x 1024 resolution minimum, 64K colours and 16 bit or higher color depth
Display card with multiple monitor support
.9 LAN communications - Ethernet communications board; 3Comm or equal

.4 Operating System Software
.1 Windows XP Professional
.2 Where user interface is not provided via browser, provide complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers, and peripherals.
.3 Provide software registration cards to the Owner for all included software.

.5 Peripheral Hardware
.1 Report printer:
.1 Printer Make - Hewlett Packard DeskJet
.2 Print Speed - 600 DPI Black, 300 DPI Color
.3 Buffer - 64 K Input Print Buffer
.4 Color Printing - Include Color Kit

.2 Distributed Web Based User Interface
.1 All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.
.2 The software shall run on the Microsoft Internet Explorer (6.0 or higher) browser supporting the following functions:
.1 Configuration
.2 Commissioning
.3 Data Archiving
.4 Monitoring
.5 Commanding
.6 System Diagnostics
.3 Minimum hardware requirements:
.1 512 MB RAM
.2 2.0 GHz Clock Speed Pentium 4 Microprocessor
.3 100.0 GB Hard Drive.
.4 1 Keyboard with 83 keys (minimum).

.5 SVGA 1024x768 resolution display with 64K colors and 16 bit color depth
.6 Mouse or other pointing device

.3 Site Management User Interface Application Components

.1 Operator Interface

.1 An integrated browser based client application shall be used as the user operator interface program.

.2 The System shall employ an event-driven rather than a device polling methodology to dynamically capture and present new data to the user.

.3 All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.

.4 The user interface software shall provide help menus and instructions for each operation and/or application.

.5 The system shall support customization of the UI configuration and a home page display for each operator.

.6 The system shall support user preferences in the following screen presentations:

.1 Alarm
.2 Trend
.3 Display
.4 Applications

.7 All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.

.8 The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:

.1 User access for selective information retrieval and control command execution
.2 Monitoring and reporting
.3 Alarm, non-normal, and return to normal condition annunciation
.4 Selective operator override and other control actions
.5 Information archiving, manipulation, formatting, display and reporting
.6 BMS internal performance supervision and diagnostics
.7 On-line access to user HELP menus
.8 On-line access to current BMS as-built records and documentation
.9 Means for the controlled re-programming, re-configuration of BMS operation and for the manipulation of BMS database information in compliance with the prevailing codes, approvals and regulations for individual BMS applications

.9 The system shall support a list of application programs configured by the users that are called up by the following means:
  .1 The Tools Menu
  .2 Hyperlinks within the graphics displays
  .3 Key sequences
.10 The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

.2 Navigation Trees
  .1 The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.
  .2 Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.
  .3 The navigation trees shall be "dockable" to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.

.3 Alarms
  .1 Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
    .1 Log date and time of alarm occurrence.
    .2 Generate a "Pop-Up" window, with audible alarm, informing a user that an alarm has been received.
    .3 Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
    .4 Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
    .5 Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.

.6 Any attribute of any object in the system may be designated to report an alarm.

.2 The BMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.

.3 The BMS shall allow a minimum of 4 categories of alarm sounds customizable through user defined wav.files.

.4 The BMS shall annunciate application alarms at minimum, as required by Part 3.

.4 Reports and Summaries

.1 Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:

.1 All points in the BMS

.2 All points in each BMS application

.3 All points in a specific controller

.4 All points in a user-defined group of points

.5 All points currently in alarm

.6 All points locked out

.7 All BMS schedules

All user defined and adjustable variables, schedules, interlocks and the like.

.2 Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.

.3 Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.

.4 The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.

.5 Provide the capability to view command and modify large quantities of similar data in tailored summaries created online without the use of a secondary application like a spreadsheet. Summary definition shall allow up to seven user defined columns describing attributes to be displayed including custom column labels. Up to 100 rows per summary shall be supported. Summary viewing shall be available over the network using a standard Web browser.

.6 Provide a focused set of reports that includes essential information required for effective management of energy resources within the facility. Energy reports shall be configurable from predefined, preconfigured templates. Required includes but shall not be limited to:

.1 Energy Overview

.2 Load Profile

.3 Simple Energy Cost

.4 Consumption
.5 Equipment Runtime
.6 Electrical Energy
.7 Energy Production

.7 Reports shall be selectable by date, time, area and device. Each report shall include a color visual summary of essential energy information.

.5 Schedules

.1 A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
.1 Weekly schedules
.2 Exception Schedules
.3 Monthly calendars

.2 Weekly schedules shall be provided for each group of equipment with a specific time use schedule.

.3 It shall be possible to define one or more exception schedules for each schedule including references to calendars

.4 Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.

.5 Changes to schedules made from the User Interface shall directly modify the Network Automation Engine schedule database.

.6 Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard.

.7 Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.

.8 Software shall be provided to configure and implement optimal start and stop programming based on existing indoor and outdoor environmental conditions as well as equipment operating history

.6 Password

.1 Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.

.2 Each user shall have the following: a user name (accept 24 characters minimum), a password (accept 12 characters minimum), and access levels.

.3 The system shall allow each user to change his or her password at will.

.4 When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.

.5 A minimum of five levels of access shall be supported individually or in any combination as follows:
  .1 Level 1 = View Data
  .2 Level 2 = Command
  .3 Level 3 = Operator Overrides
  .4 Level 4 = Database Modification
  .5 Level 5 = Database Configuration
  .6 Level 6 = All privileges, including Password Add/Modify
.6 A minimum of 100 unique passwords shall be supported.
.7 Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
.8 The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.

.7 Screen Manager
  .1 The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.

.8 Dynamic Color Graphics
  .1 The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.
  .2 The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed. The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
  .3 Graphics runtime functions - A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:
    .1 All graphics shall be fully scalable
    .2 The graphics shall support a maintained aspect ratio.
    .3 Multiple fonts shall be supported.
    .4 Unique background shall be assignable on a per graphic basis.
    .5 The color of all animations and values on displays shall indicate if the status of the object attribute.

.4 Operation from graphics - It shall be possible to change values (setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device

.5 Graphic editing tool - A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.

The graphic editing tool shall in general provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.

In addition, the graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.

.6 Aliasing - Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.

.9 Historical trending and data collection

.1 Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows;

.1 Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:

.1 Defined time interval

.2 Upon a change of value

.2 Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.

.2 Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.

.3 The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in either Microsoft Access or SQL database format.

.10 Trend data viewing and analysis

.1 Provide a trend viewing utility that shall have access to all database points.

.2 It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated

trend name.

.3 The trend viewing utility shall have the capability to define trend study displays to include multiple trends

.4 Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.

.5 Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.

.6 Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.

.7 Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.

.8 The Display shall support the user's ability to change colors, sample sizes, and types of markers.

.11 Database Management

.1 Where a separate SQL database is utilized for information storage the System shall provide a Database Manager that separates the database monitoring and managing functions by supporting two separate windows.

.2 Database secure access shall be accomplished using standard SQL authentication including the ability to access data for use outside of the Building Automation application.

.3 The database managing function shall include summarized information on trend, alarm, event, and audit for the following database management actions:

.1 Backup

.2 Purge

.3 Restore

.4 The Database Manager shall support four tabs:

Statistics - shall display Database Server information and Trend, Alarm (Event), and Audit information on the Metasys Databases.

.1 Maintenance - shall provide an easy method of purging records from the Metasys Server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting the database, and allowing for the retention of a selected number of day's data.

.2 Backup - Shall provide the means to create a database backup file and select a storage location.

.3 Restore - shall provide a restricted means of restoring a database by requiring the user to log into an Expert Mode in order to view the Restore screen.

.5 The Status Bar shall appear at the bottom of all Metasys Database Manager Tabs and shall provide information on the current database

activity. The following icons shall be provided:

.1 Ready
.2 Purging Record from a database
.3 Action Failed
.4 Refreshing Statistics
.5 Restoring database
.6 Shrinking a database
.7 Backing up a database
.8 Resetting internet information Services
.9 Starting the Metasys Device Manager
.10 Shutting down the Metasys Device Manager
.11 Action successful

.6 The Database Manager monitoring functions shall be accessed through the Monitoring Settings window and shall continuously read database information once the user has logged in.

.7 The System shall provide user notification via taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.

.8 The Monitoring Settings window shall have the following sections:

.1 General - Shall allow the user to set and review scan intervals and start times.
.2 Email - Shall allow the user to create and review e-mail and phone text messages to be delivered when a Warning or Alarm is generated.
.3 Warning - shall allow the user to define the Warning limit parameters, set the Reminder Frequency, and link the e-mail message.
.4 Alarm - shall allow the user to define the Alarm limit parameters, set the Reminder Frequency, and link the e-mail message.
.5 Database login - Shall protect the system from unauthorized database manipulation by creating a Read Access and a Write Access for each of the Trend, Alarm (Event) and Audit databases as well as an Expert Mode required to restore a database.

.9 The Monitoring Settings Taskbar shall provide the following informational icons:

.1 Normal - Indicates by color and size that all databases are within their limits.
.2 Warning - Indicates by color and size that one or more databases have exceeded their Warning limit.
.3 Alarm - Indicates by color and size that one or more databases have exceeded their Alarm limit.

.10 The System shall provide user notification via Taskbar icons and e-mail messages when a database value has exceeded a warning or alarm

limit.

.4 Portable Operator Terminal (Existing)

.1 For systems that do not provide full access to systems configuration and definition via the Browser Based user interface the BMS Contractor shall provide a portable operator terminal for programming purposes. The terminal shall be configured as follows:

.1 Personal Laptop Computer Manufacturer - Dell, Compaq or HP
.2 1 GB RAM (256 MB minimum) - XP Professional
.3 1.8 GHz Clock Speed Pentium 4 Microprocessor (800 MHz minimum)
.4 40 GB Hard Drive (40 GB minimum)
.5 (1) CD-ROM Drive, 32x speed
.6 (1) Serial (1) Parallel (2) USB ports
.7 1 Keyboard with 83 keys (minimum).
.8 Integral 2 button Track Point or Track Ball.
.9 10" SVGA 1024x768 resolution color display
.10 Two PCMCIA Type II or one Type III card slot
.11 Complete operator workstation software package, including any hardware or software.
.12 Original printed manuals for all software and peripherals.
.13 Original installation disks or CD for all software, device drivers, and peripherals
.14 Software registration cards for all included software shall be provided to the Owner.
.15 Carrying case
.16 Spare battery.
.17 External power supply/battery charger

.2 Proprietary Portable Terminal

.1 Manufacturers providing proprietary portable terminals shall submit technical data sheets for the terminal and all associated software and hardware.
.2 The proprietary terminal shall meet the same operator interface software requirements as specified above.

.3 Software

.1 Portable operator terminals shall support all controllers within the system on a direct-connect communications basis.
.2 When used to access First or Second Tier controllers, the portable operator terminal shall utilize the standard operator workstation software, as previously defined.
.3 When used to access Application Specific Controllers, the portable operator terminal shall utilize either the standard operator workstation software, as previously defined, or controller-specific utility software.

.5 Ready Access Portal User Interface

.1 BMS Contractor shall provide and install all computer hardware and software required for the purpose of configuration and consolidation of information

and programs required for the delivery of a Task Focused, Web Based Portal to the BMS. This Ready Access Portal shall provide a natural, complementary extension to the Metasys site management user interface previously described.

.2 Ready Access Portal Architecture - The architecture of the system shall be implemented to conform to industry standards, so that it can accommodate the required applications provided by the BMS Contractor as well as communicate information too and from the Metasys system Site Director.

.3 User Interface Application Components

.1 The ready access portal shall provide an intuitive user interface to key Metasys functions and tasks via web browser.

.2 Plug-ins or special software shall not be required for access to alarm, summary, schedule and trend data.

.3 The portal shall include the ability to view full graphical representations of systems and equipment on PC platforms

.4 The control system shall provide Secure Sockets Level (SSL) and Active Directory service support. If the Active Directory service and Single Sign-On features are enabled and the user is logged in to the Windows desktop, the login screen does not appear and access to the system is automatic.

.5 Provide a common tool for graphics creation, schedule creation, custom programming, user access and hardware definition

.6 Information shall be accessible on both personal computer and handheld device platforms as follows:

.1 Personal computers - Internet Explorer Version 7.0 recommended

.2 Handheld devices - Internet Explorer for Window Mobile Version 5.0 or 6.0 recommended. UI is optimized for devices with a 240 x 320 pixel screen size (QVGA). Other devices may display the UI but full functionality is not guaranteed.

.4 Operator Interface

.1 Password access shall be as described previously for management portal UI

.2 Once logged in, the System shall display a pre-selected screen tailored to the task requirements of the individual user.

.3 The User Interface shall utilize an intuitive navigation and display method designed for operators who access the system for casual information and control or on an infrequent basis. It shall feature three basic components;

.1 Radio buttons for selection of the type of information to be displayed including Alerts, Summary, Schedules and Diagnostics

.2 Navigation tree for selection of the specific data to be displayed on screen for the selected type. The navigation tree may be hidden and expanded by the operator to optimize the

display of information

.3 A display window that provides the selected information by type in a pre-configured tabular format

.4 The user interface software shall provide help menus and instructions for each operation and/or application.

.5 The system shall provide support for up to 100 concurrent users from an unlimited universe individuals with defined password access to the system

.6 The system shall provide utilize Secure Sockets Level (SSL) support as required. This to allows the ready access portal to communicate across a network in a way designed to prevent eavesdropping, tampering, and message forgery. It provides endpoint authentication and communications privacy over the network using cryptography

.7 The system shall have the capability to display multiple navigation trees that correspond to the user views configured in the management portal UI.

.8 The alert summary of the remote access portal shall, at the minimum, provide the following information

.1 Alert (Alarm) type
.2 Date and time of alert occurrence
.3 Priority (color coded to level)
.4 Item name.
.5 Item value (if applicable)
.6 Message

Any attribute of any object in the system may be designated to report an alarm

.9 A standard summary on the remote access portal shall, at the minimum, provide the following information;

.1 Point type graphic icon
.2 Item name
.3 Item value
.4 Item status
.5 Access to the Change Value window (if applicable) for the purpose of setting, holding or releasing an item value

.10 The schedule detail summary of the remote access portal shall, at the minimum, provide the following information

.1 Scheduled occurrences including time and value
.2 Scheduled overrides including start time, end time and value
.3 A list of all scheduled items including name and attribute, value, status and priority
.4 Access to the Add Temporary Override window for the purpose of adding a temporary override to the schedule

.11 The diagnostic (trend) summary of the remote access portal as viewed on a personal computing device shall provide the following

information.

.1 Item name
.2 Item status
.3 Trend name
.4 Trend status
.5 Full path name
.6 Access to trend detail summary including trended value, time and date arranged in a user selectable format of 1 hour, 12 hours, 24 hours, 48 hours or 72 hours

2.4 BUILDING CONTROLLER SOFTWARE

.1 General:

.1 Furnish the following applications software to form a complete operating system for building and energy management as described in this specification.

.2 The software programs specified in this Section shall be provided as an integral part of Building Controllers and shall not be dependent upon any higher level computer or another controller for execution.

.3 All points, panels and programs shall be identified by a 30 character name. All points shall also be identified by a 16 character point descriptor. The same names shall be displayed at both Building Controller and the Operator Interface.

.4 All digital points shall have a user defined two-state status indication with 8 characters minimum (e.g. Summer, Enabled, Disabled, Abnormal).

.5 Building Controllers shall have the ability to perform energy management routines including but not limited to time of day scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides, start stop time optimization, automatic daylight savings time switch over, night setback control, enthalpy switch over, peak demand limiting, temperature-compensated duty cycling, heating / cooling interlock, supply temperature reset, priority load shedding, and power failure restart.

.6 The Building Controllers shall have the ability to perform the following pre tested control algorithms:

.1 Two position control
.2 Proportional control
.3 Proportional plus integral control
.4 Proportional, integral, plus derivative control
.5 Automatic tuning of control loops
.6 Model-Free Adaptive Control

.7 Building Controllers shall not be susceptible to Microsoft Windows operating systems based viruses.

.2 System Security

.1 User access shall be secured using individual security passwords and user names.

.2 Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.

.3 User Log On / Log Off attempts shall be recorded.

.4 The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.

.3 User Defined Control Applications:

.1 Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

.2 It shall be possible to use any system measured point data or status, any system calculated data, a result from any process or any user-defined constant in any controller in the system.

.3 Any process shall be able to issue commands to points in any and all other controllers in the system.

.4 Processes shall be able to generate operator messages and advisories to other operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.

.5 Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation and historical summaries of program development.

.6 Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.

.4 Alarm Management:

.1 Alarm management shall be provided to monitor and direct alarm information to operator devices. Each Building Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the Building Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.

.2 An Alarm "shelving" feature shall be provided to disable alarms during testing. (Pull the Plug, etc.).

.3 Conditional alarming shall allow generation of alarms based upon user defined multiple criteria.

.4 Binary Alarms. Each binary object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.

.5 Analog Alarms. Each analog object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.

.6 All alarm or point change reports shall include the point's user defined language description and the time and date of occurrence.

.7 The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be

provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, Building Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each Building Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.

.8 Alarm reports and messages shall be routed to user-defined list of operator workstations, or other devices based on time and other conditions. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display graphics.

.9 In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.

.1 Each Building Controller shall be capable of storing a library of at least 50 alarm messages. Each message may be assignable to any number of points in the Controller.

.10 Operator-selected alarms shall be capable of initiating a call to a remote operator device.

.5 Scheduling:

.1 Provide a comprehensive menu driven program to automatically start and stop designated object or group of objects in the system according to a stored time.

.2 It shall be possible to define a group of objects as a custom event (i.e. meeting, athletic activity, etc.). Events can then be scheduled to operate all necessary equipment automatically.

.3 For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start or stop within that group.

.4 The operator shall be able to define the following information:

.1 Time, day

.2 Commands such as on, off, auto, and so forth.

.3 Time delays between successive commands.

.4 There shall be provisions for manual overriding of each schedule by an appropriate operator.

.5 It shall be possible to schedule calendar-based events up to one year in advance based on the following:

.1 Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop, and night economizer. When a group of objects are scheduled together as an Event, provide the capability to adjust the start and stop times for each member.

.2 Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the

standard schedule for that day of the week.

.3 Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

.6 Night setback control. The system shall provide the ability to automatically adjust setpoints for night control.

.7 Loop Control. A PID (proportional-integral-derivative) closed-loop control algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, set point, and weighting parameters shall be user-selectable.

.8 Sequencing. Provide application software based upon the sequences of operation specified to properly sequence equipment.

.9 Staggered Start:

.1 This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user definable.

.2 Upon the resumption of power, each Building Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.

.10 Totalization:

.1 Run-Time Totalization. Building Controllers shall automatically accumulate and store run-time hours for all digital input and output points. A high runtime alarm shall be assigned, if required, by the operator.

.2 Consumption totalization. Building Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and digital pulse input type points.

.3 Event totalization. Building Controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly or monthly basis for all points. The event totalization feature shall be able to store the records associated with events before reset.

.11 Data Collection:

.1 A variety of historical data collection utilities shall be provided to manually or automatically sample, store, and display system data for all points.

.2 Building Controllers shall store point history data for selected analog and digital inputs and outputs:

.1 Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each Building Controllers point group.

.3 Trend data shall be stored at the Building Controllers and uploaded to the

workstation when retrieval is desired. Uploads shall occur based upon either user-defined interval, manual command or when the trend buffers are full. All trend data shall be available for use in 3rd party personal computer applications.

.4 Loop Tuning. Building Controllers shall also provide high resolution sampling capability for verification of DDC control loop performance. Documented evidence of tuned control loop performance shall be provided on a <monthly, seasonal, quarterly, annual> period.

.1 For Model-Free Adaptive Control loops, evidence of tuned control loop performance shall be provided via graphical plots or trended data logs. Graphical plots shall minimally include depictions of setpoint, process variable (output), and control variable (e.g., temperature). Other parameters that may influence loop control shall also be included in the plot (e.g., fan on/off, mixed-air temp).

.2 For PID control loops, operator-initiated automatic and manual loop tuning algorithms shall be provided for all operator-selected PID control loops. Evidence of tuned control loop performance shall be provided via graphical plots or trended data logs for all loops.

.1 In automatic mode, the controller shall perform a step response test with a minimum one-second resolution, evaluate the trend data, calculate the new PID gains and input these values into the selected LOOP statement.

.2 Loop tuning shall be capable of being initiated either locally at the Building Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.`

2.5 BUILDING CONTROLLERS

.1 Building Controllers shall be 32 bit, multi-tasking, multi-user, real-time 48 MHz digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.

.2 Each Building Controller shall support a minimum of 3 directly connected Secondary Networks.

.3 Each Building Controller shall have sufficient memory, a minimum of 72 megabyte, to support its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, operator I/O, and dial-up communications.

.4 Building Controller shall have an integral real-time clock.

.5 Each Building Controller shall support firmware upgrades without the need to change hardware.

.6 Spare Point Capacity. Each Building Controller shall have a minimum of 10 percent spare point capacity.

.1 The type of spares shall be in the same proportion as the implemented I/O functions of the panel, but in no case shall there be less than one spare of each implemented I/O type.

.2 Provide all processors, power supplies, and communication controllers so that the implementation of adding a point to the spare point location only requires the addition of the appropriate:

.1 Expansion modules

.2 Sensor/actuator

.3 Field wiring/tubing.

.7 Serial Communication. Building Controllers shall provide at least two EIA-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, and portable laptop operator's terminals. Building Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected printers or terminals.

.8 I/O Status and Indication. Building Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. All wiring connections shall be made to field-removable terminals.

.9 Self Diagnostics. Each Building Controller shall continuously perform self diagnostics, communication diagnosis, and diagnosis of all panel components. The Building Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication for any system.

.10 Power loss. In the event of the loss of power, there shall be an orderly shutdown of all Building Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 100 hours.

.11 Environment.

.1 Controller hardware shall be suitable for the anticipated ambient conditions.

.2 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).

.3 Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).

.12 Immunity to power and noise.

.1 Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.

.1 Operation shall be protected against electrical noise of 5 to 120 Hz and

from keyed radios up to 5 W at 1 m (3 ft).

.2 Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
- .1 RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V
- .2 Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
- .3 Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
- .4 Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)

.3 Isolation shall be provided at all Building Controller's AC input terminals to suppress induced voltage transients consistent with:
- .1 IEEE Standard 587 1980
- .2 UL 864 Supply Line Transients
- .3 Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

.13 Minimum Approved Building Controllers. BMS Contractors shall furnish Building Controllers as listed below. Providing an approved controller does not release the contractor from meeting all performance, software and hardware specifications for Building Controllers and system operations.
- .1 Johnson Controls - FEC (field Equipment Controllers)
- .2 Honeywell International, EBI Automation System (with ILON 1000 and XL5000 in a common enclosure as a DDC panel).
- .3 Siemens Building Technologies Inc. - Modular Building/Equipment Controllers (MBC/MEC).

2.6 NETWORK AUTOMATION ENGINES (NAE)

.1 The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.

.2 Automation network - The NAE shall reside on the automation network and shall support a subnet of system controllers.

.3 User Interface - Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
- .1 The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
- .2 The NAE shall support a minimum of two (2) concurrent users.
- .3 The web based user shall have the capability to access all system data through one NAE.
- .4 Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
- .5 Systems that require the user to address more than one NAE to access all

system information are not acceptable.

.6 The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.

.7 Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.

.8 The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
Configuration
Commissioning
Data Archiving
Monitoring
Commanding
System Diagnostics

.9 Systems that require workstation software or modified web browsers are not acceptable.

.10 The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

.4 Processor - The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.

.5 Memory - Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

.6 Hardware Real Time Clock - The NAE shall include an integrated, hardware-Based, real-time clock.

.7 The NAE shall include troubleshooting LED indicators to identify the following conditions:

.1 Power - On/Off

.2 Ethernet Traffic - Ethernet Traffic/No Ethernet Traffic

.3 Ethernet Connection Speed - 10 Mbps/100 Mbps

.4 FC Bus - Normal Communications/No Field Communications

.5 Peer Communication - Data Traffic between NAE Devices

.6 Run - NAE Running/NAE in Startup/NAE Shutting Down/Software Not Running

.7 Bat Fault - Battery Defective, Data Protection Battery Not Installed

.8 Fault - General Fault

.9 Modem RX - NAE Modem Receiving Data

.10 Modem TX - NAE Modem Transmitting Data

.8 Communications Ports - The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.

.1 USB port

.2 RS-232 serial data communication port

.3 RS-485 port

.4 Ethernet port

.9 Diagnostics - The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

.10 Power Failure - In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

.1 During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.

.2 Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

.11 Certification - The NAE shall be listed by Underwriters Laboratories (UL).

.12 Controller network - The NAE shall support both of the following communication protocols on the controller network:

.1 The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
A BACnet Protocol Implementation Conformance Statement shall be provided for the NAE.
The Conformance Statements shall be submitted 10 days prior to bidding.
The NAE shall support a minimum of 100 control devices.

.2 The NAE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10.
All LonWorks controls devices shall be LonMark certified.
The NAE shall support a minimum of 127 LonWorks enabled control devices.

2.7 POWER SUPPLIES AND LINE FILTERING

.1 Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

.2 DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand a 150% current overload for at least three seconds without trip-out or failure.

.1 Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.

.2 Line voltage units shall be UL recognized and CSA approved.

.3 Power line filtering.

.1 Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:

.1 Dielectric strength of 1000 volts minimum

.2 Response time of 10 nanoseconds or less

.3 Transverse mode noise attenuation of 65 dB or greater

.4 Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.

2.8 COMMUNICATION AND CONTROL WIRING

.1 General:

.1 Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 16 unless otherwise noted herein.

.2 All insulated wire to be copper conductors, UL labeled for 90°C minimum service.

.2 Wire Sizing and Insulation

.1 Wiring shall comply with minimum wire size and insulation based on services listed below:

.1

Service	Minimum Gage/Type	Insulation Class
AC 24V Power	12 Ga Solid	600 Volt
DC 24V Power	10 Ga Solid	600 Volt
Class 1	14 Ga Stranded	600 Volt
Class 2	18 Ga Stranded	300 Volt
Class 3	18 Ga Stranded	300 Volt

.2 Provide plenum-rated cable when open cable is permitted in supply or return air plenum where allowed per execution specifications defined in Paragraph 3.07

.3 Power Wiring:

.1 115V power circuit wiring above 100 feet distance shall use minimum 10 gage.

.2 24V control power wiring above 200 feet distance shall use minimum 12 gage.

.4 Control Wiring:

.1 Digital Input/Output wiring shall use Class 2 twisted pair, insulated.

.2 Analog inputs shall use Class 2 twisted shielded pair, insulated and jacketed and require a grounded shield.

.3 Actuators with tri-state control shall use 3 conductor with same characteristics

.5 Communication Wiring

.1 Ethernet Cable shall be minimum CAT5

.2 Secondary level network shall be 24 gage, TSP, low capacitance cable

.6 Approved Cable Manufacturers:

.1 Wiring from the following manufacturers which meet the above criteria shall be acceptable:

.1 Anixter

.2 Belden

.3 Cerco

2.9 DDC SYSTEM CONTROLLERS

.1 Field Equipment Controller (FEC)

.1 The FEC shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol. The FEC shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network. The FEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label. The FEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC). A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.

.2 The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable. .

.3 The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

.4 The FEC shall include a removable base to allow pre-wiring without the controller.

.5 The FEC shall include troubleshooting LED indicators to identify the following conditions:

.1 Power On

.2 Power Off

.3 Download or Startup in progress, not ready for normal operation

.4 No Faults

.5 Device Fault

.6 Field Controller Bus - Normal Data Transmission

.7 Field Controller Bus - No Data Transmission

.8 Field Controller Bus - No Communication

.9 Sensor-Actuator Bus - Normal Data Transmission

.10 Sensor-Actuator Bus - No Data Transmission

.11 Sensor-Actuator Bus - No Communication

.6 The FEC shall accommodate the direct wiring of analog and binary I/O field

points.

.7 The FEC shall support the following types of inputs and outputs:
- .1 Universal Inputs - shall be configured to monitor any of the following:
  - Analog Input, Voltage Mode
  - Analog Input, Current Mode
  - Analog Input, Resistive Mode
  - Binary Input, Dry Contact Maintained Mode
  - Binary Input, Pulse Counter Mode
- .2 Binary Inputs - shall be configured to monitor either of the following:
  - Dry Contact Maintained Mode
  - Pulse Counter Mode
- .3 Analog Outputs - shall be configured to output either of the following
  - Analog Output, Voltage Mode
  - Analog Output, current Mode
- .4 Binary Outputs - shall output the following:
  - 24 VAC Triac
- .5 Configurable Outputs - shall be capable of the following:
  - Analog Output, Voltage Mode
  - Binary Output Mode

.8 The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
- .1 The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
- .2 The FC Bus shall support communications between the FECs and the NAE.
- .3 The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.
- .4 The FC Bus shall support a minimum of 100 IOMs and FECs in any combination.
- .5 The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.

.9 The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
- .1 The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.
- .2 The SA Bus shall support a minimum of 10 devices per trunk.
- .3 The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.

.10 The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.

.11 The FEC shall support, but not be limited to, the following:
- .1 Chilled water/central plant automation applications including but not limited to the selection and sequencing of up to 8 chillers of different sizes (constant or variable speed capacity control), 8 primary and

secondary chilled water pumps, as well as selection and sequencing of cooling towers and bypass valve. Sequencing of the devices shall consider user-defined efficiency ratings, runtime equalization and number-of-starts/number-of -stops.

.2 Heating central plant applications

.3 Built-up air handling units for special applications

.4 Terminal units

.5 Special programs as required for systems control

.12 The FEC shall support a Local Controller Display as an integral part of the FEC.

.1 The Display shall use a BACnet Standard SSPC-135, clause 9 Master-Slave/Token-Passing protocol.

.2 The Display shall allow the user to view monitored points without logging into the system.

.3 The Display shall allow the user to view and change setpoints, modes of operation, and parameters.

.4 The Display shall provide password protection with user adjustable password timeout.

.5 The Display shall be menu driven with separate paths for:
Input/Output
Parameter/Setpoint
Overrides

.6 The Display shall use easy-to-read English text messages.

.7 The Display shall allow the user to select the points to be shown and in what order.

.8 The Display shall support a back lit Liquid Crystal Display (LCD) with adjustable contrast and brightens and automatic backlight brightening during user interaction.

.9 The display shall be a minimum of 4 lines and a minimum of 20 characters per line

.10 The Display shall have a keypad with no more than 6 keys.

2.10 INPUT/OUTPUT INTERFACE

.1 Hardwired inputs and outputs may tie into the system through building or application specific controllers.

.2 All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to the controller.

.3 Binary inputs shall allow the monitoring of On/Off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the

controller) being applied.

.4 Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.

.5 Analog inputs shall allow the monitoring of low-voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with-and field configurable to- commonly available sensing devices.

.6 Binary outputs shall provide for On/Off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers shall have three-position (On/Off/Auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.

.7 Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC, 4 to 20 mA or 0-20 PSI signal as required to provide proper control of the output device. Analog outputs on building or custom application controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.

.8 Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct-mounted heating coils, zone dampers, radiation, etc.). Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

.9 System Object Capacity. The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.11 FIELD DEVICES

.1 Input/Output Module

.1 The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.

.2 The IOM shall communicate with the FEC over the FC Bus or the SA Bus.

.3 The IOM shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

.1 The IOM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

.2 The IOM shall be tested and certified as a BACnet Application Specific Controller (B-ASC).

.3 A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.

.4 The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

.5 The IOM shall have a minimum of 4 points to a maximum of 17 points.

.6 The IOM shall support the following types of inputs and outputs:

.1 Universal Inputs - shall be configured to monitor any of the following:

.1 Analog Input, Voltage Mode
.2 Analog Input, Current Mode
.3 Analog Input, Resistive Mode
.4 Binary Input, Dry Contact Maintained Mode
.5 Binary Input, Pulse Counter Mode

.2 Binary Inputs - shall be configured to monitor either of the following:

.1 Dry Contact Maintained Mode
.2 Pulse Counter Mode

.3 Analog Outputs - shall be configured to output either of the following

.1 Analog Output, Voltage Mode
.2 Analog Output, current Mode

.4 Binary Outputs - shall output 24 VAC Triac

.5 Configurable Outputs - shall be capable of the following:

.1 Analog Output, Voltage Mode
.2 Binary Output Mode

.7 The IOM shall include troubleshooting LED indicators to identify the following conditions:

.1 Power On
.2 Power Off
.3 Download or Startup in progress, not ready for normal operation
.4 No Faults
.5 Device Fault
.6 Normal Data Transmission
.7 No Data Transmission
.8 No Communication

.2 Networked Thermostat (TEC 26XX)

.1 The networked thermostat shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters, reheat coils or other similar equipment.

.2 The TEC shall communicate over the Field Controller Bus using BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.

.3 The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

.1 The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).

.2 A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.

.3 The Conformance Statement shall be submitted 10 days prior to bidding.

.4 The Networked Thermostat shall support remote read/write and parameter adjustment from the web based User Interfaceable through a Network Automation Engine.

.5 The Networked Thermostat shall include an intuitive User Interface providing plain text messages.

.1 Two line, 8 character backlit display

.2 LED indicators for Fan, Heat, and Cool status

.3 Five (5) User Interface Keys

.1 Mode

.2 Fan

.3 Override

.4 Degrees C/F

.5 Up/Down

.4 The display shall continuously scroll through the following parameters:

.1 Room Temperature

.2 System Mode

.3 Schedule Status - Occupied/Unoccupied/Override

.4 Applicable Alarms

.6 The Networked Thermostat shall provide the flexibility to support any one of the following inputs:

.1 Integral Indoor Air Temperature Sensor

.2 Duct Mount Air Temperature Sensor

.3 Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator

.4 Two configurable binary inputs

.7 The Networked Thermostat shall provide the flexibility to support any one of the following outputs:

.1 Three Speed Fan Control

.2 Two On/Off

.3 Two Floating

.4 Two Proportional (0 to 10V)

.8 The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.

.9 The Networked Thermostat shall provide the flexibility to adjust the following parameters:

.1 Adjustable Temporary Occupancy from 0 to 24 hours

.2 Adjustable heating/cooling deadband from 2° F to 5° F

.3 Adjustable heating/cooling cycles per hour from 4 to 8

.10 Where required by application and indicated on plans or room schedules provide the Networked Thermostat with an integral Passive Infra-Red (PIR) occupancy sensor.

.11 The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

.3 VAV Modular Assembly

.1 The VAV Modular Assembly shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units. It shall address both single and dual duct applications.

.2 The VMA shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

.1 The VMA shall be tested and certified as a BACnet Application Specific Controller (B-ASC).

.2 A BACnet Protocol Implementation Conformance Statement shall be provided for the VMA.

.3 The Conformance Statement shall be submitted 10 days prior to bidding.

.3 The VAV Modular Assembly shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.

.4 The VAV Modular Assembly shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.

.5 The VAV Modular Assembly shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.

.6 The VAV Modular Assembly shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

.7 The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 30 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.

.8 The controller shall determine airflow by dynamic pressure measurement using an integral dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters.

.9 Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.

.10 The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.

.11 Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.

.12 The controller shall provide the ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.

.13 Control setpoint changes initiated over the network shall be written to VMA non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.

.14 The controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.

.15 The controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.

.16 The controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.

.17 Controller performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The VMA shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.

.1 Absolute temperature loop error
.2 Signed temperature loop error
.3 Absolute airflow loop error
.4 Signed airflow loop error
.5 Average damper actuator duty cycle

.18 The controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:

.1 Unreliable space temperature sensor
.2 Unreliable differential pressure sensor
.3 Starved box
.4 Actuator stall
.5 Insufficient cooling
.6 Insufficient heating

.19 The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The VMA would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.

.20 The controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow Based on the percent of outdoor air in the primary air stream.

.21 The controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.

.22 Inputs:

.1 Analog inputs with user defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:

.1 0-10 VDC Sensors

.2 1000ohm RTDs
.3 NTC Thermistors

.2 Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."

.3 For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.

.4 Provide side loop application for humidity control.

.23 Outputs

.1 Analog outputs shall provide the following control outputs:
0-10 VDC

.2 Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.

.3 For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.

.24 Application Configuration

.1 The VAV Modular Assembly shall be configured with a software tool that provides a simple Question/Answer format for developing applications and downloading.

.25 Sensor Support

.1 The VAV Modular Assembly shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.

.2 The VMA shall support an LCD display room sensor.

.3 The VMA shall also support standard room sensors as defined by analog input requirements.

.4 The VMA shall support humidity sensors defined by the AI side loop.

.4 Network Sensors

.1 The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:

.1 Zone Temperature
.2 Zone Humidity
.3 Zone Setpoint
.4 Discharge Air Temperature
.5 Zone CO2

.2 The NS shall transmit the information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.

.3 The NS shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

.1 The NS shall be tested and certified as a BACnet Smart Sensors (B-SS).

.2 A BACnet Protocol Implementation Conformance Statement shall be provided for the NS.

.4 The Network Zone Temperature Sensors shall include the following items:

.1 A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint

.2 An LED to indicate the status of the Override feature

.3 A button to toggle the temperature display between Fahrenheit and

Celsius
.4 A button to initiate a timed override command
.5 Available in either surface mount or wall mount
.6 Available with either screw terminals or phone jack

.5 The Network Discharge Air Sensors shall include the following:
.1 4 inch or 8 inch duct insertion probe
.2 10 foot pigtail lead
.3 Dip Switches for programmable address selection
.4 Ability to provide an averaging temperature from multiple locations
.5 Ability to provide a selectable temperature from multiple locations

.6 The Network CO2 Zone Sensors shall include the following:
.1 Available in either surface mount or wall mount
.2 Available with screw terminals or phone jack

.5 Many-To-One Wireless Room Temperature Sensor System (WRS-XTX-0000)

.1 The Many-To-One System Receiver (WRS Receiver) shall receive wireless Radio Frequency (RF) signals containing temperature data from multiple Wireless Room Temperature Sensors (WRS Sensors).
.1 The WRS Receiver shall use direct sequence spread spectrum RF technology.
.2 The WRS Receiver shall operate on the 2.4 GHZ ISM Band.
.3 The WRS Receiver shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
.4 The WRS Receiver shall be FCC compliant to CFR Part 15 subpart B Class A.
.5 The WRS Receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
.6 The WRS Receiver shall be capable of communication with WRS Sensors up to a distance of 200 Feet.
.7 The WRS Receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
.8 The WRS Receiver shall have LED indicators to provide information regarding the following conditions:
.1 Power On/Off
.2 Ethernet - Receiver Activity/No Activity
.3 Wireless Normal Mode - Transmission from sensors/No Transmission
.4 Wireless Rapid Transmit Mode - No transmission/ weak signal/Adequate signal/Excellent signal
.5 Ethernet Connection - No connection/10Mbps connection/100Mbps connection
.6 Network Activity - No Network Activity/Half-Duplex Communication/Full
.7 Duplex Communication

.2 The WRS Sensors shall sense and report room temperatures to the WRS

Receiver.

.1 The WRS Sensors shall use direct sequence spread spectrum RF technology.

.2 The WRS Sensors shall operate on the 2.4 GHZ ISM Band.

.3 The WRS Sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.

.4 The WRS sensors shall be FCC compliant to CFR Part 15 subpart B Class A.

.5 The WRS sensors shall be available with

.1 Warmer/Cooler Set Point Adjustment

.2 No Set Point Adjustment

.3 Set Point Adjustment Scale - 55 to 85° F.

.6 The WRS sensors shall be assembled in NEMA 1 plastic housings.

.6 ZFR1800 Series Wireless Field Bus System

.1 The ZFR1800 Series System shall employ ZigBee technology to create a wireless mesh network to provide wireless connectivity for Metasys BACnet devices at multiple system levels. This includes communications from FEC and VMA field controllers to sensors and from engines to these field controllers. Wireless devices shall co-exist on the same network with hardwired devices. Hardwired controllers shall be capable of retrofit to wireless devices with no special software.

.2 The ZFR1810 Wireless Field Bus Coordinator shall provide a wireless interface between supported field controllers and an NAE35/45/55 or NCE25 supervisory controller via the BACnet MS/TP field bus. Each wireless mesh network shall be provided with a ZFR1810 Coordinator for initiation and formation of the network

.1 The ZFR Coordinator shall use direct sequence spread spectrum RF technology.

.2 The ZFR Coordinator shall operate on the 2.4 GHZ ISM Band.

.3 The ZFR Coordinator shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.

.4 The ZFR Coordinator shall be FCC compliant to CFR Part 15 subpart B Class A.

.5 The ZFR Coordinator shall operate as a bidirectional transceiver with the sensors and routers to confirm and synchronize data transmission.

.6 The ZFR Coordinator shall be capable of communication with sensors and routers up to a maximum distance of 250 Feet (line of sight).

.7 The ZFR Coordinator shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.

.8 The ZFR Coordinator shall have LED indicators to provide diagnostic information required for efficient operation and commissioning.

.3 The ZFR1811Wireless Field Bus Router shall be used with any model Field Equipment Controller (FEC) or VMA1600 series VAV Modular Assembly to provide a wireless interface to supervisory engines, via the ZFR1810

Coordinator, and associated WRZ Wireless Mesh Room Temperature Sensors. .

.1 The ZFR1811 Router shall use direct sequence spread spectrum RF technology.

.2 The ZFR1811 Router shall operate on the 2.4 GHZ ISM Band.

.3 The ZFR1811 Router shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.

.4 The ZFR1811 Router shall be FCC compliant to CFR Part 15 subpart B Class A.

.5 The ZFR1811 Router shall operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.

.6 The ZFR1811 Router shall be capable of communication with other mesh network devices at a maximum distance of 250 feet (line of sight).

.7 The ZFR1811 Router shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.

.8 The ZFR1811 Router shall provide LED indication for use in commissioning and troubleshooting that can be disabled.

.4 The WRZ-TT Series Wireless Room Temperature Sensors shall sense and transmit room temperatures, room set point, room occupancy notification low battery condition to an associated ZFR1811 Router.

.1 The WRZ Sensors shall use direct sequence spread spectrum RF technology.

.2 The WRZ Sensors shall operate on the 2.4 GHZ ISM Band.

.3 The WRZ Sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.

.4 The WRZ sensors shall be FCC compliant to CFR Part 15 subpart B Class A.

.5 The WRZ sensors shall be available with

.1 Warmer/Cooler Set Point Adjustment

.2 No Set Point Adjustment

.3 Set Point Adjustment Scale - 55 to 85° F.

.6 Wireless sensors shall be provided with display of room temperature, signal strength, fan mode, occupancy and network status as required by application and indicated on plans or in schedules.

.7 The WRZ sensors shall be assembled in NEMA 1 plastic housings.

.7 One-to-One Wireless Room Temperature Sensor System (WRZ)

.1 The One-To-One Wireless Receiver (WRS Receiver) shall receive wireless Radio Frequency (RF) signals containing temperature data from multiple Wireless Room Temperature Sensors (WRZ Sensors) and communicate this information to either FEC or VMA controllers via the Sensor/Actuator (SA) Bus.

.1 The WRZ Receiver shall use direct sequence spread spectrum RF technology.

.2 The WRZ Receiver shall operate on the 2.4 GHZ ISM Band.

.3 The WRZ Receiver shall meet the IEEE 802.15.4 standard for low-power,

low duty-cycle RF transmitting systems.

.4 The WRZ Receiver shall be FCC compliant to CFR Part 15 subpart B Class A.

.5 The WRZ Receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.

.6 The WRZ Receiver shall be capable of communication with from one to five WRZ Sensors up to a distance of 200 Feet.

.7 The WRZ Receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.

.8 The WRZ Receiver shall have LED indicators to provide information regarding the following conditions:

.1 Power

.2 SA Bus - Receiver Activity/No Activity

.3 Wireless RF - Transmission from sensors/No Transmission

.4 Wireless Rapid Transmit Mode - No transmission/ weak signal/Adequate signal/Excellent signal

.2 The WRZ Sensors shall sense and report room temperatures to the WRZ Receiver.

.1 The WRZ Sensors shall use direct sequence spread spectrum RF technology.

.2 The WRZ Sensors shall operate on the 2.4 GHZ ISM Band.

.3 The WRZ Sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.

.4 The WRZ sensors shall be FCC compliant to CFR Part 15 subpart B Class A.

.5 The WRZ sensors shall be available with

.1 Warmer/Cooler Set Point Adjustment

.2 No Set Point Adjustment

.3 Set Point Adjustment Scale - 55 to 85° F.

.6 The WRZ sensors shall be assembled in NEMA 1 plastic housings.

2.12 SYSTEM TOOLS

.1 System Configuration Tool (SCT)

.1 The Configuration Tool shall be a software package enabling a computer platform to be used as a stand-alone engineering configuration tool for a Network Automation Engine (NAE).

.2 The configuration tool shall provide an archive database for the configuration and application data.

.3 The configuration tool shall have the same look-and-feel at the User Interface (UI) regardless of whether the configuration is being done online or offline.

.4 The configuration tool shall include the following features:

.1 Basic system navigation tree for connected networks

.2 Integration of LonWorks, and BACnet enabled devices

.3 Customized user navigation trees

.4 Point naming operating parameter setting
.5 Graphic diagram configuration
.6 Alarm and event message routing
.7 Graphical logic connector tool for custom programming
.8 Downloading, uploading, and archiving databases

.5 The configuration tool shall have the capability to automatically discover field devices on connected buses and networks. Automatic discovery shall be available for the following field devices:
.1 BACnet Devices
.2 LonWorks devices

.6 The configuration tool shall be capable of programming the Field Equipment Controllers.
.1 The configuration tool shall provide the capability to configure, simulate, and commission the Field Equipment Controllers.
.2 The configuration tool shall allow the FECs to be run in Simulation Mode to verify the applications.
.3 The configuration tool shall contain a library of standard applications to be used for configuration.

.7 The configuration tool shall be capable of programming the field devices.
.1 The configuration tool shall provide the capability to configure, simulate, and commission the field devices.
.2 The configuration tool shall allow the field devices to be run in Simulation Mode to verify the applications.
.3 The configuration tool shall contain a library of standard applications to be used for configuration

.8 A wireless access point shall allow a wireless enabled portable PC to make a temporary Ethernet connection to the automation network.
.1 The wireless connection shall allow the PC to access configuration tool through the web browser using the User Interface (UI).
.2 The wireless use of configuration tool shall be the same as a wired connection in every respect.
.3 The wireless connection shall use the Bluetooth Wireless Technology.

.2 Handheld VAV Balancing Sensor

.1 The sensor shall be a light weight portable device of dimensions not more than 3.2 x 3.2 x 1.0 inches.

.2 The sensor shall be capable of displaying data and setting balancing parameters for VAV control applications.

.3 The sensor shall be powered through a connection to either the Sensor-Actuator (SA) or the Field Controller (FC) Bus.

.4 The sensor shall be a menu driven device that shall modify itself automatically depending upon what type of application resides in the controller.

.5 The sensor shall contain a dial and two buttons to navigate through the menu and to set balancing parameters.

.6 The sensor shall provide an adjustable time-out parameter that will return the

controller to normal operation if the balancing operation is aborted or abandoned.

.7 The sensor shall include the following
5 foot retractable cable
Laminated user guide
Nylon caring case

.8 The sensor shall be Underwriters Laboratory UL 916 listed and CSA certified C22.2 N. 205, CFR47.

2.13 INPUT DEVICES

.1 General Requirements

.1 Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

.2 Temperature Sensors

.1 General Requirements:

.1 Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.

.2 The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.

.3 The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	**Accuracy**
Chilled Water	+ 0.5 F°.
Room Temp	+ 0.5 F°.
Duct Temperature	+ 0.5 F°.
All Others	+ 0.75 F°.

.2 Room Temperature Sensors

.1 Room sensors shall be constructed for either surface or wall box mounting.

.2 Room sensors shall have the following options when specified:
Setpoint reset slide switch providing a +3 degree (adjustable) range.
Individual heating/cooling setpoint slide switches.
A momentary override request push button for activation of after-hours operation.
Analog thermometer.

.3 Room Temperature Sensors with Integral Display

.1 Room sensors shall be constructed for either surface or wall box mounting.

.2 Room sensors shall have an integral LCD display and four button keypad with the following capabilities:
Display room and outside air temperatures.
Display and adjust room comfort setpoint.

Display and adjust fan operation status.
Timed override request push button with LED status for activation of - after-hours operation.
Display controller mode.
Password selectable adjustment of setpoint and override modes.

.4 Thermo wells
.1 When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
.2 Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.
.3 Thermo wells and sensors shall be mounted in a threadolet or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.
.4 Thermo wells shall be constructed of 316 stainless steel.

.5 Outside Air Sensors
.1 Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
.2 Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
.3 Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

.6 Duct Mount Sensors
.1 Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
.2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
.3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

.7 Averaging Sensors
.1 For ductwork greater in any dimension that 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
.2 For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
.3 Capillary supports at the sides of the duct shall be provided to support the sensing string.

.8 Acceptable Manufacturers: Johnson Controls

.3 Humidity Sensors
.1 The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
.2 The humidity transmitter shall be equipped with non-interactive span and zero

adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.

.3 The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.

.4 Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.

.5 A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.

.6 Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.

.7 Acceptable Manufacturers: Johnson Controls, Veris Industries, and Mamac.

.4 Indoor Air Quality (CO2) Sensors

.1 Provide indoor air quality sensors to monitor Carbon Dioxide (CO2) levels in full compliance with CaGBC requirements for LEED credit EQc1.

.2 The sensors shall be of microprocessor-based photoacoustic type with heated stannic dioxide semiconductor.

.3 The CO2 sensors shall have no more than 1% drift during the first year of operation and minimal drift thereafter so that no calibration will be required.

.4 The units shall be wall mounted or duct mounted type as indicated in the sequence of operation.

.5 Wall mounted sensors shall be provided with white plastic cover, without LED indicators.

.6 Duct mounted sensors shall be provided with LED indicators in a dust proof plastic housing with transparent cover.

.5 Differential Pressure Transmitters

.1 General Air and Water Pressure Transmitter Requirements:

.1 Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.

.2 Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.

.3 Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.

.4 A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.

.2 Low Differential Water Pressure Applications (0" - 20" w.c.)

.1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow

meter differential pressure or water pressure sensing points.

.2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
.01-20" w.c. input differential pressure range.
4-20 mA output.
Maintain accuracy up to 20 to 1 ratio turndown.
Reference Accuracy: +0.2% of full span.

.3 Medium to High Differential Water Pressure Applications (Over 21" w.c.)

.1 The differential pressure transmitter shall meet the low pressure transmitter specifications with the following exceptions:
Differential pressure range 10" w.c. to 300 PSI.
Reference Accuracy: +1% of full span (includes non-linearity, hysteresis, and repeatability).

.2 Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.

.4 Building Differential Air Pressure Applications (-1" to +1" w.c.)

.1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.

.2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
-1.00 to +1.00 w.c. input differential pressure ranges. (Select range appropriate for system application)
4-20 mA output.
Maintain accuracy up to 20 to 1 ratio turndown.
Reference Accuracy: +0.2% of full span.

.3 Acceptable Manufacturers: Johnson Controls

.5 Low Differential Air Pressure Applications (0" to 5" w.c.)

.1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.

.2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
(0.00 - 1.00" to 5.00") w.c. input differential pressure ranges. (Select range appropriate for system application.)
4-20 mA output.
Maintain accuracy up to 20 to 1 ratio turndown.
Reference Accuracy: +0.2% of full span.

.3 Acceptable Manufacturers: Johnson Controls

.6 Medium Differential Air Pressure Applications (5" to 21" w.c.)

.1 The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements:
Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability.
Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 PSIG.
Thermal Effects: <+.033 F.S./Deg. F. over 40 F. to 100 F. (calibrated at 70 F.).

.2 Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.

.3 Acceptable manufacturers: Johnson Controls and Setra.

.6 Flow Monitoring

.1 Air Flow Monitoring

.1 Fan Inlet Air Flow Measuring Stations

.1 At the inlet of each fan and near the exit of the inlet sound trap, airflow traverse probes shall be provided that shall continuously monitor the fan air volumes and system velocity pressure.

.2 The airflow traverse probe shall not induce a measurable pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the air stream. Each airflow-measuring probe shall contain multiple total and static pressure sensors placed at equal distances along the probe length. The number of sensors on each probe and the quantity of probes utilized at each installation shall comply with the ASHRAE Standards for duct traversing.

.3 Airflow measuring stations shall be manufactured by Ebtron, or Johnson Controls.

.2 Single Probe Air Flow Measuring Sensor

.1 The single probe airflow-measuring sensor shall be duct mounted with an adjustable sensor insertion length of up to eight inches. The transmitter shall produce a 4-20 mA or 0-10 VDC signal linear to air velocity. The sensor shall be a hot wire anemometer and utilize two temperature sensors and a heater element temperature. The other sensor shall measure the downstream air temperature. The temperature differential shall be directly related to airflow velocity.

.3 Duct Air Flow Measuring Stations

.1 Each device shall be designed and built to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of fundamentals, as well as in the Industrial Ventilation Handbook.

.2 Airflow measuring stations shall be fabricated of 14-gauge galvanized steel welded casing with 90 Deg. connecting flanges in configuration and size equal to that of the duct into which it is mounted. Each station shall be complete with an air directionalizer and parallel cell profile suppressor (3/4" maximum cell) across the entering air stream and mechanically fastened to the casing in such a way to withstand velocities up to 6000 feet per minute. This air directionalizer and parallel cell honeycomb suppressor shall provide 98% free area, equalize the velocity profile, and eliminate turbulent and rotational flow from the air stream prior to the measuring point.

.3 The total pressure measurement side (high side) will be designed and spaced to the Industrial Ventilation Manual 16th Edition, Page 9-5. The self-averaging manifolding will be manufactured of brass and copper components.

.4 The static pressure sensing probes (low side) shall be bullet-nosed shaped, per detailed radius, as illustrated in Industrial Ventilation Manual 16th Edition, Page 9-5.

.5 The main take-off point from both the total pressure and the static pressure manifolds must be symmetrical.

.6 Total and static pressure manifolds shall terminate with external ports for connection to control tubing. An identification label shall be placed on each unit casing, listing model number, size, area, and specified airflow capacity.

.7 Acceptable manufacturers: Johnson Controls

.4 Static Pressure Traverse Probe

.1 Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.

.2 Water Flow Monitoring

.1 Water flow meters shall be electromagnetic type with integral microprocessor-Based electronics. The meter shall have an accuracy of 0.25%.

.2 Acceptable manufacturers: Onicon

.7 Power Monitoring Devices

.1 Current Measurement (Amps)

.1 Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5

Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.

.2 Current Transformer - A split core current transformer shall be provided to monitor motor amps.
Operating frequency - 50 - 400 Hz.
Insulation - 0.6 Kv class 10Kv BIL.
UL recognized.
Five amp secondary.
Select current ration as appropriate for application.
Acceptable manufacturers: Veris Industries

.3 Current Transducer - A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
6X input over amp rating for AC inrushes of up to 120 amps.
Manufactured to UL 1244.
Accuracy: +.5%, Ripple +1%.
Minimum load resistance 30kOhm.
Input 0-20 Amps.
Output 4-20 mA.
Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%)

.8 Refrigerant Leak Detectors

.1 The refrigerant leak detector shall be a standalone device and shall provide a SPDT output to directly energize the refrigeration room exhaust ventilation fans. The detector shall include a sensor or sensors connected to a control panel. Two relay contacts at the control panel shall provide trouble and alarm indication to the Facility Management System. The alarm relay contact shall also directly energize the exhaust fans.

.2 The refrigerant leak detector shall sense the type of refrigerant used in the specified chillers. Multiple sensors shall be required to detect different refrigerants and/or provide proper sensing coverage for the area of the refrigeration room.

.3 Acceptable manufacturers: Johnson Controls

.9 Status and Safety Switches

.1 General Requirements

.1 Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

.2 Current Sensing Switches

.1 The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A

conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.

.2 Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.

.3 Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

.3 Acceptable manufacturers: Johnson Controls

.4 Air Filter Status Switches

.1 Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.

.2 A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.

.3 Provide appropriate scale range and differential adjustment for intended service.

.5 Acceptable manufacturers: Johnson Controls

.6 Air Flow Switches

.1 Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

.7 Acceptable manufacturers: Johnson Controls

.8 Air Pressure Safety Switches

.1 Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.

.2 Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

.9 Acceptable manufacturers: Johnson Controls

.10 Water Flow Switches

.1 Water flow switches shall be equal to the Johnson Controls P74.

.11 Low Temperature Limit Switches

.1 The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.

.2 The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.

.3 For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

.4 The low temperature limit switch shall be equal to Johnson Controls A70.

2.14 OUTPUT DEVICES

.1 Actuators
 .1 General Requirements
  .1 Damper and valve actuators shall be electronic, as specified in the System Description section.
 .2 Electronic Damper Actuators
  .1 Electronic damper actuators shall be direct shaft mount.
  .2 Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.
  .3 Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
  .4 Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.
 .3 Acceptable manufacturers: Johnson Controls
 .4 Electronic Valve Actuators
  .1 Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
  .2 Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized Based on valve manufacturer's recommendations for flow and pressure

differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.

.3 Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

.4 Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.

.5 Acceptable manufacturers: Johnson Controls

.2 Control Dampers

.1 The BMS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the Drawings.

.2 All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.

.3 All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.

.4 Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.

.5 Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g.

.6 One piece rolled blade dampers with exposed or concealed linkage may be

used with face velocities of 1500 FPM or below. Acceptable manufacturers are: Ruskin CD36, and Tamco.

.7 Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

.3 Control Relays

.1 Control Pilot Relays

.1 Control pilot relays shall be of a modular plug-in design with retaining springs or clips.

.2 Mounting Bases shall be snap-mount.

.3 DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.

.4 Contacts shall be rated for 10 amps at 120VAC.

.5 Relays shall have an integral indicator light and check button.

.2 Acceptable manufacturers: Johnson Controls

.4 Control Valves

.1 All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Specification.

.2 Chilled water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Modulating water valves shall be sized per manufacturer's recommendations for the given application. In general, valves (2 or 3-way) serving variable flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no less than 5 PSI. Valves (3-way) serving constant flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.

.3 Ball valves shall be used for hot and chilled water applications, water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units except those described hereinafter.

.4 Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all special applications as indicated on the valve schedule. Valve discs shall be composition type. Valve stems shall be stainless steel.

.5 Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless steel vane. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.

.6 Acceptable manufacturers: Johnson Controls

2.15 AUXILIARY CONTROL DEVICES

.1 General

.1 Specified in this section are the following hard wired input/output devices connected to the Building Controller or ASC.

.1 Automatic Dampers
.2 Electric Damper Actuators
.3 Automatic Control Valves
.4 Binary Temperature Devices
.5 Temperature Sensors
.6 Humidity Sensors
.7 Indoor Air Quality (CO2/VOC) Space Sensors
.8 Relays
.9 Current Switches
.10 Local Control panels

.2 Electric Damper Actuators

.1 General

.1 The actuator shall have mechanical or electronic stall protection to prevent damage to the actuator throughout the rotation of the actuator.

.2 Where shown, for power-failure/safety applications, an internal mechanical, spring-return mechanism shall be built into the actuator housing. Alternatively, an uninterruptible power supply (UPS) may be provided. On terminal unit valves actuators capacitor driven fail action is permitted.

.3 Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range.

.4 All 24 VAC/VDC actuators shall operate on Class 2 wiring.

.5 All actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring-return actuators with more than 7 Nm (60 in.-lb) torque capacity shall have a manual crank for this purpose.

.6 Electric actuators for emergency generator damper control shall be rated for 350 degree F. maximum operating temperature and capable to drive fully open and close within 15 seconds.

.7 Acceptable manufacturer Siemens Building Technologies, Johnson Controls, Honeywell & Belimo.

.3 Automatic Control Valves

.1 General:

.1 Control valves shall be two-way or three-way type single seated globe type for two-position or modulating service as shown. Valves shall meet ANSI Class IV leakage rating.

.2 Body pressure rating and connection type construction shall conform to pipe, fitting and valve schedules. Where pressure and flow combinations exceed ratings for commercial valves and operators, industrial class valves and operators shall be provided.

.3 Valve operators shall be of electric type.

.4 The valves shall be quiet in operation and fail-safe in either normally open or normally closed position in the event of power failure.

.5 Control valve operators shall be sized to close against a differential pressure equal to the design pump head plus 10 percent.

.6 Furnish differential pressure control valves for all water systems as shown on plans and/or specified in the sequence of operations.

.7 Provide valves 2" and smaller with screwed end bronze bodies and stainless steel trim. Provide valves 2-1/2" and larger with flanged ends, cast iron body and stainless steel trim.

.8 For modulating service that require large valve size (above 6"), such as cooling tower temperature bypass, chiller head pressure ,etc. where proper control with globe type control valve cannot be achieved or the application is not economical butterfly or v-port ball valves are allowed.

.9 Acceptable manufacturer Siemens Building Technologies, Johnson Controls & Honeywell.

.2 Water Valves:

.1 Control valves shall be of equal percentage flow characteristics for modulating service.

.4 Binary Temperature Devices

.1 Line-voltage space thermostat:

.1 Line-voltage thermostats shall be bimetal-actuated, snap acting SPDT contact, enclosed, UL listed for electrical rating. The thermostat cover shall provide exposed set point adjustment knob. The thermostat shall operate within the 55°F to 85°F setpoint range, with 2°F maximum differential.

.2 Low-temperature safety thermostat:

.1 Low-limit air stream thermostats shall be UL listed, vapor pressure type, with a sensing element of 20 ft. minimum length. Element shall respond to the lowest temperature sensed by any 1 ft. section. The low-limit thermostat shall be automatic reset, SPDT type.

.5 Temperature Sensors

.1 Provide the following instrumentation as required by the monitoring, control and optimization functions. All temperature sensor shall use platinum RTD elements only, nickel or silicon are not acceptable. All control signals shall be via a 4-20 mA loop.

.2 Room Temperature:

.1	Temperature monitoring range	+40/+90 F (+40/120 F for high temp alarms)
.2	Output signal	4-20 mA
.3	Installation adjustments	none required
.4	Calibration adjustments	zero & span
.5	Factory calibration point	70 deg F
.6	Accuracy at calibration point	+0.5 F

.3 Liquid Immersion Temperature

.1	Temperature monitoring range	+20/+120 F or +70/+220 F
.2	Output signal	4-20 mA
.3	Installation adjustment	none required
.4	Calibration adjustments	zero & span
.5	Factory calibration point	70 deg F
.6	Accuracy at calibration point	+0.5 F

.4 Duct (Single Point) Temperature

.1	Temperature monitoring range	+20/+120 F
.2	Output signal	4-20 mA
.3	Installation adjustments	none required
.4	Calibration adjustments	zero & span
.5	Factory calibration point	70 deg F
.6	Accuracy at calibration point	+0.5 F

.5 Duct (Averaging) Temperature

.1	Temperature monitoring range	+20/+120 F
.2	Output signal	4 - 20 mA
.3	Installation adjustments	none required
.4	Calibration adjustments	zero & span
.5	Factory calibration point	70 deg F
.6	Accuracy at calibration point	+0.5 F

.6 Outside Air Temperature

.1	Temperature monitoring range	-50/+122
.2	Output signal	4-20 mA
.3	Installation adjustments	none required
.4	Calibration adjustments	zero & span
.5	Factory calibration point	70 deg F
.6	Accuracy at calibration point	+0.5 F

.6 Dew Point/Humidity Sensors

.1 Outside Air Dew Point Temperature

.1	Dew point monitoring range	-40/+115 F DP, 12% to 99% RH
.2	Output signal	4-20 mA

.3	Calibration adjustments	zero & span
.4	Factory calibration point	70 F
.5	Accuracy at calibration point	+2.0 Fdp

.2 Room/duct Relative Humidity

.1	Sensor Humidity range	0 to 100%
.2	Operating temperature	15 F to +170 F
.3	Accuracy	+2% RH
.4	Sensing element	Capacitive sensor
.5	Output signal	4-20 mA DC
.6	Installation adjustments	zero & span
.7	Operating temperature	15 F to +170 F
.8	Voltage requirement	12-36 VDC

.7 Pressure Sensors

.1 Air Static Pressure Sensor

.1	Duct Static range	-.5 to + 7.5"wg
.2	Accuracy	+ .05" w.g.
.3	Output signal	4 - 20 mA

.8 Indoor Air quality (CO2/VOC) Sensors

.1 Provide indoor air quality sensors to monitor Carbon Dioxide (CO2) and Volatile Organic Compound (VOC) levels.

.2 The sensors shall be of microprocessor-based photoacoustic type with heated stannic dioxide semiconductor.

.3 The CO2 sensors shall have no more than 1% drift during the first year of operation and minimal drift thereafter so that no calibration will be required.

.4 The units shall be wall or duct mounted type as indicated on plans and in the sequence of operation.

.5 Wall mounted sensors shall be provided with white plastic cover, without LED indicators.

.6 Duct mounted sensors shall be provided with LED indicators in a dust proof plastic housing with transparent cover.

.7 The VOC sensor shall have automatic self calibrating capability to ensure accuracy.

.8 The sensor shall meet the following requirements:

.1	Operating voltage:	24 VAC +/- 20%
.2	Frequency:	50/60 Hz
.3	Power consumption:	max. 6 VA
.4	CO2 measuring range:	0 - 2000 ppm
.5	Tolerance:	+/- 100 ppm
.6	Output:	0 - 10 VAC
.7	Calibration:	none required
.8	VOC measurement range:	0 - 10 V VOC
.9	Permissible air velocity in duct:	<26.2 Ft/s.

.9 Relays

.1 Control relays shall be UL listed plug-in type with dust cover and LED

"energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

.10 Current Switches

.1 Current-operated switches shall be self-powered, solid-state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

2.16 MISCELLANEOUS DEVICES

.1 Local Control Panels

.1 All control panels shall be factory constructed, incorporating the BMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.

.2 In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices-such as relays, transducers, and so forth-that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.

.3 All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.

.4 Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.

.5 All wiring shall be neatly installed in plastic trays or tie-wrapped.

.6 A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

.2 Power Supplies

.1 DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.

.2 Input: 120 VAC +10%, 60Hz.

.3 Output: 24 VDC.

.4 Line Regulation: +0.05% for 10% line change.

.5 Load Regulation: +0.05% for 50% load change.

.6 Ripple and Noise: 1 mV rms, 5 mV peak to peak.

.7 An appropriately sized fuse and fuse block shall be provided and located next to the power supply.

.8 A power disconnect switch shall be provided next to the power supply.

.3 Thermostats

.1 Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

3 EXCECUTION

3.1 GENERAL

.1 The Building Management System (BMS) shall be fully integrated, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as hereinafter specified.

.2 The BMS shall be an open architecture with the capabilities to support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards but shall not be limited to their use only. The BMS shall also be able to and integrate a wide variety of third-party devices and applications via existing vendor protocols and through the latest software standards.

.3 The Metasys system operating software shall be the latest generation.

.4 The BMS shall be capable of;

.1 LonWorks communication using the LonTalk protocol as required,

.2 BACnet communication according to ASHRAE standard SPC-135A/95,

.3 OPC server communications to OPC Data Access 2.0 and Alarms & Events 1.0.

.5 The system shall be designed for use on the Internet, or intranets using off-the-shelf industry standard technology, compatible with other Owner provided networks.

.6 The complete temperature control system shall be DDC with electric actuation as specified herein.

.7 All wiring, conduit, panels, and accessories for a complete operational system.

.8 BMS Contractor shall be responsible for all electrical work associated with the BMS.

.1 Perform all wiring in accordance with all local and national codes.

.2 Install all line voltage wiring, concealed or exposed, in conduit in accordance ith the division 16 specifications, NEC and local building code.

.3 Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers and operator's workstations.

.9 The open protocol building management system shall be as follows:

.1 Capable of high speed Ethernet communication using TCP/IP protocol.

.2 The system shall be capable of supporting both standard and vendor specific protocols to integrate a wide variety of third-party devices and legacy systems.

.3 The system shall be capable of supporting wireless secondary level networks and sensor communications using a mesh topology and IEEE 802.15.4 network.

.4 The intent is to either use the Operator Workstation provided under this contract to communicate with control systems provided by other vendors or to allow information about the system provided in this contract to be sent to another workstation. This allows the user to have a single seat from which to perform daily operation.

.10 Provide system graphics for each controlled device and/or integrated systems as required by the owner. Origin of information shall be transparent to the operator and shall be controlled, displayed, trended, etc. as if the points were hardwired to the BMS.

.11 One (1) Personal computer operator workstation, associated peripherals and equipment required to set up dynamic color graphic PC console at the Chief Engineer's Office.

.12 Primary DDC panels as follows:

.1 Minimum one (1) BMS system Primary DDC panel per floor. The application specific controllers installed for the terminal units on a floor will be connected to the BMS panel on the same floor.

.2 Minimum one (1) BMS system Primary DDC panel per each major mechanical system:

.1 Air Handling Unit

.3 It shall be acceptable to combine up to three (3) of the following mechanical equipment into one (1) Primary DDC panel:

.1 Exhaust Fans

.2 Standalone Supply Fans

.3 Package AC Units

.4 It is acceptable to wire the following systems into any of the Primary DDC panels:

.1 Miscellaneous alarm monitoring (i.e. ATS, leak, temperature, light …etc.)

.2 Miscellaneous equipment (i.e. Unit Heater, Domestic Water Heater, Standalone Dampers …etc.)

.5 Motors in motor control centers shall be controlled from the DDC controller associated with HVAC system. It shall not be acceptable to control all motors in a MCC from one DDC controller dedicated to the MCC. The intent of this specification is that the loss of any one DDC controller shall not affect the operation of other HVAC systems, only for the points connected to the DDC controller.

.13 Stand-alone Application Specific Controllers (ASCs) for terminal equipment (CAV, FP VAV, and VAV units, and fan coil units).

3.2 EXAMINATION

.1 The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.

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

.3 The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate-or if any

discrepancies occur between the plans and the contractor's work and the plans and the work of others-the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others.

3.3 PROTECTION

.1 The contractor shall protect all work and material from damage by its employees and/or subcontractors and shall be liable for all damage thus caused.

.2 The contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted.

3.4 COORDINATION

.1 Site

.1 The project coordination between trades is the responsibility of the prime contractor who is the one tier higher contractual partner such as mechanical contractor, general contractor as applicable.

.2 The controls contractor shall follow prime contractor's job schedule and coordinate all project related activities through the prime contactor except otherwise agreed or in minor job site issues. Reasonable judgment shall be applied.

.3 Where the work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment.

.4 If the contractor deviates form the job schedule and installs work without coordinating with other trades, so as to cause interference with work of other trades, the contractor shall make the necessary changes to correct the condition without extra charge.

.5 Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

.2 Test and Balance

.1 The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.

.2 In addition, the contractor shall provide a qualified technician for duration of 8 hours to assist in the test and balance process.

3.5 COORDINATION OF WORK BY OTHERS

.1 The demarcation of work and responsibilities between the BMS Contractor and other related Divisions shall be as outlined below in the BMS RESPONSIBILITY MATRIX. This Section shall be responsible for coordinating all work with other parties.

BMS RESPONSIBILITY MATRIX				
WORK	**SUPPLY**	**INSTALL**	**LOW. VOLT. WIRING/ CONDUIT**	**POWER WIRING/ CONDUIT**
BMS low voltage and communication wiring	BMS	BMS	BMS	N/A
BMS conduits and raceway	BMS	BMS	BMS	BMS
VAV box controls	BMS	15	BMS	16
Pipe insertion devices and taps including termowells, flow and pressure station	BMS	15	BMS	BMS
Automatic valves	BMS	15	BMS	N/A
Automatic dampers	BMS	15	N/A	N/A
Automatic damper actuators	BMS	BMS	BMS	16
Fire/Smoke Dampers	15	15	16	16
Fire Dampers	15	15	N/A	N/A
Smoke Detectors	16	16	16	16
Fire Alarm shutdown relay interlock wiring	16	16	16	16
Fire Alarm smoke control relay interlock wiring	16	16	16	16
Fireman's Smoke Control Override Panel	16	16	16	16
Boiler & Chiller flow switches	15	15	BMS	N/A
Boiler & Chiller wiring	15	15	15	15
Water treatment system	15	15	15	16
VFDs	15	16	BMS	16
Refrigerant monitors	15	BMS	BMS	16
Computer Room A/C Unit field-mounted controls	15/BMS	BMS	BMS	16
Fan Coil Unit controls	BMS	BMS	BMS	16
Unit Heater controls	BMS	BMS	BMS	16
Packaged RTU field-mounted controls	15/BMS	BMS	BMS	16

3.6 GENERAL WORKMANSHIP

.1 Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

.2 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

.3 Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).

.4 Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

.5 All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.7 INSTALLATION PRACTICES

.1 BMS Wiring

.1 All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this section.

.2 All BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations.

.3 Class 2 Wiring

.1 All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.

.2 Class 2 wiring in concealed accessible locations shall be FT-6 plenum rated.

.3 Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.

.4 Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.

.5 Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

.2 BMS Line Voltage Power Source

.1 120-volt AC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 16.

.2 Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.

.3 DDC terminal unit controllers may use AC power from motor power circuits.

.3 BMS Raceway

.1 All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2".
.2 Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
.3 All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
.4 Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

.4 Penetrations
.1 Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.
.2 All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
.3 All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
.4 Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

.5 BMS Identification Standards
.1 Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.
.2 Cable types specified in Item A shall be color coded for easy identification and troubleshooting.

.6 BMS Panel Installation
.1 The BMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
.2 The BMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

.7 Input Devices
.1 All Input devices shall be installed per the manufacturer recommendation
.2 Locate components of the BMS in accessible local control panels wherever possible.

.8 HVAC Input Devices - Genera1
.1 All Input devices shall be installed per the manufacturer recommendation
.2 Locate components of the BMS in accessible local control panels wherever possible.
.3 The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
.4 Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.
.5 Outside Air Sensors

.1 Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
.2 Sensors shall be installed with a rain proof, perforated cover.

.6 Water Differential Pressure Sensors
.1 Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device.
.2 Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
.3 The transmitters shall be installed in an accessible location wherever possible.

.7 Medium to High Differential Water Pressure Applications (Over 21" w.c.):
.1 Air bleed units, bypass valves and compression fittings shall be provided.

.8 Building Differential Air Pressure Applications (-1" to +1" w.c.):
.1 Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
.2 The interior tip shall be inconspicuous and located as shown on the drawings.

.9 Air Flow Measuring Stations:
.1 Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct.
.2 Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.

.10 Duct Temperature Sensors:
.1 Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
.2 The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
.3 For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
.4 The sensor shall be mounted to suitable supports using factory approved element holders.

.11 Space Sensors:
.1 Shall be mounted per ADA requirements.
.2 Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.

.12 Low Temperature Limit Switches:
.1 Install on the discharge side of the first water or steam coil in the air stream.
.2 Mount element horizontally across duct in a serpentine pattern insuring

each square foot of coil is protected by 1 foot of sensor.

.3 For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.

.13 Air Differential Pressure Status Switches:

.1 Install with static pressure tips, tubing, fittings, and air filter.

.14 Water Differential Pressure Status Switches:

.1 Install with shut off valves for isolation.

.9 HVAC Output Devices

.1 All output devices shall be installed per the manufacturers' recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.

.2 Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.

.3 Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.

.4 Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.

.5 Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Management System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

3.8 FIELD QUALITY CONTROL

.1 All work, materials, and equipment shall comply with the rules and regulations of applicable local, provincial and federal codes and standards.

.2 Contractor shall continually monitor the field installation for code compliance and quality of workmanship.

3.9 WIRING

.1 All control and interlock wiring shall comply with national and local electrical codes and Division 16 of this specification. Where the requirements of this section differ from those in Division 16, the requirements of this section shall take precedence.

.2 All NEC Class 1 (line voltage) wiring shall be UL Listed in approved conduit according to NEC and Division 16 requirements.

.3 All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage

power circuits shall be sub fused when required to meet Class 2 current limit.)

.4 Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in conduit may be used provided that cables are UL Listed for the intended application. For example, cables used in ceiling plenums shall be UL Listed specifically for that purpose.

.5 All wiring in mechanical, electrical, or service rooms-or where subject to mechanical damage- shall be installed in conduit.

.6 Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

.7 Do not install wiring in conduit containing tubing.

.8 Where plenum rated cable is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft) intervals.

.9 Where plenum rated cable is used without conduit, it shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical conduits, piping, or ceiling suspension systems.

.10 All wire-to-device connections shall be made at a terminal block or wire nut. All wire-to-wire connections shall be at a terminal strip or wire nut.

.11 All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

.12 Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers or interposing relays.

.13 All plenum rated wiring shall be installed as continuous lengths, with no splices permitted between termination points

.14 All wiring in conduit shall be installed as continuous lengths, with no splices permitted between termination points or junction boxes.

.15 Maintain fire rating at all penetrations. Install plenum wiring in sleeves where it passes through walls and floors.

.16 Size and type of conduit and size and type of wire shall be the responsibility of the contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.

.17 Include one pull string in each conduit 3/4 in. or larger.

.18 Control and status relays are to be located in designated enclosures only. These enclosures can include packaged equipment control panel enclosures unless they also contain Class 1 starters.

.19 Conceal all conduit, except within mechanical, electrical, or service rooms. Install conduit to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g., steam pipes or flues).

.20 Secure conduit with conduit clamps fastened to the structure and spaced according to code requirements. Conduit and pull boxes may not be hung on

flexible duct strap or tie rods. Conduits may not be run on or attached to ductwork.

.21 Adhere to this specification's Division 16 requirements where conduit crosses building expansion joints.

.22 The Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

.23 Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal conduit less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

.24 Conduit must be adequately supported, properly reamed at both ends, and left clean and free of obstructions. Conduit sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.10 COMMUNICATION WIRING

.1 The contractor shall adhere to the items listed in the "Wiring" article in Part 3 of the specification.

.2 All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

.3 Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

.4 Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

.5 Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

.6 When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to the manufacturer's instructions.

.7 All runs of communication wiring shall be unspliced length when that length is commercially available.

.8 All communication wiring shall be labeled to indicate origination and destination data.

.9 Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.11 INSTALLATION OF SENSORS

.1 General:

.1 Install sensors in accordance with the manufacturer's recommendations.

.2 Mount sensors rigidly and adequately for the environment within which the sensor operates.

.3 Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

.4 All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

.5 Sensors used in mixing plenums and hot and cold decks shall be of the averaging type.

.6 Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across the full face of the coil.

.7 All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

.8 Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.

.2 Room Instrument Mounting

.1 Room instruments, including but not limited to wall mounted thermostats and sensors located in occupied spaces shall be mounted 53 inches above the finished floor unless otherwise shown.

.3 Instrumentation Installed in Piping Systems

.1 Thermometers and temperature sensing elements installed in liquid systems shall be installed in thermowells.

.2 Gauges in piping systems subject to pulsation shall have snubbers.

.3 Gauges for steam service shall have pigtail fittings with isolation valve.

.4 Duct Smoke Detectors

.1 Duct smoke detectors will be provided by the Fire Alarm System Contractor in supply and return air ducts in accordance with Division 16

.2 Contractor shall connect the DDC System to the auxiliary contacts provided on the Smoke Detector as required for system safeties and to provide alarms to the DDC system.

.5 Averaging Temperature Sensing Elements

.1 Sensing elements shall be installed in a serpentine pattern.

.2 Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

.6 Relative Humidity Sensors

.1 Relative humidity sensors in supply air ducts shall be installed at least 3m (10 feet) downstream of humidity injection elements.

3.12 ACTUATORS

.1 Mount and link control damper actuators according to manufacturer's instructions.

.1 To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.

.2 Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

.3 Provide all mounting hardware and linkages for actuator installation.

.2 Electric/Electronic

.1 Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.

.2 Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

.3 Identification of Tubing and Wiring

.1 All wiring and cabling including that within factory-fabricated panels shall be labeled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.

.2 Permanently label or code each point of field terminal strips to show the instrument or item served.

.3 All pneumatic tubing shall be labeled at each end within 5 cm (2 in.) of termination with a descriptive identifier.

3.13 IDENTIFICATION OF HARDWARE AND WIRING

.1 All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.

.2 All pneumatic tubing shall be labeled at each end within 5 cm (2 in.) of termination with a descriptive identifier.

.3 Permanently label or code each point of field terminal strips to show the instrument or item served.

.4 Identify control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.

.5 Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.

.6 Identify room sensors relating to terminal box or valves with nameplates.

.7 Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

.8 Identifiers shall match record documents.

3.14 PROGRAMMING

.1 Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% of available memory free within the primary controller for future use.

.2 Point Naming: System point names shall be modular in design and shall be identical to the existing nomenclature(s), allowing easy operator interface

without the use of a written point index. Point Naming standard shall be agreed upon between owner and BAS contractor. Refer to Submittals section in the General Section.

.3 Software Programming

.1 Provide programming for the system and adhere to the sequences of operation provided. The contractor also shall provide all other system programming necessary for the operation of the system, but not specified in this document. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation and be of different font and color in text editor. Use the appropriate technique based on one of the following programming types:

.1 Text-based:

.1 Must provide actions for all possible situations

.2 Must be modular and structured

.3 Must be commented

.4 Must provide line by line programing and compilation wizard to allow for ease of editing.

.2 Graphic-based:

.1 Must provide actions for all possible situations

.2 Must provide programing and compilation wizard to allow for ease of editing.

.3 Must be documented

.4 Operator Interface

.1 Standard graphics-Provide graphics for all mechanical systems and floor plans of the building identical to the existing representations. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as set points.

.2 Show terminal equipment information on a "graphic" summary table. Provide dynamic information for each point shown.

.3 The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

.4 Contractor shall provide necessary programming to create all reports refered to in Part 2 Operator Interface Software

3.15 CONTROL SYSTEM CHECKOUT AND TESTING

.1 Phase I - Field I/O Commissioning

.1 Verify that each control panel has been installed according to plans, specifications and approved shop drawings. Calibrate, test, and have signed

off each control sensor and device.

3.16 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

.1 Demonstration

.1 Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.'

.2 The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The engineer will be present to observe and review these tests. The engineer shall be notified at least 10 days in advance of the start of the testing procedures.

.3 The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.

.4 The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.

.5 As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.

.6 Demonstrate compliance with Part 1, "System Performance."

.7 Demonstrate compliance with sequences of operation through all modes of operation.

.8 Demonstrate complete operation of operator interface.

.2 Acceptance

.1 All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.

.2 The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

3.17 BMS SPECIFIC REQUIREMENTS

.1 Graphic Displays
.1 Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
.2 User shall access the various system schematics via a graphical penetration scheme and/or menu selection.
.2 Custom Reports, provide custom reports as follows for this project:
.1 Energy Overview
.2 Consumption
.3 Energy Production
.4 Electrical Energy - Consumption and Demand
.5 Simple Cost
.6 Equipment Runtime
.7 Load Profile
.3 Actuation / Control Type
.1 Primary Equipment
.1 Controls shall be provided by equipment manufacturer as specified herein.
.2 Damper and valve actuation shall be electric with spring return to failsafe position as indicated in the sequence of operation.
.3 Where modulation is required, associated damper and valve actuation shall utilize proportional signal, 0-10VDC or 4-20mA, incremental or pulse-type actuation will not be accepted.
.2 Air Handling Equipment
.1 All air handlers shall be controlled with a HVAC-DDC Controller
.2 All damper and valve actuation shall be electric and spring return to failsafe position.
.3 Where modulation is required, associated damper and valve actuation shall utilize proportional signal, 0-10VDC or 4-20mA, incremental or pulse-type actuation will not be accepted.
.3 Terminal Equipment:
.1 Terminal Units (VAV, UV, radiation, convection, FCU, etc.) shall have electric damper and valve actuation.
.2 All Terminal Units shall be controlled with HVAC-DDC Controller
.3 Where modulation is required, associated damper and valve actuation shall utilize proportional signal, 0-10VDC or 4-20mA, incremental or pulse-type actuation will not be accepted.

3.18 COMMISSIONING

.1 Fully commission all aspects of the Building Management System work.
.2 Acceptance Check Sheet
.1 Prepare a check sheet that includes all points for all functions of the BMS as indicated on the point list included in this specification.
.2 Submit the check sheet to the Consultant for approval

.3 The Consultant will use the check sheet as the basis for acceptance with the BMS Contractor.

.3 Promptly rectify all listed deficiencies and submit to the Engineer that this has been done.

.4 On completion of in-house commissioning, notify Commissioning Agent and arrange for and complete commissioning requirements of Section 13025.

3.19 CLEANING

.1 The contractor shall clean up all debris resulting from their activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

.2 At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

.3 At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.20 TRAINING

.1 The BMS contractor shall provide the following training services:

.1 One day of BMS Operator Training by a BMS specialist.

.1 BMS architecture overview.
.2 Help File System.
.3 Basic Navigation of the System with the User Interface.
.4 Commanding Objects.
.5 Scheduling.
.6 Setting up Alarms.
.7 Responding to Alarms.
.8 Trending.
.9 Totalization.
.10 Setting up Passwords.
.11 User Views.
.12 Audit Trails.
.13 Sending Reports to Printers, Pagers, Emails, etc.

.2 One-half day (4 hours each) of on-site orientation on two (2) separate occasions 3-months apart, by a BMS technician who is fully knowledgeable of the specific installation details of the project. This orientation shall consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

END OF SECTION

Waterloo Regional Health Network (WRHN)

Positron Emission Tomography (PET) CT Scanner

APPENDIX A

Planned Work ICRA Matrix Form

September 2026

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Appendix A: Preventive Measures Analysis- to be completed during the planning stages of construction/renovation/redevelopment/maintenance

Project and Location: PET CT Scan, WRHN @ Midtown
Rooms: 1F, 1G CAIP, Nuclear Medicine and "Clean" Equipment Storage space 2F/2G

Proposed Start Date and Length of Project: September 2026, 1 mo duration

Description of Work:

Installation of new PET CT Scanner

- Within existing Nuclear Medicine space:
  - Wall demolition of the existing back wall, construction of a cleanable sliding door to hide/ protect associated equipment/ cooling etc
  - Cabling for new equipment
- Coring below into 1G CAIP affecting three rooms to attach baseplate for table and camera
- Removal of ceiling for installation of HVAC and associated connections
- Repair/ reinforcement of lead lining of walls, potentially requiring removal of all drywall, pending analysis

Renovation of equipment space for new Nuclear Medicine Injection Rooms

- Utilizing existing supply storage space adjacent to ICUA, New Construction of new injection space for Nuc Med
- Renovation of currently unfinished space, allowing for access to plumbing, mechanical, and electrical services from within
- Installation of separation walls, dropped ceiling, washrooms,
  - Includes Injection Rooms, office, EVS closet, Stretcher area.
- Coring below into 1F MH affecting three rooms to tie-in plumbing

Existing Hot Lab-

- Coring/ cutting of existing stainless steel table, and installation of holder for radioactive waste collection to improve workflow

Patient population in space and surrounding will continue to occupy space

Preventive Measures Analysis:

Type of construction activity as per CSA Stds A, B, C, or D: D

Patient Population Risk Group 1, 2, 3, 4: 3

Preventive Measure (I, II, III, IV): IV

Other areas impacted (e.g., , above, below or adjacent to construction or connected by ducts, conduit space): 1F MH (115, 116, 117), 1G CAIP (119, 120, 121)

Additional requirements: (include additional information or drawings as necessary):

Negative Air will be out the existing windows for all spaces.
Hoarding in 1F and 1G will be solid wall in consideration of patient population.
Man door to be created with window within 1G rooms to alleviate the need for traffic using 1G CAIP doors if possible.
Existing ICU storage room to be decanted (clinical implications recognized)
Confirmation of separate ventilation system/ ability to close ventilation system to ICU to minimize impact
Full rigid hoarding required to true deck, with all perforations sealed in full perimeter
Prefer full closure of ICU double doors on both sides for duration of project at connecting point (double layer plastic is adequate if fire / emergency access is required) with change in staff/ patient traffic patterns
Contractor traffic to be from back door at ground
All supplies and equipment to be maintained as closed and clean, with no potential impact from elements
Contractor to be reminded to maintain site as clean daily.

Contractor: TBD

Contact Person: **Phone #:**	**Pager#:**
Engineering/Maintenance MRP: Janella Lasam, Marko Sekulov	
IPAC Practitioner: Karen Straus, Nicolas Orrego 519-502-4862	
Analysis completed by: Signature:	**Date:** Jul 23, 2025

General Instructions: Use the tables in the following order to determine the required Infection Prevention and Control Measures and Precautions

1. Use table 1 to identify the **Type of Construction Activity.**
2. Use table 2 to identify the **Patient Risk Groups** affected by the construction activity.
3. Use table 3 to find the **Class of Precautions** by matching the **Patient Risk Group** with the **Type of Construction Activity**.
4. After following the previous 3 steps, refer to **table 4** for a brief description of the required infection control precautions. Refer to the main body of the policy for additional Preventive Measures that must be followed during construction and renovation procedures.

TABLE 1. Construction Activity Type

The type of work to be done impacts the measures required to complete it safely. The following is a list of frequent activities. If the planned work is not listed, please consult the CSA standard Z317.13-12 "Infection Control during Construction, Renovation and Maintenance of Healthcare Facilities" and/or consult with Infection Prevention and Control

Type A	**Inspection and Non-Invasive Activities *i**ncludes, but not limited to:* • Activities that require single controlled opening in a wall or ceiling for minor work or visual inspection by removing no more than one ceiling or access panel • Painting or wall covering Electrical trim work, • Minor plumbing that disrupts water supply (hot water supply not affected) for less than 15 min. in localized patient care area (ie/ one room) • Other maintenance activities which do not generate dust or require cutting of walls or access to ceilings other than for visual inspection
Type B	**Small scale, short duration, minimal dust activities** *includes but not limited to:* • Activities that require access to and use of chase spaces • Cutting a small opening in a contained space where dust migration can be controlled e.g. cutting of walls or ceilings to provide an access point for installing or repairing minor electrical work, ventilation components, telephone wires, or computer cables • Sanding, or repair of small area of walls Plumbing work that disrupts water supply for less than 30 min in more than one patient care area
Type C	**Activities that generates a moderate to high level of dust, cause a moderate service disruption, requires demolition or removal of any fixed facility component (e.g., a sink) or assembly (e.g., a countertop or cupboard) or cannot be completed in a single work shift *i**ncludes but is not limited to:*** • Sanding of walls in preparation for painting or wall covering • Removal of existing drywall floor coverings, ceiling tiles and casework • New wall construction • minor duct work • Electrical work above ceilings • major cabling activities • Plumbing work that disrupts water supply for more than 30 minutes but less than 1 hour in more than one patient care area

Type D	**Activities that generate high level of dust, activities that necessitate significant service disruptions and major demolition and construction activities requiring consecutive work shifts to complete** *includes but is not limited to:* • Activities requiring heavy demolition or removal of a complete cabling system • New construction that requires consecutive work shifts • Plumbing work that disrupts water supply for greater 1 hour or more in more than one patient care area • Soil excavation

Table 2. Population Risk Groups and Geographical Areas

Population Risk Group	Typical Areas
Group 1 **Lowest risk**	• Office areas • Unoccupied wards • Public areas Laundry and soiled linen sorting or storage areas • Physical plant workshops • Housekeeping rooms and closets
Group 2 **Medium risk**	• Patient care areas, unless listed in Group 3 or Group 4 • Outpatient clinics (except oncology and surgery) • Admission and discharge units • Waiting rooms • Autopsy and morgue • Occupational therapy areas remote from patient care areas • Physical therapy areas remote from patient care areas
Group 3 **Medium to high risk**	• Emergency (except trauma rooms) • Diagnostic imaging • Labour and birthing rooms without OR capacity • Nurseries for healthy newborns • **Nuclear medicine (Above 1G CAIP)** • Hydrotherapy • Echocardiography • Laboratories • General medical and surgical wards (includes all areas including soiled and clean utility rooms) • Pediatrics • Geriatrics • Long-term care • **Mental health - main entrance and rooms (Existing storage space is above 1F MH) F169 /F170** • Food preparation, serving, and dining areas • Respiratory therapy • Clean linen handling and storage areas
Group 4 **Highest risk**	• **Intensive care units (ICUs) (Existing storage space is adjacent to 2F ICU)** • Operating rooms (including prep, induction, post-anesthetic

	care unit (PACU), and scrub areas) • Anaesthesia storage areas and workrooms • Oncology units and outpatient clinics for cancer patients • Transplant units and outpatient clinics for transplant patients • Wards and outpatient clinics for patients with AIDS or other immunodeficiency diseases • Dialysis units • Critical care nurseries (NICU) • Labour and delivery operating rooms • Cardiac catheterization and angiography • Interventional radiology • Diagnostic Imaging • Cardiovascular and cardiology patient areas • Endoscopy • Pharmacy admixture rooms • Medical device reprocessing • Clean and sterile storage • Burn care units • Animal rooms • Trauma rooms • Protective environment isolation rooms • Tissue culture laboratories • Bronchoscopy • Cystoscopy • Pacemaker insertion rooms • Dental procedure rooms

Table 3: Risk Matrix:
Class Precautions for Construction Projects by Patient Risk (Class I,II,III, IV)

Patient Risk Group	Type A	Type B	Type C	Type D
Group 1 (low)	**I**	**II**	**II**	**III/IV**
Group 2 (medium)	**I**	**II**	**III**	**IV**
Group 3 (medium high)	**I**	**III**	**III/IV**	**IV**
Group 4 (highest)	**I-III**	**III/IV**	**III/IV**	**IV**

Table 4: Infection Control Precautions by Class
This is a description of the Infection Prevention and Control Requirements for Preventive Measures I,II, III, and IV.

I	Project designate should Identify essential services that could be disruptive and appropriate measures to address disruption Constructors shall be responsible for: <u>Dust and control and cleaning of area following activity</u> • Use methods to minimize raising dust from construction activities • Cover or remove patient care equipment and supplies to protect from dust exposure • Ceiling Tiles: Immediately replace when removed for visual inspection • The transportation route for clean supplies is not near contaminated materials • Avoid moving patients through work areas • Ensure the work area is cleaned with a HEPA vacuum after the work is completed. <u>Plumbing</u> • Schedule water interruptions during low user activity

	• Ensure faucet aerators are not used or installed • Maintain a dry work environment • Ensure gaskets and items made of materials that support the growth of legionella are not used
II	**In addition to Preventative Measures I** Constructors shall be responsible for: <u>Dust Control</u> • Decrease airborne dust by cleaning with wet mop. Place walk off mat at entrance/exit • Sealing windows and unused doors, covering holes in the wall if exposed for > 4 hrs • Water mist work surfaces to control dust while cutting • Remove and replace wet porous ceiling tiles; nonporous tiles can be removed, cleaned with an acceptable hospital disinfectant and replaced when dry • Debris should be covered during transport with a hard cover or dampened tarp and removed during low activity times. <u>HVAC</u> • Block and seal air vents/duct openings before starting • Monitor the change or clean filters during construction as required • Remove or isolate HVAC system in areas where work is being performed to prevent contamination of the duct system • Disable supply and return to the area under construction. • Install a certified DOP tested portable negative air unit, which must be operated for 24/7 hours during the construction period • When the permanent air handling system shall be used for exhausting air from the construction zone via a portable negative air unit, the following conditions shall be maintained: **a)** The air handling system is an exhaust system that leads directly to the outdoors; **b)** An engineering analysis is performed to ensure that the exhaust system continues to perform its intended function and that the operation of the HVAC system is not compromised. **c)** The operation of the exhaust fan shall be monitored and alarmed to building operations staff **d)** Alarmed in the construction zone **e)** If the conditions outlined in terms (a) to (c) cannot be satisfied, then the steps outlined in Preventive Measure III shall be followed. <u>Plumbing</u> Determine whether domestic cold, hot, and recirculation water lines will be affected by the construction. The assessment shall include: • Identifying plumbing lines that will need to be shut off or interrupted using existing valves; or isolated by additional valves; • Determining the method to be used to sanitize the water lines before occupancy; • Drafting the procedure to be used to sanitize the water system, including identifying the required equipment

III	**In addition to Preventative Measures I and II** Constructors shall be responsible for: • Notify Infection Prevention and Control to review and complete Site Prep and During Construction check lists <u>Dust Control</u> Install "***a solid impermeable dust barrier, from the floor to the underside of the deck*** *(including the areas above false ceilings) consisting of two layers of 0.15 mm (6 mil) polyethylene (or an equivalent barrier accepted by the MDT) and a gypsum wallboard protective layer"* CSA guidelines z317.13-12 • The barriers must be two layers of 0.15 mm (6ml) fire retardant polyethylene or and equivalent barrier and gypsum wall board protection on steel studs approved by the multidisciplinary team • Debris chutes for removal of construction materials, must be enclosed down to the waste container must also be enclosed. The Chute room must have a negative pressure compared to non-construction area • Seal all windows and doors between the construction and the healthcare facility areas with 2 layers of 6 mil fire retardant poly and 1 layer of drywall. Seal openings from removed tiles in the ceilings until replaced • Vacuum mechanical and electrical systems and spaces above drop ceilings to the underside of the deck required • Remove protective clothing before entering patient care area <u>HVAC</u> • Electronic monitoring and data logging of differential pressures between construction and hospital zones of dust barriers is conducted. Note: the monitor needs to have an audible alarm. • Verify calculation for construction space volume and number of HEPA negative air units required to achieve 7.5 Pa of pressure. • Maintain negative pressure at 0.03 wc (7.5 Pa) in construction area and for the duration of the project with the CHAUs running continuously. • Anterooms are constructed at access points to the construction area if access is from within the healthcare facility. • Check for air leakage paths between construction and healthcare facility areas • Increase air filter exchange frequency • Ventilation system should be cleaned and balanced after completion of construction • Disable the ventilation system and seal duct openings in the construction area until the project is completed; • Maintain negative pressure within the construction area by using portable HEPA filter – equipped air filtration units that include pressure gauges and an alarm. Filters shall be monitored and replaced if clogged or functioning below the manufacturer's specifications; Ensure that the air is exhausted directly outside and away from intake vents and filtered through a HEPA filter. In conditions that prohibit exhausting exhaust outside, consult IPAC. <u>Plumbing</u> • Dead leg water pipes are removed when found during construction at the connection to a main line • Flush water lines at the site and in adjacent areas before patient occupation • Check temperatures before patient occupation Cellulose based materials are protected from dust and moisture Mechanical equipment and materials are protected from dust and moisture exposure

	Location of demolition chutes (if applicable) and waste bins are to be preapproved; waste bins are covered.
IV	**In addition to Preventative Measures I, II and III** **Constructor shall be responsible for** • Notify Infection Prevention and Control to review /complete Construction check lists Dust and Control • Ensure that all access shall be from outside the occupied areas of the health care facility or construct anterooms at access points to the construction area if access is from within the health care facility • Place a walk-off mat outside and inside the anteroom to trap dust from equipment, debris and the shoes of personnel leaving the construction area. Walk off mats shall be sufficient size to ensure that the constructors have to place both feet on the mat at least once on exiting the construction area • Ensure constructors leave the construction area through the anteroom so that they can be vacuumed with a HEPA filter-equipped vacuum cleaner before leaving o Wear protective clothing that is to be removed each time they leave the construction area • Repair holes in hoarding walls within 8hr or seal them temporarily • Carefully remove barrier walls and use short term protection to minimize environmental contamination

Table 4: Time required for airborne contaminate removal at efficiencies of 99% and 99.9%

	Time required for removal (min.)	
Air changes per hour (ACH)	**99% efficiency***	**99.9% efficiency****
2	**138**	**207**
4	**69**	**104**
6	**46**	**69**
8	**35**	**52**
10	**28**	**41**
12	**23**	**35**
15	**18**	**28**
20	**14**	**21**
50	**6**	**8**

* Exhaust fans shall run after the completion of construction to remove 99% of airborne contaminants in Preventive Measures I and II areas.
**Exhaust fans shall run after the completion of construction to remove 99.9% of airborne contaminants in Preventative Measures III and IV areas.
Values apply to an empty room with no aerosol-generating source. Removal times will be longer in rooms or areas with imperfect mixing or air stagnation.
Note: This table has been adapted from Table B.1 of the US Department of Health and Human Service's Guidelines for Environmental Infection Control in Health-care Facilities**.**

Waterloo Regional Health Network (WRHN)

Positron Emission Tomography (PET) CT Scanner

APPENDIX B

Contractor Handbook

September 2026

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Contractor Handbook

Effective: April 2026

Relationship to Contracts and Purchase Orders

This Contractor Handbook (the "Handbook") establishes baseline operational, safety, and conduct expectations for all Contractors working on WRHN property and/or pursuant to any WRHN contracts, agreements, or purchase orders.

This Handbook does not replace, amend, or override executed contracts or agreements (e.g., CCDC agreements, WRHN standard terms) or purchase orders. Where a contract or Purchase Order imposes more specific or stringent requirements, those requirements shall prevail.

This Handbook is incorporated by reference into Contractor agreements and applies to all individuals performing work on WRHN property, contracts, and/or projects, and/or sites.

How to Use This Handbook

This Handbook is intended to support safe, consistent, and coordinated work on WRHN property by setting out practical, day-to-day expectations for Contractors while on WRHN Property.

Where a Contractor's executed agreement, contract, or purchase order includes more specific requirements, or there is any ambiguity or incontinency, the terms of the agreement, contract, or purchase order shall take precedence

For clarity, nothing in this Handbook or its appendices is intended to amend or override the terms of an executed agreement, contract or purchase order. Where a conflict exists, the order of precedence is as follows:

1. The executed agreement, contract or purchase order;
2. Applicable WRHN policies; and
3. This Contractor Handbook.

** WRHN reserves the right to revise and redistribute this policy as it is currently under review. An updated copy will be shared when completed.*

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Quick Reference Summary

✓ Contractor and it's personnel and employee's must wear the WRHN identification badge at all times and sign in/out as directed for the project and/or WRHN Property.
✓ Follow all posted safety rules and required personal protective equipment (PPE).
✓ Submit the required Hospital Work Request and/or Work Permit and receive approval before performing any work that impacts hospital systems (e.g., hot work, fire alarm, HVAC, plumbing, medical gases).
✓ Maintain clean and orderly work areas; remove waste daily.
✓ Store tools, equipment, and materials safely in approved or designated areas.
✓ Immediately report all incidents, injuries, hazards, or unplanned service interruptions to the Designated WRHN Point of Contact.
✓ Coordinate all deliveries in advance; no unapproved drop shipping to loading docks or Receiving.
✓ Follow all Infection Prevention & Control (IPAC) requirements, including applicable ICRA and Preventive Measures Analysis (PMA), when working in or near patient care areas.
✓ Obtain all required regulatory permits, certificates, and approvals prior to commencing work.
✓ Respect procurement blackout periods and do not offer gratuities or incentives to WRHN staff.
✓ Direct questions or concerns to your Designated WRHN Point of Contact.

Refer to the full handbook for detailed requirements, procedures, and contact information.

Part A — Overview & Governance

1. Overview & Governance

This Handbook sets out expectations for Contractors on WRHN property and clarifies ownership across departments. This Handbook is version controlled. Contractors are expected to comply with the latest version issued at the time of any engagement, unless otherwise specified in the applicable contract, agreement, or purchase order.

Ownership & Maintenance of the Document: The Supply Chain Department is the administrative owner of this Handbook and is responsible for maintaining the master version, coordinating updates, and ensuring the document remains current.

While Supply Chain maintains administrative ownership, the content within this Handbook is informed and maintained collaboratively with subject-matter experts across WRHN, including Facilities Operations, Redevelopment, Infection Prevention & Control, IT, Risk, and other applicable departments.

WRHN generally reviews the Handbook on an annual basis, with additional reviews conducted as required based on operational, regulatory, or contractual changes and/or requirements. Updates will be made in consultation with the appropriate subject-matter experts.

2. Scope – All WRHN Properties:

This Handbook applies to all **Contractors** performing work on WRHN Property.

Any Vendor that performs on-site installation, commissioning, modification, or physical work at a WRHN site is deemed a Contractor for the purposes of this Handbook and is subject to its requirements, as determined by WRHN in it's sole and unfettered direction.

Where there is uncertainty as to whether an activity constitutes "work," WRHN will apply the more stringent requirements.

This Handbook is intended to be provided to Contractors **at the time of engagement by Supply Chain**, including it through contract or purchase order documentation, where applicable.

3. Contractor Acknowledgement & Compliance

3.1 Contractors acknowledge that compliance with this Handbook is a condition of performing work on WRHN property.

3.2 The Contractor is responsible for ensuring that all employees and subcontractors assigned to WRHN sites:
3.2.1 Have reviewed this Handbook
3.2.2 Understand applicable requirements
3.2.3 Comply with all policies, procedures, and directions issued by WRHN

4. Definitions

4.1 **Accessibility for Ontarians with Disabilities Act (AODA):** an Ontario law, enacted in 2005, that requires organizations to identify, remove, and prevent barriers for people with disabilities.

4.2 **Authority Having Jurisdiction (AHJ):** The Authority Having Jurisdiction (AHJ) is the organization or individual with the legal authority to interpret, enforce, and approve compliance with applicable codes, standards, or regulations.

4.3 **Constructor (OHSA): The party who assumes overall responsibility for a construction** project under Ontario's Occupational Health and Safety Act. This is assumed to be the general contractor unless co-ordinated in advance with the Designated WRHN Point of Contact.

4.4 **Conflict of Interest (COI)**: A situation in which a Representative has a private interest or a relationship with a related person that creates, either in appearance or in reality, a perceived or real opportunity for improper influence in the performance of their duties and responsibilities to the Hospital. This would include all situations which would cause an independent observer to reasonably question whether the professional actions or decisions of the Representative are compromised by considerations of personal gain, financial or otherwise. A conflict of interest may be real, potential or perceived.

4.5 **Consultant**: A person or company that provides expert or strategic advice under an agreement, other than an employment agreement.

4.6 **Consulting Services**: Services involving expertise, advice, or recommendations provided for consideration and decision-making.

4.7 **Contract**: A contract is a written document that formalizes an agreement between two or more parties. It specifies the rights, duties, and obligations of each party. Contracts are legally enforceable and require an offer, acceptance, clear terms, and mutual consent. Contracts often involve the exchange of goods, services, or financial consideration.

4.8 **Contractor:** For the purposes of this Handbook, a Contractor is a party that holds a contract with WRHN to perform work and is responsible for the execution of that work. It is the responsibility of the Contractor to ensure that all subcontractors comply with all language/requirements in the Handbook.

If you ask the question: "Is the party Doing work or Supplying Goods?"

- ✓ If the answer is "do work" = Contractor
- ✓ If the answer is "supply goods" = Vendor

A Vendor becomes a Contractor when the PO/Contract requires them to:

- ✓ Install equipment
- ✓ Commission systems
- ✓ Modify existing infrastructure
- ✓ Perform on-site work beyond delivery

In short: if WRHN is paying for effort and execution, they fall under the Contractor Handbook; if we're paying for a thing, they fall under the Vendor lens.

4.9 **Delivery Driver:** Performs deliveries to departments or loading docks.

4.10 **Define Site:** A WRHN-owned, leased, or operated physical location where WRHN conducts clinical, administrative, research, or support services. A Site includes all associated buildings, grounds, parking areas, loading docks, and any interior or exterior spaces where Contractors, Vendors, or External Service Providers may perform work or provide services.

4.11 **Designated WRHN Point of Contact:** The WRHN employee assigned as the primary liaison for coordinating work or services with the external provider. This individual may be a Project Coordinator, Contract Administrator, Sourcing representative, a Project Manager, etc. depending on the nature of the engagement.
Note: The designated WRHN point of contact will be identified during the project kick-off or implementation phase and communicated to the external service provider to ensure clarity on roles and responsibilities.

4.12 **External Service Provider:** Any non-WRHN person or business on-site for construction, maintenance, delivery, installation, service, consulting, sales or other business-related support. This could be a Contractor or Vendor, or both.

4.13 **Hospital:** Means the Waterloo Regional Health Network (WRHN).

4.14 **Infection Control Risk Assessment (ICRA):** Part of the Infection Control Project Plan, a process used to identify design elements that increase the risk of microbial transmission in the environment. This assessment reviews the population and program impacted, and what disruptions may result from the project.

4.15 **Installer:** Specialized personnel who install equipment or systems purchased from a vendor. Installers may overlap with contractors if installation involves construction or technical integration.
Examples: MRI machine installers, IT hardware technicians.

4.16 **OHSA:** Means the Occupational Health and Safety Act, R.S.O. 1990, c O.1 as amended and any and all Regulations thereto.

4.17 **Owner:** For the purposes of this handbook the Owner is defined as Waterloo Regional Health Network (WRHN).

4.18 **Preventive Measures Analysis (PMA):** Part of the Infection Control Project Plan, a documented process of identifying the preventive measures (steps taken to change process, create barriers, or include precautionary measures to reduce contaminant spread) planned to mitigate the risks contained in the Infection Control Risk Assessment (ICRA).

4.19 **Sub-Contractor:** A person or entity having a direct contract with the Contractor to perform a part or parts of the work.

4.20 **Vendor:** For the purposes of this Handbook, a *Vendor* is a party that holds a purchase order or agreement with WRHN solely for the supply of goods and does not assume responsibility for the execution of on-site work.

If you ask the question: "Is the party doing work or to Supplying Goods?

- ✓ If the answer is "do work" = Contractor
- ✓ If the answer is "supply goods" = Vendor

A Vendor becomes a Contractor when the PO/Contract requires them to:

- ✓ Install equipment
- ✓ Commission systems
- ✓ Modify existing infrastructure
- ✓ Perform on-site work beyond delivery

In short: if WRHN is paying for effort and execution, they fall under the Contractor Handbook; if we're paying for a thing, they fall under the Vendor lens.

4.21 **Work Permit:** Formal authorization required for any work that impacts hospital systems (e.g., hot work, fire alarm, HVAC, plumbing, medical gases). Permits ensure safety and coordination with hospital operations.

4.22 **Enforcement & Consequences of Non-compliance**: Compliance with this handbook is a condition of performing work on WRHN property. Where a Contractor, or their personnel fail to comply with this handbook, WRHN may, at it's discretion and without limiting any contractual rights:

1. Require Corrective action within a specified timeframe
2. Suspend or stop work until compliance is achieved
3. Deny or revoke site access for specified individuals
4. Require the removal of personnel from WRHN sites and/or
5. Escalate the matter in accordance with the applicable contract, PO or WRHN Policy.

Part B — General Contractor Requirements

1. Professional Conduct & Respectful Workplace

1.1 All external service personnel must act courteously, follow WRHN respectful workplace rules, and refrain from harassment, violence, or inappropriate behavior. If WRHN determines that any external personnel are in direct conflict with WRHN's respectful workplace policies or present a potential threat to the safety or security of patients, staff, or occupants, WRHN reserves the right to request their immediate removal from site.
See Appendix H – Respectful Workplace Policy.

2. Procurement Conduct: Blackout Periods & Conflicts of Interest

2.2 Respect blackout periods during competitive procurements; avoid communications that may influence outcomes.

2.3 No gratuities/incentives to staff; supplier incentives must be expressed in quality, service, and price and formalized contractually.

3. Invoice Requirements (Mandatory for Processing)

3.1 To ensure accuracy, compliance, and alignment with WRHN's internal controls, all invoices must meet the following requirements before they will be processed by Accounts Payable:

- 3.1.1 Every invoice must reference an approved Purchase Order (PO) or a valid, active contract.
- 3.1.2 Invoices without a PO or contract number will be rejected and returned to the submitting department for correction.
- 3.1.3 Departments are responsible for ensuring that no work, goods, or services are initiated without a PO or contract in place (per WRHN Signing Authority and Purchasing Policy).
- 3.1.4 Rush/after-the-fact invoices will not be accepted unless accompanied by a documented exception approved by Sourcing and Finance.
- 3.1.5 This requirement minimizes invoice discrepancies, ensures proper financial controls, supports BPS compliance, and strengthens WRHN's contract management discipline.
- 3.1.6 When payment is administered under a CCDC or comparable construction contract, the prescribed application for Payment and Payment process will supersede all standard invoice processing requirements.

4. Product Quality Issues and Recalls

4.1 Contractors must ensure that all materials, equipment, and products brought onto any WRHN site are:

- 4.1.1 Suitable for use in a healthcare environment, including consideration of safety, infection prevention, and operational impacts.
- 4.1.2 Fit for intended purpose, in safe working condition, and performing as expected
- 4.1.3 Compliant with applicable codes, standards, and certifications, where required.
- 4.1.4 Free from known defects that could compromise safety, performance, or reliability

Note: Where new components are unavailable or impractical due to legacy systems, obsolete infrastructure, or manufacturer limitations, refurbished or reconditioned components may be used, provided they are appropriate for the application and meet applicable safety, certification, or performance requirements.

5. Defective or Nonconforming Materials

5.1 If any material, tool, or equipment is found to be defective, malfunctioning, damaged, not performing as expected, or incorrect for its intended use, the Contractor must **immediately stop work involving the affected item** and:

- 5.1.1 Remove the item from service
- 5.1.2 Clearly tag and isolate the item to prevent further use
- 5.1.3 Notify the designated WRHN point of contact as soon as possible, providing relevant details (e.g., product description, serial number, supplier, and observed issue)

6. Product Recalls

6.1 In the event a product recall, safety notice, or manufacturer advisory is issued that may impact work on a WRHN site, the Contractor must:

- 6.1.1 Stop using or installing the affected product
- 6.1.2 Notify the designated WRHN point of contact promptly
- 6.1.3 Follow direction from WRHN regarding continued use, removal, replacement, or isolation of the affected product
- 6.1.4 Provide written confirmation of any corrective actions taken, as requested

6.2 Responsibilities, costs, scheduling impacts, and remedies associated with recalled or substituted products shall be addressed in accordance with the applicable contract, purchase order, or agreed project terms, and coordinated through the designated WRHN point of contact.

7. Escalations

7.1 All escalations and dispute resolution activities must adhere to the specific process as outlined and defined in the applicable PO or Contract governing the work.

8. Privacy & Confidentiality (PHIPA)

8.1 Protect personal health information at all times. Do not access, collect, share, photograph, or record patient information in care areas without explicit authorization.

9. Accessibility (AODA)

9.1 Maintain accessible temporary routes, clear signage, and barrier-free access when work impacts public spaces; provide assistance as needed.

10. Health Requirements

10.1 WRHN requires all Contractors to comply with applicable Employee Health requirements for working in a healthcare setting.

10.2 The Contractor is responsible for ensuring that all personnel who are assigned to WRHN sites and meet specific criteria, have met the mandatory immunization and tuberculosis (TB) testing requirements. Of note, WRHN does not routinely collect or maintain individual immunization or TB testing records, but requires a signed attestation from the Contractor verifying health requirements of the personnel who meet the following criteria:

- 10.2.1 Working in clinical/patient-care area for four (4) or more consecutive days
- 10.2.2 Working in a non-clinical area for project duration of 1 month or more
- 10.2.3 Contractors and sub-contractors who are completing strictly outdoor project work do not require a signed attestation

10.3 Contractors must:

- 10.3.1 Provide a copy of a signed Attestation of Health Requirements to the designated WRHN point of contact
- 10.3.2 Ensure no worker attends WRHN sites if symptomatic (fever, gastrointestinal symptoms, new onset cough/rash/sore throat) or otherwise unwell.
- 10.3.3 If requested, provide specific immunization and TB testing proof in the event that an exposure/outbreak occurs, or as part of a WRHN auditing process.

11. Security & Background Screening

11.1 WRHN reserves the right, at its discretion, to request confirmation of background screening for any contractor personnel assigned to high-sensitivity areas (including but not limited to Pediatrics, Mental Health and secure units). Such requirements will be determined on a case-by-case basis by the **Contract or Purchase Order** and communicated by WRHN's Designated Point of Contact.

11.2 The Contractor is fully responsible for ensuring the appropriate supervision and conduct of all personnel while on-site, including within high-sensitivity areas.

12. Incident & Hazard Reporting

12.1 Immediately report safety/security incidents, injuries, and hazards to your Designated WRHN point of contact.

13. Safety & Emergency Codes

13.1 The Contractor is responsible for ensuring that the health and safety of workers on a construction project are protected and that all work is performed in compliance with the Occupational Health and Safety Act (OHSA) and its regulations

13.2 Section 23 of the O.H.S. Act requires a Constructor to ensure:

13.2.1 The measures and procedures prescribed by the O.H.S. Act and the regulations thereto are carried out on a construction project;

13.2.2 Every employer and every worker performing work on the project complies with the O.H.S. Act and the regulations; and

13.2.3 The health and safety of workers on the construction project are protected.

13.3 External personnel must know Contractor and external service provider responsibilities under WRHN emergency codes (see Appendix E). Sample actions include stopping work in the code area, evacuating when instructed, and maintaining safe egress.

13.4 Contractor personnel must comply with all hospital safety rules, including wearing prescribed PPE; immediate spill cleanup and notification; keeping doors and passageways clear; prohibiting horseplay and intoxicants; and using traffic spotters for equipment. If a critical injury or death were to occur, the designated WRHN point of contact must be notified to ensure appropriate follow-up and Ministry of Labour reporting. Contractors must provide copies of regular safety meeting records to the designated WRHN point of contact when requested. Where contractor-specific PPE or health and safety requirements exceed hospital requirements, the more stringent requirement shall apply

13.5 Upon request a Contractor is required to prepare a project specific HSE (Health, Safety and Environment) Plan to support their on site work. HSE Plan is to be provided to WRHN for review, feedback and approval prior to mobilizing for work

13.6 In addition to legislative and contractor requirements, WRHN requests that relevant WRHN safety and emergency reference materials (including the WRHN Contractor Handbook and Emergency Codes Quick Reference) be visibly posted on the contractor supplied job board or equivalent site communication tool, where practicable, to support ongoing awareness.

14. Smoking and Vaping

14.1 Are prohibited anywhere on WRHN property, and within nine (9) metres of any building entrance or exit, regardless of property lines. Smoke-Free Ontario Act, 2017 (SFOA, 2017)

15. Communication & Incident Reporting

15.1 Clear, timely communication is critical in a healthcare environment.

15.2 Contractors must immediately report the following to their WRHN Designated WRHN Point of Contact:
15.2.1 Injuries, near misses, or safety incidents
15.2.2 Hazards or unsafe conditions
15.2.3 Property damage
15.2.4 Security concerns
15.2.5 Unplanned service interruptions or system impacts

15.3 Incidents requiring emergency response must follow WRHN emergency procedures first, followed by notification to the designated WRHN point of contact.

15.4 Failure to report incidents or hazards promptly may result in corrective action, removal from site, or contractual consequences.

16. Media Relations

16.1 Do not engage with media about hospital projects; refer inquiries to WRHN Public Affairs.

17. Communication and Posting Expectations

17.1 Contractors must ensure that a current copy of this Contractor Handbook, is readily accessible at the work site for all Contractor and Sub-Contractor personnel.

Part C — Site Access & Logistics

1. Access, Badges Sign-In/Out for External Providers coming to site

1.1 All external service providers must be sponsored by a designated WRHN point of contact.

1.2 WRHN Host Responsibilities

The designated WRHN point of contact is responsible for coordinating all access requirements, including:

1.2.1 Accompanying the contractor or other external service provider to the PASS (Parking and Security Office) office (if applicable) for badge issuance.
1.2.2 Defining where the Sign in/out will be take place.
1.2.3 Ensuring all badges, and keys are retrieved at project completion.
1.2.4 Returning all credentials to the appropriate issuing department.

1.3 Contractor Responsibilities

1.3.1 Wear the required identification as directed by your designated WRHN point of contact.
1.3.2 Return badges as instructed by the WRHN Point of Contact (either daily or at the end of the project, depending on badge type and pre-determined arrangement).
1.3.3 Return all keys provided.

1.4 **WRHN reserves the right to apply replacement fees or administrative charges at its discretion**, including but not limited to fees for lost keys.

1.5 **Loss of any master key may result in a minimum replacement cost of $5,000**, in addition to any related security or re-keying expenses.

1.6 Repeated failures to return credentials, misuse of access, or loss of keys may result in **fees, suspension of site access, or removal from the project**, at WRHN's discretion.

2. Parking

2.1 Parking will not be provided to contractors/subcontractors; each are responsible for arranging and paying for their own parking for the duration of the project.

2.2 Parking - Use of WRHN's public parking lots for contractor parking is to be approved by the designated WRHN point of contact.

2.3 Parking Availability and related fees may vary by site and may be updated by WRHN Parking Services as required. All contractors and external service providers are required to pay the daily posted rate or may purchase a monthly parking pass, as per WRHN Parking Policy.

3. Deliveries

3.1 **General Responsibility** - Contractors are responsible for ordering, transporting, unloading, storing, and managing all materials related to their work, unless WRHN has explicitly agreed in advance to support a specific delivery.

3.2 **Unapproved Deliveries -** (No Drop Shipping)

3.2.1 Contractors must not send, courier, ship, or arrange for any materials, equipment, or packages (including courier or FedEx-type deliveries) to arrive at WRHN Receiving or loading docks unless:

3.2.2 The delivery has been pre-approved, and

3.2.3 WRHN Receiving has been notified in advance by the designated WRHN point of contact.

** If WRHN did not order it, approve it, or expect it — it must not show up at our docks or Receiving*

3.3 **Use of WRHN Loading Docks -** WRHN loading docks are not for routine contractor deliveries. Short-term use of a loading dock may be requested only for large or heavy deliveries and only with prior approval from:

3.3.1 the designated WRHN point of contact, and

3.3.2 WRHN Receiving.

3.3.3 Items must not be left unattended or stored on the loading dock.

3.3.4 Dock access depends on WRHN operational priorities and may not be available on the requested date.

3.4 **Delivery Coordination Requirements -** When any delivery is required, Contractors must coordinate **in advance** with the designated WRHN point of contact to confirm:

3.4.1 Approved delivery date and time
3.4.2 Approved delivery location (dock, entrance, or staging area)
3.4.3 Infection prevention and control (IPAC) requirements
3.4.4 Safe transport routes through patient or public areas
3.4.5 Special access needs (e.g., service elevators or security access)

3.5 **Staging and Storage** - Contractors are responsible for managing approved staging areas and ensuring materials do not obstruct hospital operations, exits, corridors, or access routes.

4. Appointment Scheduling & Site Access

4.1 All external business engagements must be coordinated through WRHN Sourcing Department. Contractors and other External service providers are seen by appointment only.

4.2 Casual or unscheduled visits to departments, lounges, or facilities are strictly prohibited.

4.3 If a Contractors or other External Service Providers wishes to discuss new opportunities or services with any department, they must first contact Sourcing, which will engage the appropriate internal stakeholders as needed.

4.4 This process ensures compliance with WRHN procurement policies and maintains fairness, transparency, and operational control.

5. Tools & Equipment

5.1 All equipment and tools required to complete the work will be provided by the Contractor. The Hospital will not provide the Contractor with any tools or equipment required to complete the work. All tools and equipment will be used and stored by the Contractor in a safe manner and maintained in safe working condition. Contractors are responsible for the storage and security of their own tools and equipment.

6. Use of WRHN Utilities, Elevators & Building Infrastructure

6.1 Contractors must not use WRHN utilities, building systems, or infrastructure without prior approval from the designated WRHN point of contact.

6.2 This includes, but is not limited to:

6.2.1 Electrical power
6.2.2 Water (potable or non-potable)
6.2.3 Medical gases
6.2.4 Data/network connections
6.2.5 Service or public elevators
6.2.6 Any use of service or public elevators for moving materials, equipment, tools, or waste

6.3 Where approved, such use must:
6.3.1 Be coordinated in advance
6.3.2 Avoid peak clinical hours and sensitive patient care periods
6.3.3 Comply with all safety, IPAC, and operational requirements

6.4 **Elevator Use – Important:**
6.4.1 Any movement of materials, equipment, skids, pallets, toolboxes, or waste using WRHN elevators must be approved in advance by the designated WRHN point of contact.
6.4.2 Posted elevator weight limits do not authorize use without approval.
6.4.3 Contractors must follow site-specific elevator direction provided by WRHN and may be required to:
6.4.3.1 Use a designated elevator
6.4.3.2 Protect elevator finishes
6.4.3.3 Follow WRHN-approved loading and movement instructions
6.4.3.4 Any damage resulting from contractor use will be repaired at the contractor's expense.
6.4.4 Unauthorized use of utilities or elevators may result in work stoppage, back-charges, or removal from site.

Part D — Safety, Infection Control & Work Controls

1. Planned Essential Services Shutdowns and Work Authorization Requirements

Purpose: The Planned Essential Service Shutdown and Work Request Policy is a standard, safe, and clinically informed process for planning and executing any Planned Essential Service Shutdown or Critical System Impairment that could affect patient care, staff safety, building operations or regulatory compliance. It applies to

ALL WRHN sites and must be followed by all Contractor personnel doing work on hospital grounds.

1.1 If your activity affects any essential or critical building system / service (including but not limited to; hot work, fire alarm, fire suppression, HVAC, plumbing, steam, compressed air, medical gases, etc.), you must first review the Planned Essential Service Shutdown and Work Request Policy and associated Workflow, then submit a Work Shutdown Request Form and Method of Procedure (MOP) to your designated WRHN point of contact. Written approval from the WRHN designated point of contact and a WRHN signed Work Shutdown Request Form are both required prior to proceeding with the work.

* See **Appendix Z** for the WRHN Planned Essential Service Shutdown and Work Request Policy, Workflow and Shutdown Request Form.

2. Infection Prevention & Control (CSA Z317.13) –

Purpose: To prevent the transmission of infection and protect patients, staff, and visitors during construction, renovation, maintenance, and related activities.

2.1 All construction related activity must comply with CSA Z317.13 and the WRHN CRMD Policy, which governs the ICRA, Preventive Measures Analysis (PMA), Multi-Disciplinary Team (MDT) review, barrier/negative pressure planning, and site monitoring requirements. The ICRA and PMA processes must be completed as defined in the CRMD Policy, and any project specific variations require MDT approval including IPAC and OH&S.-related activity must comply with CSA Z317.13 and the WRHN -pressure planning, and site monitoring requirements.-specific variations require MDT approval including IPAC and OH&S.

*See **Appendix A** for the WRHN Construction, Renovation, Maintenance, and Design (CRMD)

3. Fire Safety, Hot Work & ESA Considerations

Purpose: To safeguard hospital property, staff, and patients by enforcing fire safety, hot work, and electrical safety standards.

3.1 Contractors must restore the integrity of any fire separations disturbed during work. This includes patching holes and using fire stop materials that meet applicable CSA/ULC standards and are approved by the local building authority having jurisdiction (AHJ).

3.2 If the work does not require a building permit, or is not part of a larger project requiring a permit, fire stopping must be performed by an individual trained and certified by a fire stopping product manufacturer (e.g., Hilti, 3M).

3.3 Maintain clear egress routes and access to fire extinguishing equipment at all times.

3.4 Contractors must maintain free access at all times from the street to fire hydrants and to outside connections for standpipes or other fire extinguishing equipment, whether permanent or temporary. No materials, equipment, or vehicles may be placed within 3 metres of hydrants or connections, nor between hydrants/connections and the center of the street.

3.5 Contractors must maintain free access at all times to control valves, hose/fire lines within the building, portable extinguishers, pull stations, and fire phone stations.

3.6 If exits are disabled (permanently or temporarily), contractors must establish and clearly mark alternate exit routes inside and outside the building, with approval from designated WRHN point of contact at least a minimum of 48 hours in advance. The designated WRHN point of contact must notify all affected areas and Occupational Safety prior to closure or change of fire exit routes.

3.7 Storage of work site materials is not permitted in hospital corridors, patient rooms, or stairwells.

3.8 Hot Work requires a permit and strict precautions, including fire watch, shielding, appropriate extinguisher type, detector isolation, and identification of the nearest pull station.

3.9 In the event of any shutdown of fire protection equipment and systems or part thereof, the Fire Department and occupants must be notified, and instructions must be posted as to alternative provisions or actions to be taken in case of an emergency.

These provisions and actions must be acceptable to the Fire Marshall. An attempt to minimize the impact of the malfunctioning equipment must be indicated (i.e. where portions of a sprinkler, fire alarm or standpipe system is placed out of service, service to remaining portions be maintained) and where necessary, the use of WRHN communication devices should be employed to notify concerned parties of emergencies. Assistance and direction for specific situations may be sought from the Fire Department.

Fire Watch

When any portion of a fire alarm, sprinkler, or other fire protection system is impaired, isolated or out of service, the Director of Facilities Services (or designate) must be notified immediately. The following measures shall be implemented and maintained until all systems are fully restored and operational:

- A dedicated fire watch shall be implemented **immediately** upon impairment of any fire protection system.
- The frequency and extent of patrols shall be determined based on risk, in consultation with the WRHN designated point of contact and Facilities. At a minimum, patrols shall be conducted hourly, with increased frequency required in high-risk areas and patient care environments.
- Fire watch personnel shall be; assigned exclusively to fire watch duties with no additional responsibilities) and be trained in fire safety procedures and emergency response.
- Fire watch personnel shall ensure that all fire protection equipment and building features (i.e. emergency lighting, fire separations, fire alarm system, sprinkler system, and fire extinguishers) are checked, tested, and maintained in accordance with Parts 2,6 and 7 of the Ontario Fire Code.
- Fire watch personnel shall ensure access to roadways, fire routes, hydrants and pumper connections are accessible for the Fire Department.
- When signs of fire are detected, fire watch personnel conducting a fire watch shall notify all building occupants to implement code red procedures.
- A fire watch log shall be maintained at all times and must include the following; date and time of each patrol, name of fire watch personnel, areas inspected, observations and deficiencies identified (if any), any actions take (if any).
- Any deficiencies noted must be forwarded to facilities services immediately and measures taken to correct the deficiencies must be recorded.
- All written records of tests and corrective measures must be kept for two years after they are made, and the records shall be available upon request to the Chief Fire Official as per section 1.1.2 of the Ontario Fire Code.
- Fire watch requirements shall be implemented in accordance with the Fire Code and the facility Fire Safety Plan and may be adjusted as directed by the local Authority Having Jurisdiction (AHJ).

3.10 All electrical work must comply with ESA requirements; contractors must obtain inspection work orders and certificates as applicable.
*See Appendix B for the WRHN Hot Work Policy and Form

4. Lockout/Tagout Procedures

Purpose: To prevent accidental energy release and ensure safe isolation of equipment and systems during work.

4.1 All energy sources including electrical, mechanical, pneumatic, chemical, hydraulic and thermal will be physically isolated and proper lock out and tag out procedures used before performing work, in accordance with WRHN Lockout/Tagout requirements.

4.2 Contractors must comply with WRHN Lockout/Tagout procedures and directions provided by WRHN Facilities Operations. Contractors are responsible for supplying their own personal locks, tags, and hasps unless otherwise directed.

4.3 WRHN Facilities Operations retains authority for lockout coordination, system isolation, and lock removal. Contractors must not remove or interfere with any lock other than their own.
*See Appendix C for the WRHN Lock Out Tag Out Policy and Forms

5. Temporary Wiring & Overloading

Purpose: To prevent electrical hazards and structural failures by ensuring safe installation, inspection, and removal of temporary wiring and by avoiding overloading.

5.1 Temporary wiring, drop cords, and extension cables must be inspected frequently for defects and removed after job completion. All wiring must comply with Building Codes, Ontario Electrical Safety Code, and safety requirements. Only metal cages are permitted for temporary incandescent lights

5.2 Contractors must ensure that structural elements, temporary supports, falsework, and scaffolding are not overloaded. Any uncertainty regarding loading conditions requires consultation and approval from a professional engineer or other competent authority. Approval must come in the form of a written stamped engineering letter / report.
*See Appendix D for the WRHN Include WRHN Low Voltage Wiring Policy

6. Waste, Hazardous Materials & Temporary Works

Purpose: To maintain a clean, safe environment and ensure proper handling, removal, and disposal of waste and hazardous materials.

6.1 **General Waste**

6.1.1 Work areas must be cleaned daily. All waste generated by the Contractor must be removed from the site regularly.

6.1.2 Contractors are responsible for the removal and off-site disposal of all waste generated by their work, including all associated costs.
6.1.3 Disposal of waste by burning on or near hospital property is not permitted.
6.1.4 Roof drains, floor drains, sinks, toilets, or any hospital drainage system must not be used for disposal of liquids, washout, or waste of any kind.

6.2 **Dumpsters, Staging & Transport of Waste**

6.2.1 If a dumpster or waste staging area is required, this must be coordinated in advance with the designated WRHN point of contact to ensure safe placement and to avoid blocking loading docks, exits, or emergency access routes.
6.2.2 All waste moved through hospital spaces must be covered and transported in accordance with Infection Prevention and Control (IPAC) requirements for the project.
6.2.3 Use of elevators for waste removal must be coordinated in advance and approved by the designated WRHN point of contact. Contractors must follow site-specific direction provided by WRHN.
6.2.4 Any damage to elevators or hospital property resulting from contractor use will be repaired at the contractor's expense.

6.3 **Hazardous Materials & Disposal**

6.3.1 Hazardous waste must be handled and disposed of in accordance with applicable local and provincial legislation, including Ministry of the Environment and Ministry of Health requirements.
6.3.2 Disposal of hazardous materials into storm sewers, sanitary sewers, waterways, or the environment is strictly prohibited.
6.3.3 Where required, Contractors must provide WRHN with documentation confirming proper disposal.

6.4 **Flammable & Compressed Materials**

6.4.1 Flammable liquids (e.g., gasoline) must be stored in approved metal safety containers and dispensed outdoors.
6.4.2 Flammable and combustible materials must be removed from the hospital building daily unless otherwise approved.

6.5 **Training, SDS & Temporary Work Controls**

6.5.1 Contractors are responsible for ensuring that all personnel have completed any legislated training required to perform their work (e.g., WHMIS, Working at Heights, equipment-specific training).
6.5.2 Safety Data Sheets (SDS) for all hazardous materials used on site must be maintained by the Contractor and be available on site. Copies must be provided to the designated WRHN point of contact upon request.

6.5.3 Hazardous materials must not be stored or used near ventilation intakes unless approved and controlled as part of the project's safety and IPAC requirements.

6.5.4 Temporary wiring, equipment, and supports must comply with applicable codes and safety standards. Overloading is prohibited, and approval is required before using powder-actuated tools or similar equipment.

7. Substances & Hazard Disclosure Designated Substances & Hazard Disclosure.

Purpose: To ensure contractors are aware of, and safely manage, designated substances that may be present within WRHN facilities in compliance with regulatory requirements.

7.1 WRHN facilities include older buildings where designated substances (as defined under Ontario Regulation 490/09) may be present. These substances include, but are not limited to:

- 7.1.1 Asbestos
- 7.1.2 Lead
- 7.1.3 Silica
- 7.1.4 Mercury

7.2 Other hazardous materials identified in the project specific Designated Substance Report (DSR).

7.3 If applicable Contractors must review the DSR provided by WRHN before commencing any work that may disturb building materials.

7.4 Contractors are responsible for:

- 7.4.1 Complying with all requirements under the Occupational Health and Safety Act (OHSA) and applicable regulations.
- 7.4.2 Implementing appropriate control measures (e.g., containment, PPE, air monitoring) when working near or disturbing designated substances.
- 7.4.3 Flagging to the immediate attention of the designated WRHN contact upon discovery of presumed/confirmed substance not previously identified.
- 7.4.4 The contractor acknowledges receipt of the DSR and confirms compliance with all safety protocols.

8. Noise, Vibration & Odour Control –

Purpose: To minimize disruption to patient care and hospital operations by managing noise, vibration, and odours generated by contractor activities.

8.1 Contractors must manage noise, vibration, and odours generated by their work to minimize disruption to patients, staff, and hospital operations.

8.2 Requirements include:
- 8.2.1 Scheduling high-noise or high-vibration activities during approved hours only
- 8.2.2 Implementing noise and vibration mitigation measures as required by the scope of work
- 8.2.3 Ceasing work immediately if directed due to patient care impacts

8.3 Where work may generate significant vibration (e.g., drilling, cutting, demolition), contractors may be required to:
- 8.3.1 Provide advance notice
- 8.3.2 Implement vibration controls
- 8.3.3 Participate in vibration monitoring as directed by WRHN

8.4 Odour-producing activities (e.g., painting, adhesives, sealants) must be controlled through ventilation, containment, and product selection approved in advance. Products with strong or persistent odours may be restricted or prohibited in patient care areas.

8.5 Contractors must also comply with WRHN's Scent-Free Policy (See Appendix I), where applicable. Products, materials, or personal items with strong fragrances or sensitizing properties may be restricted or prohibited, particularly in patient care or other sensitive areas.

9. Prohibited Items & Substances

Purpose: To protect patient safety and maintain a secure healthcare environment by restricting high-risk or unauthorized items on WRHN property.

9.1 To protect patient safety and maintain a secure healthcare environment, the following items are strictly prohibited on WRHN property unless explicitly approved in writing:
- 9.1.1 Alcohol, cannabis, or illegal substances
- 9.1.2 Firearms, weapons, or replicas
- 9.1.3 Exposed blades or tools that may reasonably be perceived as weapons, including large knives or cutting tools carried openly outside of active work areas
- 9.1.4 Unauthorized recording devices or surveillance equipment
- 9.1.5 Personal appliances or equipment not required for the work

9.1.6 Materials containing hazardous substances not disclosed and approved in advance

9.2 Tools or equipment required for the work that could pose a safety or security concern must be transported, stored, and used in a manner appropriate for a healthcare environment (e.g., secured in toolboxes or work bags when moving through public or clinical areas).

9.3 **WRHN reserves the right to determine, at its discretion, whether any item or substance is acceptable on site.**

WRHN may inspect work areas and remove prohibited or inappropriate items immediately. Violations may result in removal from site and/or further action in accordance with the applicable contract, purchase order, or WRHN policy.

Part E — Construction & Technical Requirements

Relationship to WRHN CRMD Policy (Appendix A):

All construction, renovation, maintenance, or design work must comply with the WRHN Risk Assessment & Preventive Measures During Construction, Renovation, Maintenance, and Design Policy. The CRMD Policy governs ICRA, PMA, MDT involvement, infection control requirements, preventive measure levels, and stop work authorities.-control requirements, preventive measure levels, and stop-work authorities. See Appendix A.

1. Insurance, WSIB & Constructor Duties (OHSA)

*Purpose: To ensure contractors and subcontractors meet all legal, insurance, and safety obligations, protecting both WRHN and all parties involved in the work. Insurance, indemnification, WSIB, constructor status, and liability requirements are governed first by the **executed contract** (e.g., **CCDC**, WRHN Standard Terms).*

1.2 **Where** *this Handbook references insurance or safety requirements, these apply **unless the contract explicitly states otherwise and unless otherwise agreed to:***

1.2.1 The Contractor will provide proof of Comprehensive Commercial General liability insurance on an occurrence basis for third-party bodily injury, personal

injury, and property damage, to an inclusive limit of not less than $5,000,000 per occurrence and $10,000,000 aggregate.

1.2.2 The Contractor will provide a "Clearance Certificate" from the Workplace Safety Insurance Board of Ontario (WSIB) or other proof satisfactory to the Hospital, stating that the Contractor has complied with the requirements of the Workplace Safety and Insurance Act and has an account in good standing with WSIB as of the date of the certificate/proof.

1.2.3 The Contractor will maintain the above liability insurance coverage and Workplace Safety and Insurance coverage in good standing for the duration of the contract and shall fully indemnify the Hospital for any and all costs or claims arising as a result of any claim brought against the Hospital in connection with the Contractor's performance of the contract.

1.2.4 The Contractor will ensure that all sub-contractors hired by it comply with the terms of this Policy and all Hospital policies, including the requirement for liability insurance and WSIB coverage and all requirements under the Occupational Health & Safety Act and Regulations.

2. Codes, Permits, Fees & Certificates

Purpose: To confirm all work is properly authorized, permitted, and certified in accordance with local, provincial, and national regulations.

2.1 The Contractor will file with the Ministry of Labour, a Notice of Project (NOP) designating the Contractor as the Constructor for the project. A copy of the NOP shall be posted at the entrance to the job site by the Contractor, a copy provided to the designated WRHN point of contact and the original retained by the Contractor.

2.2 Building permits, if required, will be posted prior to commencement of any work at the Hospital. A copy of the Building Permit shall be posted at the entrance to the job site by the Contractor and the original retained by the designated WRHN point of contact.

2.3 All procedures, work, and final product performed will be in compliance with the Occupational Health and Safety Act and all corresponding Regulations, including the Regulation for Health Care and Residential Facilities (O.Reg.67/93) as well as the Construction Regulations.

2.4 All work will be executed and all materials shall conform to and be inspected in strict accordance with all the laws, rules and regulations of the local and Provincial codes and all other authorities having jurisdiction.

2.5 Each Contractor may be required to obtain all necessary permits and notices, pay all fees in order that the work may be carried out and shall furnish any certificates necessary as evidence that the work installed conforms with the laws and regulations of all authorities having jurisdiction before final certificates are issued.

2.6 All contractors performing electrical work must obtain an inspection/registration workorder number, within 24 hours of commencing work on site, from the:

2.6.1 *Electrical Safety Authority Kitchener-Waterloo Processing Centre*
279 Weber Street North Waterloo, Ontario M2J 3H8
Phone: (519) 746-3040 Fax: (519) 746-3041

2.7 When work has been completed, the Contractor is required to obtain a "Certificate of Inspection" from the appropriate inspection agency and submit this with the progress draw for payment.

2.8 All changes and alterations required by an authorized inspector of any authority having jurisdiction will be carried out without charge or expense to the Hospital.

2.9 All equipment supplied must have approval of the National Fire Protection Association (NFPA) Canadian Standards Association (CSA) and Underwriters Laboratories Canada, Ontario Electrical Safety Code, or any other authority having jurisdiction.

2.10 For certain regulated systems (e.g., medical gas), inspections and certifications may be arranged directly by WRHN or its designated third-party provider. Contractors remain responsible for coordinating required inspections and providing supporting documentation, as directed by WRHN.

3. Laydown Areas & Contractor Staging Zones

Purpose: To ensure coordinated, safe, and appropriate use of WRHN property for contractor laydown areas, staging zones, and temporary site setups. Laydown and staging approvals must consider the preventive measures and traffic flow requirements identified-flow requirements identified through the ICRA/PMA process in the CRMD Policy.

3.1 Laydown areas are not guaranteed and will be reviewed project by project based on site capacity, safety, patient/public access, and operational impacts. -by-project based on site capacity, safety, patient/public access, and operational impacts.

3.2 General Contractors must request any laydown or staging area through the Designated WRHN Point of Contact as early as possible, and no later than site

mobilization. Requests may be identified at the time of tender submission where known.

3.3 Requests must include:

- 3.3.1 Required square footage
- 3.3.2 Duration
- 3.3.3 Intended use (materials, tools, equipment, trailers, storage)
- 3.3.4 Security needs
- 3.3.5 Traffic flow or access impacts

3.4 WRHN will determine whether a laydown area can be approved, modified, relocated, or denied.

3.5 Approved laydown areas must:

- 3.5.1 Remain clean, organized, and secure by the Contractor to prevent unauthorized access, movement, or safety hazards (e.g., fencing, barriers, locked containers, or other appropriate controls).
- 3.5.2 Not obstruct fire lanes, emergency routes, loading docks, public entrances, or pedestrian access.
- 3.5.3 Laydown areas must not obstruct access to critical utilities, shut-off valves, breaker panels, or emergency equipment.
- 3.5.4 Comply with Infection Prevention & Control (IPAC) and safety requirements.

3.6 Placement of trailers, containers, fencing, temporary structures, or large equipment requires WRHN approval.

3.7 All costs associated with laydown areas (e.g., fencing, ground protection, security measures) are the responsibility of the Contractor, unless otherwise specified in the contract. Contractors are responsible for snow removal and winter maintenance within their designated laydown and staging areas, unless otherwise directed by WRHN.

3.8 If a laydown area has been provided for Contractor use, WRHN assumes no responsibility for the security, loss, theft, or damage of any materials, tools, equipment, or other Contractor-owned property stored within the Contractor's laydown area. The Contractor is solely responsible for securing and protecting all such property at its own risk.

3.9 Upon completion of work, laydown and staging areas must be restored to their original condition, including surface repair, landscaping, or re-sodding where applicable.

4. Building Systems: Plumbing Dead Leg Removal and HVAC Installs/Repairs

Purpose: To protect hospital operations, environmental conditions, water quality, and patient safety during plumbing dead leg removal and HVAC installation or repair activities.

All work involving system isolation, modification, or reactivation must follow applicable shutdown and restart protocols where required.

Plumbing dead leg removal and HVAC installs/repairs shall be planned and executed in accordance with the project-specific ICRA/PMA and the direction of the MDT under the CRMD Policy.

4.1.1 Plumbing Dead Leg Pipes (WRHN)

Key Definition: A dead leg pipe is any pipe or plumbing component that contains or is likely to contain stagnant water.

- Water stagnant for more than three (3) days is considered stagnant.

All identified plumbing dead leg pipes on WRHN properties must be:

- Reported to the Manager of Facilities Operations.
- Removed in a timely manner where practical.
- Assessed with external specialists (mechanical/environmental) if required.

Allowable Dead Leg Lengths

Maximum allowable dead leg lengths depend on pipe diameter:

- < 2 inches: up to 3 inches
- >2 inches double the pipe diameter

Procedure Overview

When a dead leg pipe is identified:

1. Facilities staff or contractors notify the Manager of Facilities Operations.
2. The Manager reviews and determines required action (with external input if needed).
3. The pipe is scheduled for isolation or removal.

4. Proper PPE is required during all work.
5. Removed pipes must be taken out as close to the main line as possible.
6. If removal is not practical, the pipe must be:
    - Isolated from the live system
    - Drained
    - Permanently capped
    - Tagged with isolation status and date
7. A bleed line may be required to drain/disinfect prior to removal, based on risk factors (e.g., temperature, age, stagnation duration, contents, material).
8. Water shutdown procedures must be followed if applicable.
9. Complete removal or isolation.
10. Clean up the work area.

4.1.2 For HVAC installs/repairs, refer to CRMD Policy. See Appendix A

5. Alterations to Existing Work

Purpose: To ensure all modifications to existing structures and finishes are performed by qualified trades and restored to hospital standards. All penetrations, openings, hoarding, and restoration activities must follow the ***preventive measures*** *assigned in the PMA under the CRMD Policy.*

5.1 Where materials are to be removed for re-use or where existing finishes are to be cut and later made good, qualified tradesmen skilled in the handling of each particular material will be employed.

5.2 Damage to the existing building components or contents due to construction work will be made good. New work in existing building shall conform to requirements of applicable trade sections and hospital standards.

5.3 All services affected by work shall be cut off and properly capped or diverted. Interruption of services to or within existing buildings will not take place without prior consultation with the designated WRHN point of contact or delegate and issuance of a 'Work Permit Request Form'. (See Section 8.)

5.4 All energy sources including electrical, mechanical, pneumatic, chemical, hydraulic and thermal will be physically isolated and proper lock out and tag out procedures used before performing work. Contractors must supply their own locks, tags and

hasps. Contractors must coordinate work with other contractors and Hospital trades personnel when multiple lockouts are required. Contractors must not remove any locks other than their own.

5.5 Alterations to existing IT or low-voltage infrastructure must comply with WRHN standards and be coordinated with the appropriate WRHN team.

Part F — Project Close-Out Requirements

1. Overview

All construction, renovation, maintenance, or design work must comply with the specifications and deliverables outlined in the contract under the project/service commissioning & close-out requirements. Where contracts or agreements may not identify these requirements, it's the contractor's responsibility to confirm expectations with the WRHN designation point of contact in advance of starting work.

While projects/services may share common deliverables, every scope of work is unique and requires a specific checklist of requirements to be tailored to it's specific project needs.

Part G — Appendices

Appendix A - * WRHN Construction, Renovation, Maintenance, and Design (CRMD) Policy

Risk Assessment & Preventive Measures During Construction, Renovation, Maintenance, and Design

This document applies at all Waterloo Regional Health Network (WRHN) sites.

PURPOSE

Activities during construction, renovation, maintenance and design (CRMD) of health care facilities can create potential for development or transmission of pathogenic and opportunistic fungi and bacteria. Assessing the risks of activities and utilizing a preventive measures matrix to mitigate risk provides safety for people in and near the hospital. The purpose of this policy is to define governance, roles, and accountability for CRMD within WRHN. This policy establishes consistent processes to identify, assess, communicate, and

manage infection-related and environmental risks throughout the project life cycle, ensuring compliance with regulatory requirements and minimizing impacts on patient care and team member safety.

POLICY STATEMENT

All CRMD activities at WRHN will be assessed by a shared multidisciplinary team (MDT) including infection prevention and control (IPAC), employee health, safety, and wellness (EHSW), and involved facilities operations and redevelopment staff, with additional representation as required. Risk assessment and mitigation planning using preventive measures will be identified and followed as part of the CRMD plan developed by the WRHN MDT. At all times, WRHN CRMD will follow the legislated requirements during activity occurring within all facilities. Evidence-based practices including current relevant Canadian Standards Association documents, and those endorsed by Canadian Healthcare Engineering Society and IPAC Canada will be utilized for review and reference to guide

planning and decision-making.

SCOPE

Inclusion criteria:

All individuals involved in planned or unplanned construction, renovation, or maintenance projects within the facilities of WRHN performed by internal employees or external constructors.

Exclusion criteria:

Immediate construction or renovation required to create separation and a safe environment for patients and staff in urgent and unexpected remediation of emergency situations, including flood, fire, or equipment failure. Once safety has been secured, the the concern will be addressed with the multidisciplinary team, and the planned work will meet inclusion criteria.

RESPONSIBILITIES

All individuals participating in CRMD project planning and implementation are responsible for participating through the activities identified for their roles below. Members of the WRHN MDT and project-specific MDTs are responsible for participating in shared project review, risk identification and mitigation plans, and collaborative decision-making. The MDT will meet from planning phase, through post-completion and deficiency resolution.

Multi-Disciplinary Team (WRHN MDT/Project MDT)

- confirm appropriate approvals have been received from deciding body, such as SLT and/or associated committees, and all required oversight has been provided.
- review and clarify scope of work and complete the project summary and risk assessment
- identify the population affected and type of construction work involved based on the CSA preventive measures analysis matrix
- discuss and identify the preventive measures analysis for the project, and identify any modifications from the standard, utilizing the CSA documents to guide best practice
- identify if a project-specific meeting series is required with an expanded MDT, or if the project meets the parameters for the standing WRHN MDT meetings
- identifies frequency, and responsibility, for physical assessment of the work area and completion site monitoring tool
- identifies the process for a stop work order, in the event a significant safety risk is identified due to failure of adherence to planned preventive measures
- confirm that pre-occupancy clean is completed at the end of the project, and perform a pre-occupancy inspection, including safety, and final project walk-through
- confirm all anticipated requirements have been met upon completion and / or commissioning. Document and follow any incomplete items as project deficiencies
- discuss, maintain, and edit associated related documents as required, and at a minimum of annual review

Project Lead /Coordinator

- initiates MDT documentation related to CRMD activity
- manage information flow through the WRHN MDT, and if required, project-specific MDT
- initiate the project summary and risk assessment, including determining whether a project is likely to meet criteria as a minor project, or is considered a major project

- oversee and coordinate the activities of hospital staff and external constructors, contractors, and other external service providers during the project
- ensure that external constructors, contractors, and other external service providers understand their obligations under this policy and their contract
- ensure that hospital staff, constructors, and consultants understand and follow CSA Z317.17 and CSA Z8000
- post appropriate alert signs and contact information at entry to the work area
- communicates and posts stop work order process

Occupational Safety and Injury Prevention Consultant

- participates in WRHN MDT meetings
- ensure that members of WRHN MDT understand, and are educated about, EHSW risks of CRMD activity, including injury prevention
- consult from a safety and ergonomics based lens on project design and issues
- audit the construction area during work to bring forward risks and have issues addressed
- ensure pre-occupancy inspection is completed prior to occupancy
- ensure all non-compliance from the pre-occupancy is addressed
- ensure compliance to the Occupational Health and Safety Act and to the Ontario Regulations related to Healthcare (O.Reg 67/93) in all projects

Infection Control Practitioner

- Administrative coordination of the WRHN MDT, including responsibility for policy review cycle and location of document storage
- participates in MDT meetings
- ensure that members of the MDT understand, and are educated about, infection-related risks of CRMD activity and use of preventive measures

- ensure agreed upon preventive measures are being followed
- perform surveillance for infection and colonization in areas impacted by CRMD
- collaborate with environmental services or constructor staff to ensure cleaning of the environment during and after CRMD
- audit the program for barrier inspection and preventive measure utilization
- support designation of a traffic pattern for staff, patients, constructors, and materials that separates clean and soiled paths

Design Professionals

- Know and understand relevant best practices in current versions of CSA Z317.17 and CSA Z8000
- Provide design and documentation to meet the needs of best practice documents
- issue instruction to the constructor during construction on behalf of the facility

Constructors, contractors, and external service providers

- understand and obtain appropriate education related to safe hospital construction, including CSA Z317.17 and CSA Z 8000 best practice recommendations, mould remediation, and risk assessment and preventive measure requirements
- participate in developing or reviewing the preventive measures analysis, including IPAC and EHSW concerns for the project
- submits the final scope of work assessment for the review of the MDT, and starts work only after permission is received
- implement preventive measures plan as determined by the project MDT
- supply, build, and maintain protective barriers (hoarding) between the construction zone and the surrounding areas
- maintain construction site ventilation systems, including maintaining temperatures, humidity and airflow
- inspects barriers and ventilation systems daily and maintains a log/ checklist which is posted at the entry of the construction area, at the frequency requested by the project MDT

- be responsible for construction cleaning protocols within the work site
- be responsible for actions of their employees and sub-trades
- be responsible for physical security of the work site
- ensure proper movement and storage of supplies and equipment, maintaining a clean and dry environment during delivery, storage, and installation
- identify, close, and monitor perforations, if identified in preventive measures analysis, in walls, floors, and ceilings
- confirm required information is available/ posted at the entry of the work area
- confirm dress code required for the work area prevents contamination outside the construction area
- ensure EHSW are informed any time a critical injury may occur

Facilities Operations/ Maintenance/ Redevelopment Teams

- assess the condition of the work site prior to initiating construction project, including baseline review of mechanical systems
- coordinate as needed with constructors to ensure that contamination of air, water, medical gas, and other systems can be prevented
- monitor HVAC and air systems, increasing air system filter changes as needed during periods of heavy construction
- participate in commission of systems in constructed and renovated areas to become familiar with operation, and obtain necessary education for future operation and maintenance requirements

Supply Chain

- Ensure Risk Assessment & Preventive Measures During Construction, Renovation, Maintenance, and Design policy is included in procurement documents for any contractor or vendor activity that requires alteration to the physical environment

Clinical/ Corporate Leadership in Construction Area

- clinical or program leadership to identify risks, challenges, operational effects and communicate with MDT team or participate as an ad hoc member of the MDT for duration of project

PROCEDURE

All Projects

Project Lead will initiate the Project Summary document upon confirmation the project. Using the scope of work identified in the Project Summary the project PMA will be initiated.

Collaboration at WRHN will be achieved through an organization-wide standing multidisciplinary team, WRHN MDT. The WRHN MDT membership will include IPAC, EHSW, and Facilities Maintenance and Redevelopment members. Additional representatives may be invited as needed including but not limited to representatives from clinical teams, constructors, environmental services, quality, and risk.

The WRHN MDT will meet at least monthly. This MDT will provide initial review of all projects, including feasibility studies and early consultation, serve as the project MDT for minor projects, and immediate remediation measures for emergency situations.

The WRHN MDT, based on the project summary, will determine whether a proposed project requires a project-specific MDT based on the scope and risk of the project.

Early Works (Planning and Design to approval of contract)

Upon identification of a project, the WRHN MDT will be informed. The MDT will review and confirm design planning includes appropriate materials and strategies to support safety and efficiency of work flow.

WRHN MDT to review project summary and risk assessment, confirm population grouping, construction type, and preventive measures level, level I-IV. WRHN MDT to determine whether project is minor (Level I or II PMA, duration less than 1 week, or identification/ separation work phase of emergency remediation), or major (not meeting these criteria)

At the discretion of the WRHN MDT, a project-specific MDT with a separate meeting structure will be required for major projects with longer duration, high complexity construction activity, or extended access to high-risk population areas.

For all major projects, project-specific risk assessment and PMA will be completed.

Topics for discussion at the MDT in the planning phase include: ventilation; patient location or relocation; dust control in the work area and adjacencies; traffic patterns; construction supplies and storage; relocation of hospital supplies and storage; transportation of demolition materials; barrier planning and hoarding; air pressure differentials and construction air handling; impact on water and plumbing; constructor access to hospital services; and work hours

The project summary, risk assessment, and plan for preventive measures, and a copy of this policy, are to be included in package of shared documents provided to external contractors and constructors, including for design submissions, service contracts, and tender packages.

Constructor and designer will provide evidence of understanding their responsibilities under the most recent versions of CSA Z317.13, through references or proof of CSA-related education. If additional education may be needed for sub-trades or subcontractors, to be identified in early works discussions.

Design elements to be reviewed by the MDT on the technical drawings include, but is not limited to:

- design of patient areas, traffic patterns, and storage for all people and items including debris, clean equipment and supplies, facility equipment and supplies including conveyance system and associated components
- mechanical systems including ventilation, heating and cooling, plumbing,
- hand hygiene and personal protective equipment storage planning
- design and placement of clean, sterile, and soiled utility and storage
- specialty spaces including device reprocessing areas, airborne infection isolation rooms, operating rooms, protective environment rooms, and all procedure rooms
- furniture, fixtures, equipments, and finishes including art installations, solariums or decorative features involving living items or water elements
- human, biohazard, and general waste management

Documents developed by the WRHN MDT including project summary, risk assessment, and PMA to be retained by the organization in an electronic form, accessible by the team

Preconstruction Phase (from award of contract/approval of plan to mobilization of constructor)

WRHN MDT or project MDT to review construction plan including barrier placement and PMA with constructor, utilizing CSA Z317.17 as a guideline, and documenting any variation required from the recommended best practice. Variation from best practice cannot be approved without confirmation by both IPAC and OH&S members. If consensus is not reached at the MDT meeting on how to achieve the recommended PMA, escalation to the appropriate leadership teams may be required.

The MDT will identify and document the plan for temporarily stopping work in the construction area for failure to meet expectations within the preventive measures plan. Any member of the MDT should have the ability to initiate the work stoppage.

Identify any critical mechanical or plumbing shutdowns required and develop the procedure to ensure these occur safely jointly with operational team, with appropriate return to use. Project MDT will ensure plans are documented, and project manager to communicate plan.

MDT to communicate with staff in the area of the facility undergoing the construction the plan, scope of work, and responsibilities of the program involved.

Ongoing project documents, with decisions and changes documented from the MDT meetings to be retained by the organization

Construction Phase (from mobilization of constructor to removal of construction equipment)

Any barriers, hoarding, or physical preventive measures must be in place and inspected by the MDT, including IPAC and OH&S, prior to initiating construction work.

Pre-construction checklist to be completed by MDT, confirming review with constructor as required.

Site PMA Monitoring checklist to be completed at each site visit, documented, and shared with the MDT and constructor

MDT to conduct regular site visits of all construction areas on all sites. IPAC & EHSW to be invited to all site visits for review, at their discretion.

All MDT share responsibility of ensuring PMA, as discussed during MDT meetings, are in place throughout the construction activity. This includes walking past the work site when possible, and notifying MDT and constructor of any lapses. If there are significant lapses identified that put patients or staff at risk, a temporary work stoppage may be required.

If a work stoppage is required, an emergency MDT meeting will be held to plan an improvement strategy. A review by MDT is required prior to resuming construction activity.

Pre-Occupancy/ Commissioning Phase (End of construction to Occupancy by End User)

At the end of the project, the MDT including EHSW, IPAC, and facilities/ redevelopment will be included in the project deficiency review.

Prior to removal of separation, barriers, or hoarding, the contractor will complete a construction clean including any required above ceiling, fixture, and chase spaces required, and the MDT will conduct an on-site review including the cleanliness of the area and readiness of mechanical systems for use

Following removal of separation, barriers, or hoarding, the project manager will ensure a terminal clean of all surfaces has been completed, including all surfaces, either by environmental services or external contractor as specified in the project contract

A minimum of 24 hours should be allowed between the end of the terminal clean, and the opening of space to use to allow for identification of deficiencies, confirmation of mechanical system function, and final settling of dust or contaminants

DEFINITIONS

Adjacent Area: Areas surrounding an area where construction, renovation, or maintenance work is occurring. This includes both vertical (above and below) as well as horizontal (beside) areas. Identifying whether an area is adjacent to work planned or occurring may depend on the risk created by the work.

Anteroom: a room that is immediately adjacent to or contained within a construction area and intended for use by the constructors for purposes such as storage or removal of protective clothing, cleaning of debris-removal containers, and/or removal of contaminants from footwear. The anteroom also provides an airlock between the construction area and any adjacent clinical or patient areas.

Commissioning (Commissioning Process): a systematic verification, documentation, and training process applied to all activities during the design, construction, static verification, start-up, and functional performance testing of equipment and systems in a facility to

ensure that the facility operates in conformity with the owners project requirements and the basis of design in accordance with the contract documents.

Construction: major and minor facility activities that disturb or modify facility structures and systems. The term includes not only new construction, but also renovation, maintenance, and repair work. All construction activity is subject to the decisions and discussions occurring within the MDT, but some maintenance activity that is considered construction (such as changing a lightbulb or painting in a public area) may not be considered a project, and is therefore, not subject to the project documentation requirements.

C**onstruction air handling unit (CAHU)**: a machine used to move HEPA-filtered air into or out of a construction site.

Construction Clean: cleaning performed at the end of a workday by construction workers that removes gross soil and dirt, construction materials, and workplace hazards. Construction clean generally includes surfaces within the work environment, but does not include horizontal surfaces or areas adjacent to the job site.

Contractor: a person who undertakes a construction or renovation project for an owner. This may be the constructor (OHSA), contractor, subcontractor, construction manager, construction worker, or trades person, or other external provider The term also includes an owner or employee of an owner who undertakes all or part of a maintenance, construction or renovation project.

Constructor (OHSA): the party who assumes overall responsibility for a construction project under Ontario's Occupational Health and Safety Act. This is assumed to be the general contractor, unless coordinate in advance with the designated WRHN Point of Contact.

Construction-Related Bacteria: bacteria are diverse microorganisms that are found in soil, water, air, and on surfaces. They may live with, or without air. Bacterial growth may be supported in multiple

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construction-related activity including stagnant water formation, moisture on surfaces, contaminants on construction materials, and dispersion of bacterial spores(resistant cells produced to withstand extreme heat, cold or dehydration) to growth-supporting

environments. Legionella species, including *L. pneumophilia,* are some of the most commonly identified construction-related bacteria.

Construction-Related Fungi: fungi are diverse organisms that include yeasts, moulds, and mushrooms. They are found in soil, water, and air. Lacking chlorophyll, they derive nourishment from breaking down organic matter. Many types of fungi reproduce by spores that are easily dispersed in air. Construction activity can increase the dispersement of spores and growth of fungi. Aspergillis and moulds are two fungi which cause negative health consequences, and can be associated with construction.

Designated WRHN Point of Contact: The WRHN employee assigned as the primary liaison for coordinating work or services with the external provider. This individual may be a Project Coordinator, Contract Administrator, Sourcing representative, a Project Manager, etc. depending on the nature of the engagement.

Environmental Services: Health care facility services related to cleaning and maintaining the physical environment, including general housekeeping, waste management, pest control, and hazardous material cleanup.

High-Efficiency Particulate Air (HEPA) Filter: an air filter with an efficiency of 99.97% in the removal of airborne particles 0.3 micrometers or larger in diameter.

Infection Control Practitioner (ICP): a trained individual employed by an organization or health care facility with responsibility for development, implementation, evaluation, and education related to policies, procedures, and practices that impact the prevention and control of infections. An ICP trained in construction practices may be a project's infection control construction consultant.

Infection Control Construction Consultant: a professional with demonstrated education and training, knowledge, and experiences who advises on and monitors required infection prevention and control strategies, approaches, methods, and measures relative to construction methodologies.

Risk Assessment: part of the project plan, a process used to identify design elements that increase the risk of microbial transmission in the environment. This assessment reviews the population and program impacted, and what disruptions may result from the project.

New Construction: construction to produce all or part of a health care facility (HCF) that did not exist before the project.

Occupant: the patient or staff members that usually occupy the work environment of the project

Plenum Box: an air distribution box designed with the intent to baffle the air discharged from a CAHU, reducing channeled air from turbulent to laminar flow, while providing additional HEPA filtration.

Plumbing Dead Leg: a pipe or other plumbing component or system that has contained, contains, or will likely contain, stagnant water

Preoccupancy Inspection: A formalized end of construction review of the finished environment before return-to service which addresses all elements of employee safety and injury prevention requirements. Members of the organization's Joint Health and Safety Committee may be asked to participate with EHSW representatives as needed.

Preventive Measures Analysis (PMA): part of the Project Plan, a documented process of identifying the preventive measures (steps taken to change process, create barriers, or include precautionary measures to reduce contaminant spread) planned to mitigate the risks contained in the ICRA

Project: within this policy, construction, renovation, maintenance or design activity that extends beyond minor routine maintenance. This would require any item requiring multiple shifts to complete a planned task, dedicated coordination of more than 2 trades simultaneously, removal of wall or ceiling, or extended planned vacancy of a patient space. For example, changing the sink or repair a toilet in a washroom would not be considered a project, but changing all of the sinks on a clinical unit would be a project, as would renovating the washroom including walls and floors.

Project Lead/ Coordinator: the project lead/coordinator is the person responsible, at WRHN, for coordinating construction activity. This person may be a representative of the facilities maintenance/ operations team, the redevelopment team, digital services, or a specific program. This person is responsible for overseeing the activity, and ensuring information flow into the WRHN MDT. While this individual is often the WRHN designated point of contact, these can be separated. For example, a representative of Supply Chain could be the WRHN designated point of contact, while the Project Lead is a representative from Facilities Operations.

Multi-Disciplinary Team: a group of representatives from various disciplines in the health care facility that collaborate on a construction, renovation, maintenance, or design project for oversight and decision-making. Topics to be discussed at the MDT include project risks to

patient or hospital team members, review of construction activity within the CSA Infection Control Risk Assessment, alignment on preventive measures required for each phase of construction, injury prevention, employee health, safety, and wellness, project planning, and consideration of best practices from multiple disciplines. At WRHN, there is an organizational MDT (WRHN MDT), but individual projects, based on scope, may require a project-specific MDT. Representation on both WRHN MDT and project-specific MDT will include, at minimum, a user representative, a redevelopment/ facilities management representative, an IPAC representative, and an EHSW representative. Members may represent more than one role. Additional members may be added based on the scope and impact of the project.

Renovation: construction to modify or upgrade an existing HCF to be used for similar purposes.

Return-to-Service Cleaning: the thorough cleaning of a clinical space following construction and before the space is returned to clinical use for patient care, medical equipment, or storage of clean and sterile supplies. This cleaning includes all surfaces, and removes contaminating micro-organisms that could be acquired by subsequent occupants or staff. (Previously known as terminal construction clean, or clinical clean)

Unoccupied Space: an area where there are no patients or patient-related activities that is absent of any medical supplies or equipment. Patient care areas that are intermittently unoccupied due to designated working hours are not considered unoccupied spaces.

Walk-Off Mat: a specially designed mat that is placed outside a construction area or in an anteroom, and is intended for removal of contaminants from the footwear of workers, and bottom of surfaces (such as cart wheels)

RELATED DOCUMENTS

WRHN Toolkit for Construction, Renovation, Maintenance, and Design

REFERENCES

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Appendix B — WRHN Hot Work Policy and Form - This one includes forms – See attachments

Hot Work Policy

1. PURPOSE

To ensure the safe execution of hot work activities (e.g., welding, cutting, grinding) at WRHN facilities by minimizing fire risks and ensuring compliance with applicable safety standards. The purpose of this policy is to provide consistent instruction in the area of fire safety while

using portable hot work equipment including brazing, cutting, soldering, grinding, and welding operations, or other spark producing or open flame devices.

2. POLICY STATEMENT

WRHN is committed to maintaining a safe environment for staff, patients, and visitors. All hot work activities must follow established procedures to prevent fire hazards and ensure regulatory compliance. Hot work shall only be performed with proper authorization and safety controls in place.

3. SCOPE

This procedure applies to all employees, contractors and visitors to Waterloo Regional Health Network (WRHN) sites.

4. DEFINITIONS

4.1 Fire Watch: The responsibility of watching the person performing the hot work and the surrounding area in order to address any sparks or other sources that could cause a fire.

4.2 Hot Work: Any type of temporary work that could create an ignition source and possibly lead to a fire. Examples of hot work are welding, soldering, grinding, brazing, cutting or use of a torch for heating purposes.

4.3 Leader: The individual who has supervisory responsibility for the worker performing the hot work. This could include the employee responsible for bringing in a contractor to perform Hot Work.

5. ROLES & RESPONSIBILITIES

5.1 Facilities Department:

5.1.1 It is the responsibility of the Facilities Manager or designate to monitor compliance of this procedure.

5.1.2 It is the responsibility of the Facilities Department to file all Hot Work permits for a minimum of one year.

5.2 Leaders, Project Managers and Project Coordinators:

5.2.1 Ensure hot work equipment is maintained and in safe operational condition.

5.2.2 Ensure the precautions listed on the Hot Work Permit are understood by the person(s) performing the hot work.

5.2.3 Inform outside contractors and service personnel of this procedure and all other applicable procedures.

5.2.4 Verify that outside contractors have a Hot Work Permit if one is required for the work being conducted.

5.2.5 Train affected individuals working under their direction in the provisions of the Hot Work procedure and all requirements of the Hot Work Permit.

5.2.6 Ensure there is a properly trained person designated to perform Fire Watch.

5.2.7 Determine the amount of time the Fire Watch is to take place after the completion of the Hot Work (minimum 60 minutes – see Procedure #6)

5.3 Person Performing the Hot Work:

5.3.1 Obtain Hot Work Permit from the Facilities Department prior to starting the Hot Work.

5.3.2 Fully complete the Hot Work Permit, follow the precautions on the permit and post the permit in the designated area.

5.3.3 Use appropriate personal protective equipment (PPE) while performing hot work (welding helmets, gloves, jackets, screens, etc.).

5.4 Person(s) Performing the Fire Watch and Monitoring

5.4.1 Ensure that appropriate fire extinguishers are readily available.

5.4.2 Know how to report a fire or other emergency situations.

5.4.3 Maintain the Fire Watch for the duration of the Hot Work and for a minimum of 60 minutes after the work is completed or for the duration determined by the person(s) authorizing the Hot Work.

5.4.4 Use the appropriate personal protective equipment.

5.4.5 Complete the appropriate section of the Hot Work Permit.

5.5 Contractors:

5.5.1 Must work in compliance with this procedure.

5.5.2 It is the responsibility of the person who brings affected contractors onto organization property to ensure they are aware of and trained in the Hot Work procedure and permit system.

6. PROCEDURE

6.1 **Exemptions**

6.1.1 Hot Work Permits are not required when the hot work is being performed in an area specifically designed for hot work.

6.1.2 In order to be an exempt area, the area shall be:

- 6.1.2.1 Of non-combustible and fire-resistant construction
- 6.1.2.2 Free of combustibles and flammables
- 6.1.2.3 Suitably segregated from adjacent areas
- 6.1.2.4 Equipped with fire extinguishers
- 6.1.2.5 Equipped with adequate ventilation

7. Prohibited Hot Work Areas

7.1 Areas equipped with sprinkler systems that are out of order.

7.2 Areas, including those within confined spaces, where explosive gases, vapours, or dusts exist or could accumulate.

7.3 On containers where flammable liquids, solids or vapours may be present.

7.4 On pipes or beams that are in contact with combustible walls, ceilings, roofs or partitions where heat can travel to and can cause ignition.

8. Prior to Hot Work

8.1 Before initiating hot work, decide whether the job can be done a different way so as to avoid the hot work.

8.2 Mark the area so people are aware of the work to be performed.

8.3 Obtain a Hot Work Permit from the Facilities Department.

8.3.1

8.4 Complete appropriate sections of the Hot Work Permit.
8.4.1

8.5 Post permit in the designated area in the Facilities department and a copy of the permit on the door of the room the Hot Work is to be performed in.

8.6 Ensure a second person trained in the Hot Work Procedure witnesses that the required precautions have been taken and signs the permit.

8.7 Survey the site and ensure operational fire extinguishers and persons qualified to operate them are immediately available.

8.8 Utilize weld screens to protect others in the area from welding flash and sparks.

8.9 Ensure cutting and welding equipment are in good repair.

8.10 Ensure all Personal Protective Equipment required is in good condition and worn.

8.11 Request Facilities to shut down the fire alarm system for the area affected and if applicable by completing the "Service Shutdown Form" located within the Contractors Package.

8.12 When conducting hot work near pipes containing flammable gas, ensure the section of pipe within 1 meter (3 feet) of the hot work is covered with wet non-combustible insulating material.

8.13 Ensure that within 35 feet (11m) of where the work is being performed:
- 8.13.1 The floor is swept clean of combustibles.
- 8.13.2 Combustible floors (eg. Carpets) are covered with fire resistant tarps/blankets.
- 8.13.3 There are no flammable liquids or materials present.
- 8.13.4 There are no dangerous or volatile vapours, mists, fumes or dusts present.

8.14 When working on walls, partitions, floors and ceilings:

8.14.1 Ensure that combustibles are moved away from the other side of the wall, floor, partition or ceiling.

8.14.2 Ensure construction materials, insulation or coverings are non-combustible.

8.14.3 Ensure adequate ventilation is achieved.

9. During Hot Work

9.1 Fire watch is to be provided for the entire duration of the hot work, including during lunch and breaks.

9.2 Fire extinguishing equipment shall be maintained in close proximity to the hot work for its entire duration.

9.3 Store acetylene and other fuel in approved cylinders and in a secure and upright position.

10. After Hot Work

10.1 Fire watch must be provided for no less than 1 hour and up to 3 hours, dependent on circumstances, after the work has stopped.

10.2 Fire extinguishing equipment must remain accessible in the area until the fire monitoring is complete.

10.3 Fire Watch Duration Matrix - This matrix is to provide basic guidance for Fire Watch durations. All durations can be increased by the person authorizing Hot Work as they deem necessary.

Type of Work	No/Low risk of combustible or flammable materials	Moderate/High risk of combustible or flammable materials
Soldering	60 Minutes	120 Minutes
Cutting/Grinding	60 Minutes	120 Minutes
Welding	60 Minutes	120 Minutes

11. DOCUMENTATION

11.1 Hot Work Permit Form (see blank copy attached).

11.2 Report incident through the INCIDENT REPORTING SYSTEM as found on the WRHN Intranet home page (as needed).

12. COMPETENCIES & EDUCATION

12.1 All staff and contractors involved in hot work must read and adhere to this WRHN Hot Work Policy.

13. QUALITY ASSURANCE

13.1 Any staff member identifying potential or actual adverse outcomes resulting from implementing this policy will follow the safety incident reporting process. This document will be reviewed per hospital policy framework or any updates to the standards related to this document.

13.2 Facilities Management will conduct periodic audits of hot work permits and compliance with procedures. Non-compliance will be addressed through corrective action.

14. RELATED DOCUMENTS

14.1 "*Service Shutdown Form*" located in the *Contractors Package*

15. APPENDICES

Not applicable.

16. REFERENCES

16.1 Ontario Fire Code (O. Reg. 213/07), Part 5 – Hot Works

16.2 Occupational Health and Safety Act (R.S.O. 1990, c. O.1)

16.3 CSA Standard W117.2-19: Safety in Welding, Cutting, and Allied Processes

16.4 NFPA 51B: Standard for Fire Prevention During Welding, Cutting, and Other Hot Work

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Appendix C – WRHN Lock out Tag Out Policy - **This one includes forms – See attachments**

1. POLICY

1.1 Lock out tag out (LOTO) is the practice of securing all sources of energy when making repairs or performing maintenance. All Facilities Operations employees must follow LOTO procedures when performing repair or maintenance on any energized system or equipment. Energy source classifications include electrical, mechanical, pneumatic, hydraulic, thermal, chemical, gravitational and/or radioactive.

1.2 Equipment required for approved safety lockout procedures include mechanical isolating devices, employee lockout padlocks and hasps, group boxes, weight support arms, valve covers, and more. Mechanical isolating devices for energized systems are often specific to their use and required to set the system and/or equipment energy level to zero or to a safe level prior to any service, repair or maintenance.

1.3 On an annual basis, Facilities Operations will review the safety lockout policy in association with a physical inspection of locks/hasps.

2. PROCEDURE

2.1 Lockout Equipment

2.1.1 Facilities Operations will issue a minimum of one (1) padlock and one (1) multiple lockout hasp to each department employee. Additional equipment will be made available as required through discussion with the employee's direct supervisor. Each employee will be responsible for their assigned padlock(s) and must immediately report damage and/or loss of their padlock(s) to the Facilities Operations Manager or Assistant Manager.

2.1.2 Each padlock will be uniquely keyed. Master keying or key crossover is not permitted. Exception to this are permitted when a single piece of equipment requires multiple locks to lock out multiple sources of energy, such as a boiler. Each lock may be keyed alike with a single key to operate all locks. Multiple alike keys are not permitted.

2.1.3 Extra padlocks are available when needed and will be signed out when removed from a lockout station (see section B below for lockout station locations). If a staff member uses an extra padlock, they must record the required information in the logbooks located in the lockout stations.

2.1.4 Seasonal padlocks attached for long term use / isolation of systems shall be accompanied with a lockout tag. These locks will be kept in lockout cabinets.

3. Lockout Stations

3.1 Lockout stations are located as follows:

Midtown Campus	Chicopee Campus	Queens Blvd Campus
1B Maintenance/Facilities 2nd Floor 40 Green Mechanical Room 3F Mechanical Room 4B Mechanical Room 5A Mechanical Room 6J Mechanical Room	Village Centre 1 Maintenance/Facilities Grand River Terrace Penthouse Pioneer Terrace Penthouse Power house Union Terrace	B-118 Facilities Operations

7D Mechanical Room 8D Mechanical Room Power house	Penthouse Village Centre Penthouse	

Contents of lockout stations may include, sign out logbook, additional padlocks, hasps, red personal locks safety devices and tags. Smaller point of use stations may only have locks and tags.

4. **Procedure**: Lock Out Tag Out of Equipment

4.1 Prepare for shutdown:

- 4.1.1 Define the work to be executed;
- 4.1.2 Identify the equipment concerned;
- 4.1.3 Identify related documentation;
- 4.1.4 Define hazard of energy sources involved;
- 4.1.5 Identify hazards of energy sources to be controlled;
- 4.1.6 Identify methods or means to control the energy;
- 4.1.7 Identify persons who will be placing their individual lock on the equipment or is this a seasonal lock;
- 4.1.8 Notify those affected by the lockout.

4.2 Shutdown equipment using the normal control device(s).

4.3 Relieve any stored energy to energy level zero or to a safe level and consider secondary sources of energy.

4.4 Isolate equipment by the disconnect / isolation points for the source(s) of energy.

4.5 Lockout and tag out device application to the disconnect/isolation points:

- 4.5.1 Use a padlock and hasp to lockout equipment.
- 4.5.2 Affix a lockout tag to the padlock which will include the name of the lockout originator.
- 4.5.3 If more than one worker is working on equipment, each worker must place a padlock on the power source. If more than one power source is to be locked out:
  - 4.5.3.1 Each worker must lock out each source; or

4.5.3.2 One lock will be used on each source of energy and the keys to these locks put in a group lock box and each worker puts a lock on the group lock box.

4.5.3.3 For padlocks left on pieces of equipment for greater than one shift, the keys will be stored in a lockout cabinet (see section B above for lockout station locations) and a lockout tag will be affixed to the padlock which will include appropriate details of the lockout. Only the originator can remove the padlock, unless approved by the department manager.

4.6 Verify de-energized status by attempting to restart with control device, pressure relief valve, or other method which ensures all sources of energy have been isolated. Never assume the isolation point functions until tested.

4.7 Carry out the work.

4.7.1 After work is complete, release from lockout/tag out:

4.7.1.1 Work area and equipment must be inspected to ensure that nonessential items have been removed, such as tools, spare parts, garbage, etc.

4.7.1.2 Check work area to ensure that all employees have been accounted for and safely positioned.

4.7.1.3 Remove lockout/tag out devices and notices.

4.7.1.4 Re-energize the equipment.

4.7.1.5 Run the equipment through an operation cycle to confirm all energy sources are functioning.

5. Removal of Lock Out Tag Out – Lock Owner Unavailable

In the event the employee is not on site or otherwise unavailable, and a situation arises requiring their personal lock to be removed, the following process shall be followed:

5.1 Contact Facilities Operations Manager or Assistant Manager (Hereafter referred to as Management). Management will follow and document the steps of the removal process with Appendix 1: LOTO Lock Removal Form. Management will attempt to contact the owner of the personalized lock with the request to return to site and remove their individual lock.

5.2 If Management is unable to contact or the individual is unable to return to site, Management will determine if it is appropriate to remove the lock.

5.3 Under Management direction, only a person who is qualified by knowledge, training and/or experience may remove another person's lock once a repair, etc., is finished and a comprehensive check is conducted to ensure safe operations. Management will notify the original owner of the lock to let them know the lock was removed and complete LOTO Removal Form.

6. Documentation:

6.1 Training and assignment records shall be kept and held by managers/supervisors for three years to comply with any audits from the Ministry of Labour (MOL).

6.2 All LOTO Absent Worker Lock Removal Forms must be properly filled out and copies to be kept by managers/supervisors for three years. Digital copies are acceptable provided they are stored on a backed up server space.

7. REFERENCES

7.1 *Ontario Occupational Health and Safety Act*
7.2 *Industrial Establishments (O Reg 851)*
7.3 *Health Care and Residential Facilities (O Reg 67/93)*
7.4 *Control of Hazardous Energy Z460-05*

Appendix D – Low Voltage Wiring Policy **– No Attachments**

8. PURPOSE

The purpose of this policy is to establish clear standards and procedures for the installation, grounding, bonding, and routing of low-voltage wiring systems within Waterloo Regional Health Network (WRHN) facilities. These standards ensure:

8.1 *Safety* and Compliance: Maintaining the integrity of fire-rated assemblies through proper fire stopping and adherence to applicable codes and standards (e.g., CSA, ANSI/TIA, IEEE).

8.2 Operational Reliability: Supporting the performance and longevity of telecommunications and structured cabling systems by enforcing best practices for installation and maintenance.

8.3 Regulatory Requirements: Meeting obligations under the Canadian Electrical Code, Ontario Hydro Electrical Safety Code, and other relevant standards to comply with legislation and accreditation requirements.

8.4 Risk Mitigation: Reducing hazards associated with improper wiring, grounding, and fire barrier breaches, thereby protecting patients, staff, and infrastructure.

This policy is necessary to ensure that all low-voltage wiring work is performed consistently, safely, and in accordance with industry standards and regulatory requirements, while supporting WRHN's commitment to operational excellence and patient safety.

9. POLICY STATEMENT

Waterloo Regional Health Network (WRHN) is committed to ensuring that all low-voltage wiring installations are performed safely, consistently, and in compliance with recognized industry standards and regulatory requirements. All contractors, staff, and departments involved in the installation, maintenance, or modification of low-voltage wiring systems must adhere to the standards outlined in this policy. These standards take precedence over any conflicting specifications in project bid documents unless a written variance is approved by the Manager of Facilities Operations or Facilities Operations Project Manager. This policy reflects WRHN's dedication to maintaining system integrity, protecting life safety features such as fire separations, and supporting reliable telecommunications infrastructure across all facilities.

10. SCOPE

This policy applies to all low-voltage wiring installations, modifications, and maintenance activities within Waterloo Regional Health Network (WRHN) facilities. It covers:

10.1 Contractors performing structured cabling work under WRHN projects.

10.2 Facilities Operations staff and managers overseeing infrastructure projects.

10.3 Information Technology department responsible for network and telecommunications systems.

10.4 Any WRHN staff or third-party vendors involved in the planning, approval, or execution of low-voltage wiring work.

The policy governs all aspects of low-voltage wiring, including grounding and bonding, cable routing, fire stopping, and compliance with applicable codes and standards. It applies to both permanent and temporary installations and includes requirements for documentation and approvals.

11. DEFINITIONS

11.1 Authority Having Jurisdiction (AHJ): An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

11.2 Structured Cabling System: A standardized system of cabling and associated hardware that provides a comprehensive telecommunications infrastructure.

11.3 Grounding and Bonding: The process of connecting electrical systems to the earth (grounding) and interconnecting conductive parts to maintain equal electrical potential (bonding).

11.4 Fire Stopping: The installation of fire-resistant materials to seal openings and maintain the fire-resistance rating of walls, floors, and other barriers penetrated by cables or conduits.

11.5 Telecommunications Room: A space dedicated to housing telecommunications equipment, cable terminations, and cross-connects.

11.6 Horizontal Cabling: Cabling that runs from the telecommunications room to individual work areas, typically limited to 90 meters.

11.7 Standard Communications Outlet (SCO): A designated outlet that typically includes one voice jack, two data jacks, and a spare port in a single gang box.

12. ROLES & RESPONSIBILITIES

12.1 Director of Facilities Operations: It is the responsibility as the Director Facilities Operations to maintain this policy.

12.2 Manager of Facilities Operations / Facilities Operations Project Manager : It is the responsibility as the Facilities Operations Manager/Project Manager to provide and approve any variances surrounding this policy.

12.3 Staff & Managers: It is the responsibility of the Staff and Managers to comply with this policy.

12.4 Information Technology: It is the responsibility of the Staff and Managers to comply with this policy.

12.5 Contractors: It is the responsibility of the Contractor to understand the specifications and standards contained in this document and adhere to them.

POLICY

1. Grounding and Bonding

1.1 General

Provide grounding a bonding in accordance with good industry practices and in accordance with the following codes and standards:

1.1.1 CSA Standard C22.2 No.41-M1987 - Grounding and Bonding Equipment

1.1.2 ANSI/TIA/EIA-569-B - Telecommunications Pathways and Spaces

1.1.3 IEEE std 1100-2005 Recommended Practice for Powering and Grounding Electronic Equipment (Emerald Book)

1.2 Product

A green jacketed #6 AWG stranded copper conductor shall be used to bond the telecommunications grounding system to all:

1.2.1 Telecommunications Cabinets

1.2.2 Telecommunication Racks

1.2.3 Telecommunication Cable Tray (if required)

1.3 Procedure

1.3.1 Grounding and bonding infrastructures installed by the contractor shall not interfere with the existing grounding practices within the customer premises.

1.3.2 All telecommunications equipment shall be bonded and grounded to the provided grounding system as per ANSI-J-STD-607-A-2002.

2. Pathways for Communications Systems

2.1 General

2.1.1 All wire routes are to be submitted to the hospital Project Manager or Facilities Operations Manager for signed and dated approval prior to work commencing. Wire routes submissions are to be superimposed over top of the "Fire Separation" layer as found in the hospitals online digital drawing database.

2.1.2 The contractor shall not use any mechanical or electrical fittings to support the telecommunications cabling. All telecommunications cabling shall be independently supported.

2.1.3 The contractor shall independently support the cables above ceiling tiles in a manner where the cables do not interfere with the removal of the ceiling tiles. A minimum of 75mm or 3 (in) of clear vertical space above the ceiling tiles shall be maintained.

2.1.4 Any ceiling tiles or access panels removed by the Contractor will be re-installed in good condition. Replacement of damaged tiles or access panels is the Contractor's responsibility at no cost to the Hospital.

2.1.5 The contractor shall run all cable support hangers and innerduct parallel or perpendicular to building lines.

2.1.6 The contractor shall maintain the following minimum clearances from electrical and heat sources when routing copper cables.

Item	Minimum Separation Distances

	(<2kVA)	(2-5kVA)	(>5kVA)
Unshielded to Unshielded: Unshielded power lines or electrical equipment in proximity to open or non- metallic pathway.	127 mm (5")	305 mm (12")	610 mm (24")
Unshielded to Shielded: Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway.	64 mm (2-1/2")	152 mm (6")	305 mm (12")
Shielded to Shielded: Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway.	--	76 mm (3")	152 mm (6")
Motors	1.2 m (4'-0")		
Transformers	1.2 m (4'-0")		
Fluorescent Luminaries	300 mm (12")		
Pipes (gas, oil, water, etc.)	120 mm (5")		
HVAC (equipment, ducts, etc.)	150 mm (6")		

2.1.7 Cable support hangers must not be drilled into post-tensioning beams under any circumstances.

2.1.8 Supports shall be sized to accommodate the number of cables in each run and as per manufacturer recommendations to avoid overloading.

2.1.9 All components of cable tray which contact cables shall have rounded edges. Waterfalls shall be provided where cables must exit over sharp edge of tray.

2.1.10 Trays must be supported at both sides at intervals no greater than 1.5m (5').

2.1.11 Hangers, where utilized, shall be spaced at intervals no greater than 1.5m (5').

2.1.12 Conduits shall not have more that two 90 degree or equivalent bends in each run (max total bends = 180 degrees per run), with the bending radii not less than 10 times the conduit diameter.

2.1.13 Conduit shall adhere to the following chart in regards to conduit fill allowances:

MAXIMUM NUMBER OF CABLES BASED UPON ALLOWABLE FILL						
Conduit Trade Size	**CABLE OUTSIDE DIAMETER, mm (in)**					
	5.6 (.22)	**6.1 (.24)**	**7.4 (.29)**	**7.9 (.31)**	**9.4 (.37)**	**13.5 (.53)**
16 (1/2)	0	0	0	0	0	0
21 (3/4)	4	3	2	2	1	0
27 (1)	7	6	3	3	2	1
35 (1-1/4)	12	10	6	4	3	1
41 (1-1/2)	16	15	7	6	4	2
53 (2)	22	20	14	12	7	4
63 (2-1/2)	36	30	17	14	12	6
78 (3)	50	40	20	20	17	7

91 (3-1/2)	-	-	-	-	22	12
103 (4)	-	-	-	-	30	14

2.1.14 Note: Do not exceed 60% of maximum fill shown in above table for conduits over trade size 35 (1-1/4)

2.1.15 Obsolete cable shall be removed in all reasonable circumstances or at the discretion of the Facilities Operations Manager or Facilities Operations Project Manager. Care must be taken to avoid damaging any other cable that may be run in the same area as that cable which is to be removed.

2.1.16 Cables shall be bundled using only Velcro tie wraps. The use of plastic zip ties or metal wire ties are not permitted.

3. Communications Horizontal Cabling

3.1 General

3.1.1 Horizontal cabling is the portion of the telecommunications cabling system that extends from the work area telecommunications outlet to the horizontal cross-connect in the telecommunication room. The horizontal cabling includes the horizontal cables, the telecommunication outlet in the work area, and the horizontal cross-connect.

3.1.2 The maximum horizontal distance shall be 90 meters (295 feet), from the horizontal cross-connect in the telecommunication room to the work area outlet.

3.1.3 Typical horizontal cabling pathway will consist of a minimum 25 mm (1") metallic in-wall conduit from workstation outlet, stubbed into ceiling space. From there, cable tray or J-hooks will be installed back to the telecommunications room. Contractor shall provide cable support hangers to support telecommunications cabling between exiting conduit to entering the cable tray or j-hook, where required.

3.1.4 Surface mount conduit is only acceptable under two conditions.

3.1.4.1 In-wall conduit is not possible due to the construction of the wall. Examples are speed tile or cinderblock construction.

3.1.4.2 In-wall conduit is not practical due to the application. An example would be a high-density environment such as a training room.

3.1.5 Cabling may be run in-wall unshielded (loose) provided the following conditions are met:

3.1.5.1 The cable does not serve a clinical need or reside in a clinical space.

3.1.5.2 Approval to do so is given in writing by the Hospital Project Manager or Facilities Operations Manager.

3.1.6 Unless otherwise specified, a Standard Communications Outlet (SCO) shall consist of a voice jack, two data jacks, and a spare port in a single gang box. The SCO box and pathway leading to it shall also contain a pull string for future expandability. Other communication outlets may be installed depending on the function for that particular office or room.

4. Temporary Cabling

4.1 General

4.1.1 To satisfy the temporary cabling needs often associated with renovations and other project work, deviations from this policy may be permitted provided they meet the following criteria:

4.1.1.1 Predefined dates exist for both cabling installation and removal.

4.1.1.2 The dates and costs associated with the temporary cable installation and removal are captured in the contract documents or purchase order.

4.1.1.3 Any devastations from this policy are approved by the Facilities Operations Manager or Facilities Operations Project Manager.

4.1.2 Deviations from section 5 (Fire Stopping) will not be permitted under any circumstance.

5. Fire Stopping

5.1 General

5.1.1 The contractor shall provide all required Fire Separations with fire stop and smoke seals that form tight barriers to retard the passage of smoke and flame. These seals shall remain the same fire resistance rating as the adjacent floors, walls or other fire separation assemblies.

5.1.2 Fire stop Systems shall follow the criteria set by ULC Standard CAN4-S115 for fire stopping requirements.

5.1.3 The contractor shall be responsible to restore the integrity of any established fire barrier that the cabling contractor disturbs in any way, by any means.

5.1.4 The contractor shall be responsible to fire stop all sleeves that cross through a fire barrier, cable tray, innerduct, cable bundles, conduit; including sleeves that are empty, partially empty or filled with cabling, regardless if those sleeves were or were not found fire stopped. The installed seals shall provide and maintain the fire resistance rating of the adjacent floor, wall or other fire separation assembly. The contractor shall provide non-permanent client approved intumescent fire stopping.

5.1.5 Fire stop systems shall be UL Classified to ASTM E814 (UL 1479). A technical document demonstrating the products compliance to this standard shall be provided to the Facilities Operations Manager or Facilities Operations Project Manager prior to the installation of the fire stop system(s).

5.1.6 If the route submitted as per section 2.1 (i) penetrates an existing fire separation, the cabling contractor is also to include a material list (wire type, conduit type, fire stopping material) as part of the submission before approval is to be authorized.

5.1.7 If the work does not require a City of Kitchener building permit, or is not part of a larger project requiring City of Kitchener building permit, fire stopping must be performed by a an individual trained and certified by a fire stopping product manufacturer (Hilti, 3M, etc).

6. Identifications for Communications Systems

6.1 All drops shall be labeled on the cable at each end and clearly indicated on the cover plate and the panel schedule.

7. Public Address System

7.1 Requires written approval by the Facilities Operations Manager or Facilities Operations Project Manager.

8. Television CATV System

8.1 Requires written approval by the Facilities Operations Manager or Facilities Operations Project Manager.

9. DOCUMENTATION

9.1 **Testing and Record Documentation-** Latency testing shall be performed on all new cabling equipment projects designated for procedure and operating rooms. Results will be documented and provided to Facilities Operations Project Manager, and Facilities Operations Manager.

9.2 **As-Built Documentation -** Wire routes submissions are to be superimposed over top of the "Fire Separation" layer as found in the hospitals online digital drawing database.

10. COMPETENCIES & EDUCATION

10.1 The contractor shall only provide tradespersons who are fully trained, qualified, certified and experienced on the installation, termination and testing of the Structured Cabling System proposed.

11. QUALITY ASSURANCE

11.1 Any staff member identifying potential or actual adverse outcomes resulting from implementing this policy will follow the safety incident reporting process. This document will be reviewed per hospital policy framework or any updates to the standards related to this document.

11.2 The contractor shall make any changes or alterations required by the authorized inspector of the Authority Having Jurisdiction (AHJ).

11.3 The contractor shall not sub-contract any work without express written consent from the Owner or Owner's appointed representative.

12. RELATED DOCUMENTS

See Contractor Package.

13. APPENDICES

Not applicable.

14. REFERENCES (Codes and Standards)

14.1 The equipment, materials and installation shall conform to the latest versions of the applicable Codes, Standards (including technical service bulletins and addenda) and regulations of the authorities having jurisdiction.

14.1.1 BICSI - Telecommunications Distribution methods manual (TDMM) 11th edition

14.1.2 BICSI - Information Transport Systems Installation manual (ITSIM) 4th edition

14.1.3 BICSI - Outside Plan Design Reference Manual (OPDRM) 4th edition

14.1.4 CSA C22.1 - Canadian Electrical Code Part 1 Ontario Hydro Electrical Safety Code

14.1.5 ANSI/TIA/EIA-568-B - Commercial Building Telecommunications Cabling Standard

14.1.6 ANSI/TIA/EIA-569-B - Commercial Building Standard for Telecommunication Pathways and Spaces

14.1.7 ANSI/TIA/EIA-606-A - Administration Standard for Telecommunications Infrastructure of Commercial Buildings

14.1.8 CSA T527 - Commercial Building Grounding and Bonding Requirements for Telecommunications

14.1.9 CSA C22.2 No. 214 - Communications Cables

14.1.10 CSA C22.2 No. 232-M - Fiber Optic Cables

14.1.11 CSA C22.2 No. 182.4-M90 - Plugs, Receptacles, and Connectors for Communication Systems

14.1.12 ISO/IEC IS11801A - Generic Cabling for Customers Premises

14.1.13 Cenelec EN 50173 - Performance Requirements For generic Cabling Schemes

14.1.14 IEC 603-7, Part 7 - Detailed Specifications for Connectors, 8-Way Including Fixed and Free Connectors with Common Mating Features

14.1.15 FIPS PUB 174 - Commercial Building Telecommunications Wiring Standard. Federal Information Standard Publication

14.1.16 UL 444 and 13 - Adopted Test and Follow-up Service Requirements for the Optional Qualification of 100-Twist Pair Cables

14.1.17 IEC 807-8 - Rectangular Connectors for Frequencies below 3MHz, Part 8: Detailed Specifications for Connectors, Four Signal Contacts and Earthing Contacts for Cable Screens, First Edition

14.1.18 NEMA EC 63 - Performance Standards for Field Testing of unshielded Twisted-Pair Cabling System

14.1.19 ANSI/EIA/TIA-492AAAA - Detailed Specification for 62.5um Core Diameter/125um Cladding Diameter Class 1a Multimode, Graded Index Optical Waveguide Fibers

14.1.20 ANSI/EIA/TIA-492BAAA - Detailed Specifications for Class Iva Dispersion Unshifted Single mode Optical waveguide Fibers Used in Communication Systems
14.1.21 ANSI/EIA/TIA-492CAAA - Detailed Specifications for all Dielectric (Construction Fiber Optic Communication Cable for Indoor Plenum use, Containing Class 1a, 62.5um Core Diameter/125um Cladding Diameter Fiber Optics
14.1.22 ANSI/EIA/TIA-492DAAA - Detailed Specifications for all Dielectric Fiber Optic Communication Cable for Outdoor Plant Use, Containing Class 1, 62.5um Core Diameter/250um Cladding Diameter Fiber Optic(s)
14.1.23 ANSI/EIA/TIA-455 - Test Procedures for Fiber Optics, Cables and Transistors
14.1.24 ANSI/EIA/TIA-598 - Colour Coding of Fiber Optic Cables
14.1.25 ANSI/EIA/TIA-604-3 - FOCIS 3 Fiber Optic Connector Intermateability Standard
14.1.26 J-STD-607 - Commercial Building Grounding and Bonding Requirements for Telecommunication
14.1.27 ANSI Z136.2 - American Standards for the Safe Operation of Fiber Optic Communications Systems Utilizing Laser Diode and LED Sources
14.1.28 ANSI/ICEA S-83-596 - Fiber Optic Outside Plant Communication Cable
14.1.29 ANSI/ICEA S-83-596 - Fiber Optic Premises Distribution Cable
14.1.30 IEEE 802.3af - Data terminal Equipment (DTE) Power Over Media Dependant Interface (MDI), 2003 (Superseded by IEEE 802.3-2005)
14.1.31 ANSI/EIA/TIA-526-7 - Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant
14.1.32 IEEE 802.3an - Specification for 10 Gb/s Operation over Category 6 or higher 4-Pal Balanced Twisted Pair Cabling.

Appendix E — Emergency Codes: Contractor/Vendor Responsibilities

Emergency Extensions

WRHN @ Queens: 888

WRHN @ Midtown / Chicopee: 77

WRHN @ Withdrawal Management Clinic: 77 or 911 in an emergency

WRHN @ 850 King: 77 or 911 in an emergency

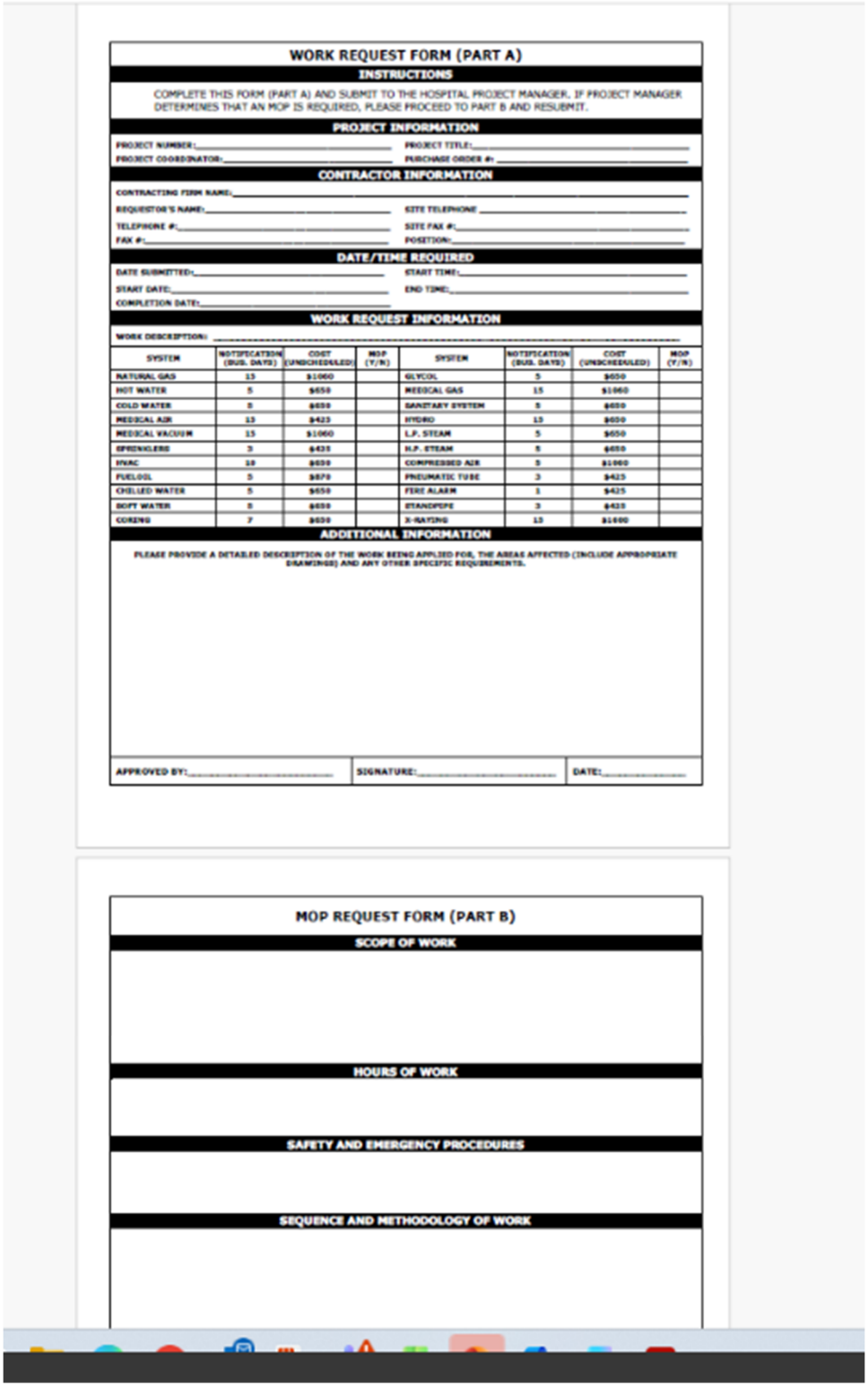
**Information provided by Brandon Furtado March 4, 2026*

Code / Type	Inside Construction Area	Outside Construction Area

Code Black – Bomb Threat	Stop work. Leave area. From a safe location report suspected items. Be prepared to identify objects if asked.	Continue normal operations. Be prepared for further instructions from WRHN.
Code Grey – Air Exclusion	Not applicable.	Stop work. Stay inside. Turn off fans/HVAC/air-moving equipment in the construction zone. Close doors/windows. Await instructions.
Code Grey – Essential Services Outage	Continue work if safe. Follow supervisor guidance. Report hazards immediately.	Continue normal operations if safe. Be prepared for further instructions.
Code Grey – Infrastructure Failure / System Loss	Continue normal operations. Watch for hazards; report via posted ext.	Continue normal operations. Watch for hazards; report via posted ext.
Code Blue – Cardiac Arrest	Stop work in immediate area of Code Blue and make room for responders.	Continue normal operations.
Code Pink – Pediatric Arrest	Stop work in immediate area of Code Pink and make room for responders.	Continue normal operations.
Code Purple – Hostage Taking	Stop work. Leave area. Notify supervisor or WRHN Project Coordinator.	Continue working indoors, but be prepared for instructions from WRHN or emergency personnel.
Code Yellow – Missing Patient	Continue normal operations. Watch for the patient as described; report if seen.	Continue working. Watch for patient; report if seen.

Code Green – Evacuation	Stop work and leave the area. Report to supervisor or WRHN Project Coordinator.	Continue normal operations unless instructed otherwise. Be prepared for direction from WRHN.
Code Brown – Chemical / Hazardous Spill	Follow contractor spill procedures. Notify supervisor & WRHN Project Coordinator. If spill is inside building envelope, call posted ext. and state: "Code Brown + location."	Continue normal operations. Be prepared for further instructions.
Code Red – Fire	Follow contractor fire procedures: pull alarm if you see, smell, hear fire or smoke, call the posted ext., provide location, close doors if safe, evacuate if instructed, and follow WRHN directions.	Continue working, but be prepared for instructions from WRHN or emergency personnel.
Code White – Violent Situation	Continue normal operations but avoid the identified area. Follow project staff direction.	Continue normal operations but be prepared for instructions from WRHN.
Code White Caution – Violent Situation with a weapon (non-firearm)	Continue normal operations but avoid the identified area. Follow project staff direction.	Continue normal operations. Avoid the area as announced.
Code Aqua – Water/Flood	Stop work if water impacts the construction zone. Protect materials if safe. Report water intrusion to WRHN Project Coordinator and posted ext.	Continue normal operations unless impacted. Await direction from WRHN Facilities/Project staff.

Appendix F – Word Request Form – See attachment



WORK REQUEST FORM (PART A)

INSTRUCTIONS

COMPLETE THIS FORM (PART A) AND SUBMIT TO THE HOSPITAL PROJECT MANAGER. IF PROJECT MANAGER DETERMINES THAT AN MOP IS REQUIRED, PLEASE PROCEED TO PART B AND RESUBMIT.

PROJECT INFORMATION

PROJECT NUMBER:_____ PROJECT TITLE:_____

PROJECT COORDINATOR:_____ PURCHASE ORDER #:_____

CONTRACTOR INFORMATION

CONTRACTING FIRM NAME:_____

REQUESTOR'S NAME:_____ SITE TELEPHONE _____

TELEPHONE #:_____ SITE FAX #:_____

FAX #:_____ POSITION:_____

DATE/TIME REQUIRED

DATE SUBMITTED:_____ START TIME:_____

START DATE:_____ END TIME:_____

COMPLETION DATE:_____

WORK REQUEST INFORMATION

WORK DESCRIPTION: _____

SYSTEM	NOTIFICATION (BUS. DAYS)	COST (UNSCHEDULED)	MOP (Y/N)	SYSTEM	NOTIFICATION (BUS. DAYS)	COST (UNSCHEDULED)	MOP (Y/N)
NATURAL GAS	15	$1060		GLYCOL	5	$650	
HOT WATER	5	$650		MEDICAL GAS	15	$1060	
COLD WATER	5	$650		SANITARY SYSTEM	5	$650	
MEDICAL AIR	15	$423		HYDRO	15	$650	
MEDICAL VACUUM	15	$1060		L.P. STEAM	5	$650	
SPRINKLERS	3	$423		H.P. STEAM	5	$650	
HVAC	10	$650		COMPRESSED AIR	5	$1060	
FUELOIL	5	$870		PNEUMATIC TUBE	3	$425	
CHILLED WATER	5	$650		FIRE ALARM	1	$425	
SOFT WATER	5	$650		STANDPIPE	3	$423	
CORING	7	$650		X-RAYING	15	$1600	

ADDITIONAL INFORMATION

PLEASE PROVIDE A DETAILED DESCRIPTION OF THE WORK BEING APPLIED FOR, THE AREAS AFFECTED (INCLUDE APPROPRIATE DRAWINGS) AND ANY OTHER SPECIFIC REQUIREMENTS.

APPROVED BY:_____ SIGNATURE:_____ DATE:_____

MOP REQUEST FORM (PART B)

SCOPE OF WORK

HOURS OF WORK

SAFETY AND EMERGENCY PROCEDURES

SEQUENCE AND METHODOLOGY OF WORK

Appendix G – Pre-Construction Checklist

Once Finalized to be pasted here.

Appendix H – Respectful Workplace Policy - For Contractors, reporting and escalation of concerns under this policy should be initiated through the WRHN Designated Point of Contact, unless otherwise directed by WRHN.

1. PURPOSE

Waterloo Regional Health Network is committed to ensuring that all members of the hospital community behave in a respectful, civil, and professional manner with each other and everyone with whom they interact in our workplace and exemplify safe and compassionate patient care. Waterloo Regional Health Network is also committed to providing and fostering a positive and respectful workplace free from; discrimination and harassment and actual, attempted or threatened violence. The Hospital recognizes that discrimination, harassment and workplace violence are health, safety and Human Resources issues which work against Hospital values. Waterloo Regional Health Network will take all reasonable precautions to prevent these behaviours and protect workers at the workplace.

This policy is intended to address behaviour which does not put Hospital Representatives in imminent danger or risk of imminent harm.

2. POLICY STATEMENT

Waterloo Regional Health Network will not tolerate incidents of discrimination or harassment or workplace violence ("Prohibited Behaviour") carried out against any Hospital Representatives at the workplace or involved in hospital business. Potential sources of Prohibited Behaviour can include workers, patients, volunteers, students, credentialed professional employees, visitors and contractors.

They could also include situations where someone in a personal relationship with a Hospital Representative may expose employees or other persons to violence in the workplace

("Workplace Domestic Violence"). For details, refer to the Domestic Violence Policy. For incidents that put Hospital Representatives in imminent danger or risk of imminent harm, Hospital Representatives should follow the Workplace Violence Policy and required procedures and protocols.

For incidents related to Patient/Visitor Prohibited Conduct please refer to Appendix D for details and the related procedures.

Hospital Representatives are encouraged to report all incidents and complaints related to Prohibited Behaviour. Waterloo Regional Health Network will investigate and deal with these reports and complaints in a fair, impartial and timely manner, including those reported by a third party.

3. SCOPE

This policy applies to all members of the Waterloo Regional Health Network community, which includes full-time, part-time, temporary, casual or contract employees, including supervisors and managers, all credentialed professional employees, physicians, board members, volunteers, post-graduate medical trainees, researchers and any students who perform work or supply services to the Hospital.

This policy should be interpreted and applied in accordance with the collective agreement(s), if applicable. In the event of any discrepancy between this Policy and an employee's employment contract, and the collective agreement(s) (if applicable), the collective agreement shall take precedence.

4. RESPONSIBILITIES Copy Link

All Hospital Representatives are responsible for maintaining a workplace free of Disrespect and Prohibited Behaviour:

Understand that actions and behaviour can and do impact others.

- Foster a respectful work environment.

- Act with the highest standards of personal and professional integrity and conduct in dealings with patients, colleagues and the public.
- Participate in education and training programs regarding Disrespect and Prohibited Behaviour.
- Address behaviour that contravenes this policy when they see it or experience it.
- Refrain from participating in or encouraging behaviour that negatively impacts other individuals.
- Attempt informal resolution of an incident of Disrespect or Prohibited Behaviour, where willing and appropriate.
- Report an incident of Disrespect or Prohibited Behaviour regarding a Hospital Representative to the Manager or Labour and Employee Relations.
- Utilize any controls and/or following preventative measures put into place to prevent Disrespect or Prohibited Behaviour.
- Support efforts aimed at preventing Prohibited Behavior by patients and/or visitors through the implementation, adherence to, and updating of the patient care plan and relevant measures, as deemed suitable.

Chief of Staff

- Establish measures and procedures to prevent Prohibited Behaviour and require credentialed employees to comply with the measures and procedures.
- Contact Labour and Employee Relations should they become aware of any complaints of Disrespect or Prohibited Behaviour that involve a credentialed employee member, so Labour and Employee Relations can conduct a threshold assessment.
- If the threshold assessment deems that Prohibited Behaviour may have been present, and the Complainant, the Respondent, or both are credentialed employee members, the Director, Labour and Employee Relations and Chief of Staff Office will jointly decide whether the complaint is investigated internal to the hospital or an external investigator will be retained.
- The Director, Labour and Employee Relations and Chief of Staff Office will decide which office will have 'carriage' of the complaint. Carriage of the complaint will involve

updating the Complainant and Respondent as appropriate, liaising with the Complainant and Respondent regarding Confidentiality Agreement, Notification Letter, Acknowledgement Letter, as well as liaising with and providing support to an external investigator where appropriate.

- Provide regular reporting to the Respectful Workplace Consultant (RWC) as it relates to the status of respectful workplace matters.

Executives

- Establish measures and procedures to prevent Prohibited Behaviour, and require Hospital Representatives to comply with the measures and procedures.
- Have Hospital Representatives (including directors) participate in the training provided on this policy.
- Hold Managers accountable for responding to, following up and resolving incidents, reports or complaints of Prohibited Behaviour.
- Follow up on any incidents reported or witnessed related to Prohibited Behaviour, including reports from a third party.
- Provide support and allocate resources as required to prevent Prohibited Behaviour, to follow up on any complaints reported, and/or on recommendations received following a Formal Investigation.

Managers

- Ensure Hospital Representatives for whom they are responsible participate in training provided on this policy and program.
- Take steps to make Hospital Representatives for whom they are responsible aware of the requirements of the Respectful Workplace Policy and Program and to foster compliance.
- Provide information on the Respectful Workplace Policy and Program to Hospital Representatives for whom they are responsible if requested and/or refer Hospital Representatives for whom they are responsible to Employee Relations.

- As needed or requested, support any Hospital Representative with an informal resolution of an incident of Disrespect or Prohibited Behaviour.
- Refer Hospital Representatives for whom they are responsible, wishing to report a complaint under this policy, to Labour and Employee Relations, where appropriate.
- Implement and maintain appropriate controls, corrective actions and measures to prevent and eliminate Prohibited Behaviours (both immediate and long-term).
- As needed, consult with the Labour and Employee Relations regarding any incidents reported or witnessed related to Prohibited Behaviour, including reports from a third party.
- Follow up on any applicable recommendations issued by the Respectful Workplace Consultant following a Formal Investigation and implement steps to prevent recurrences.
- Consult as needed with the Labour and Employee Relations regarding any aspect of this policy and procedure.

The Respectful Workplace Consultant (RWC)

- As needed or requested, support any Hospital Representative with an informal resolution of an incident of Disrespect or Prohibited Behaviour.
- Receive and follow up regarding complaints or reports brought forward by Labour and Employee Relations to the Respectful Workplace Consultant related to this policy.
- Determine who will conduct Formal Investigations appropriate to the circumstances for complaints received, taking into account conflicts of interest; consultations with the Director, Labour and Employee Relations or Chief of Staff as required.
- Provide the Complainant(s) with an Acknowledgement Letter that acknowledges receipt of the complaint and the commitment to formally investigate the concern.
- Provide the Respondent with a Notification letter that notifies the Respondent that a complaint has come forward and which includes the allegations against the Respondent.
- Conduct Formal Investigations where appropriate.

- Not disclose information about an incident or complaint except to the extent necessary to protect Hospital Representatives, to investigate a complaint, to resolve a complaint informally, or as otherwise required by law.
- Following the investigation of a complaint, provide a report including the findings and recommendations to the applicable stakeholders.
- Provide Hospital Representatives education and training regarding the requirements of this policy to all levels in the organization.
- Provide coaching and education to Hospital Representatives with the goal of improving skills and building capacity in the areas of improved communication, collaboration and conflict management.
- Where a matter is referred to the Respectful Workplace Consultant via the applicable stakeholder(s), provide early intervention in conflict situations through implementing alternative dispute resolution methods such as: mediation, education, conflict coaching and facilitated dialogue and sharing of apologies.
- Provide information about other resources for Hospital Representatives to seek help to address Disrespect or Prohibited Behaviour (e.g. Labour and Employee Relations, union representative, Employee Family and Assistance Program (EFAP), etc. as appropriate).
- At least annually, take part in the review of the Respectful Workplace Policy and Program.

Labour and Employee Relations

- Provide confidential consultation on this policy.
- Respond to questions regarding options and responsibilities under this policy.
- As needed or requested, support any Hospital Representative with an informal resolution of an incident of Disrespect or Prohibited Behaviour.
- Receive and follow up regarding complaints or reports brought forward by Hospital Representatives.
- Conduct threshold assessments to determine whether reported incidents would, if true, represent Prohibited Behaviour under this policy.

- Forward incidents that meet the threshold of Prohibited Behaviour to the Respectful Workplace Consultant for formal investigation.
- Address incidents of Disrespect accordingly.
- Receive and review, where applicable, the Formal Investigation findings.
- Following the Formal Investigation of a complaint, meet with the Complainant(s) and provide a written letter outlining the outcome of the investigation and whether any corrective and/or educational actions will be taken with regard to the Respondent(s) (as appropriate).
- Following the Formal Investigation of a complaint, meet with the Respondent(s) and provide a written letter outlining the outcome of the investigation and where appropriate, what specific corrective and/or educational actions will be taken.

Employee Health, Safety and Wellness (EHSW)

- At least annually, review and update this policy and program in consultation Labour and Employee Relations.
- Refer any reports or complaints received to Labour and Employee Relations.

Joint Health and Safety Committees (JHSCs)

- Provide input into the establishment of controls and measures to prevent Prohibited Behaviour and Disrespect.
- Provide input into the hospital training programs related to Prohibited Behaviour and Disrespect prevention.
- At least annually, take part in a review of the Respectful Workplace Policy and Program, and provide feedback.
- Post the policy on the JHSC bulletin boards and on the hospital intranet.

Purchasing

- Provide a copy of Appendix E of this policy (Contractor Requirements Under the Waterloo Regional Health Network Respectful Workplace Policy) to contractors who they deal with.

5. PROCEDURE

This policy and program define Prohibited Behaviour, and outline procedures for reporting, investigating and dealing with incidents and complaints related to this behaviour (Appendix A - Respectful Workplace Investigation Procedural Steps). All Hospital Representatives are responsible for acting in compliance with this policy and program. Waterloo Regional Health Network considers any behaviour in contravention of this policy as serious. The Hospital will take corrective and/or disciplinary action deemed necessary, up to and including termination or non-renewal of employment/contract/privileges, in order to provide a safe and respectful workplace for Hospital Representatives, as well as an environment that exemplifies safe and compassionate patient care.

Complaints made under this policy shall be made without fear of reprisal or retaliation, and Hospital Representatives will not be penalized for reporting an incident and/or lodging a complaint in good faith and/or participating in a Formal Investigation.

6. Behaviour Addressed under the Policy

There are three (3) types of workplace behaviour addressed under this policy: (1) incidents of disrespect, (2) incidents of discrimination, harassment, sexual harassment and (3) incidents of workplace violence (collectively referred to as "Prohibited Behaviour").

1. Disrespect

To ensure that all Hospital Representatives act with the highest standards of professional integrity in dealings with our patients, the public, our community and each other, all Hospital Representatives are expected to treat all those with whom they interact in the workplace with respect, civility and professionalism. Hospital Representatives are expected to be collegial, cooperative and collaborative. Behaviour that is disruptive or disrespectful creates an unproductive and uncooperative work environment and may compromise the delivery and quality of health care services and/or patient safety.

Incident(s) of Disrespect can include but are not limited to the following behaviour (that does not constitute a pattern):

- Profane, insulting, rude, demeaning or abusive language.
- Non-constructive criticism, such as that delivered in a way that intimidates, undermines confidence or implies incompetence.
- Interpersonal conflict.
- Negative comments about another's work or care.
- Outbursts of anger.
- Repeated failure to respond to work related requests.
- Failure to collaborate or cooperate.
- Engaging in microaggressions (subtle, often unconscious comments or behaviours which communicate a negative stereotype or something negative about a historically marginalized group).
- Performance issues, e.g., routinely late, repeated failure to respond to work related requests.

The above behaviours could be examples of disrespect on a, for example, infrequent basis, but could also rise to the level of Prohibited Behaviour below, particularly if they are repeated.

2. Prohibited Behaviour: Discrimination, Harassment and Sexual Harassment

The following behaviours are prohibited under this policy. Repeated incidents of Disrespect may meet one of the below definitions of Prohibited Behaviour.

Discrimination:

"Discrimination" is any practice or behaviour, whether intentional or not, which has a negative effect on an individual or group because of any of the protected grounds set out in the Ontario *Human Rights Code* (the *"Code"*), including including citizenship, race, place of origin, ethnic origin, colour, ancestry, disability, age, creed, sex/pregnancy, family status, marital status, sexual orientation, gender identity, gender expression, receipt of public assistance (in housing) and record of offenses for which a pardon has been granted under (in employment).

"Discrimination" is any practice or behaviour, whether intentional or not, which has a negative effect on an individual or group because of any of the protected grounds set out in the Ontario *Human Rights Code* (the *"Code"*), including

Examples of discrimination in the workplace include (but are not limited to):

- Willfully providing preference or disqualifying persons in consideration for job opportunities or additional shifts as a result of a person's membership in a group designed by the Ontario Human Rights Code.
- Knowingly giving preferential or unfavourable treatment to employees in terms of requested employment entitlement (i.e., vacation or leave requests) because of their membership in a designated group described above.

Discrimination does not have to be intentional to be unlawful. Unlawful discrimination may result from practices or policies that appear to be neutral but have a negative effect on applicable groups or individuals.

Harassment:

"Harassment" as used in this policy means:

a. Engaging in a course of vexatious comment(s) or conduct against a worker in a workplace that is known or ought reasonably to be known to be unwelcome; or,

b. Workplace sexual harassment.

Workplace harassment can involve unwelcome, unwanted, offensive or objectionable words or actions that are known or ought reasonably to be known to be offensive, embarrassing, humiliating or demeaning to a Hospital Representative(s) and/or denying a Hospital Representative(s) dignity and respect. Workplace harassment often involves repeated words or actions, or a pattern of behaviours, against an individual or groups of workers in the workplace that are unwelcome. However, in some cases the behaviour can be so egregious that one instance would be considered workplace harassment.

Examples of workplace harassment include:

- Making remarks, jokes or innuendos or exhibiting behaviour that demean, ridicule, intimidate, insult, embarrass, belittle, humiliate, discriminate, offend, or isolate/exclude a Hospital Representative.
- Displaying or circulating offensive pictures or materials in print or electronic form.

- Bullying, yelling at another in anger, shouting, or using obscene and/or foul language.
- Repeatedly spreading rumours and/or participating in gossip that may be deemed malicious towards a colleague.
- Repeated offensive or intimidating phone calls, e-mails, or social media messages or posts.
- Inappropriate staring.
- Excluding or isolating a colleague.
- Whispering, laughing behind the back of another Hospital Representative.
- Sexual harassment.
- Any harassment based on the Protected Grounds under the Ontario Human Rights Code.

Workplace harassment does NOT include reasonable and professional action or conduct by an employer, Chiefs of Staff, Manager, or a Hospital Representative as part of their normal work function, including performance management, attendance support, the provision of information, advice, feedback, counselling, corrective discipline and other worker / supervisory / managerial / leadership functions.

Differences of opinion, minor disagreements or inter-personal conflict between co-workers or colleagues would also NOT generally be considered workplace harassment, but may be an incident of disrespect.

Sexual Harassment:

"Sexual Harassment" as used in this policy means:

a. Engaging in a course of vexatious comment or conduct against a Hospital Representative in a workplace because of sex, sexual orientation, gender identity or gender expression, where the course of comment or conduct is known or ought reasonably to be known to be unwelcome; or

b. Making a sexual solicitation or advance where the person making the solicitation or advance is in a position to confer, grant or deny a benefit or advancement to the Hospital Representative and the person knows or ought reasonably to know that the solicitation or advance is unwelcome.

Examples of sexual harassment include, but are not limited to:

- Unwanted sexual advances.
- Asking for sex in exchange for a benefit or a favour.
- Unwelcome solicitation or advances from a Manager/authority figure, or another person who has the power to reward or punish the Hospital Representative.
- Asking for dates and not taking "no" for an answer.
- Demanding hugs.
- Making unnecessary physical contact, including unwanted touching.
- Leering, using rude or insulting language or making comments of a sexual nature toward others.
- Inquiring about others intimate activities.
- Calling people sex-specific derogatory names.
- Making sex-related comments about a person's physical characteristics or actions.
- Mimicking sexual positions.
- Inappropriate sexual touching, advances, suggestions or requests.
- Posting or sharing pornography, sexual pictures or cartoons, sexually explicit graffiti, or other sexual images (including online).
- Taking and/or sharing sexually inappropriate photographs of a person.
- Making sexual jokes.
- Spreading rumours or making derogatory remarks about a person's sexuality.
- Bragging about sexual prowess.
- Isolating, making negative comments or making fun of a person's gender identity, or because a person does not conform to sex-role stereotypes.

3. Prohibited Behaviour: Workplace Violence:

"Workplace violence" as used in this policy means:

- The exercise of physical force by a person against a Hospital Representative in a workplace, that causes or could cause physical injury.

- An attempt to exercise physical force against a Hospital Representative in a workplace, that could cause physical injury.
- A statement or behaviour, that it is reasonable for a Hospital Representative to interpret as a threat to exercise physical force, in a workplace, that could cause physical injury to the Hospital Representative.

Examples of workplace violence include, but are not limited to, any of the following against, at or towards a Hospital Representative:

- Verbally threatening to attack or harm.
- Leaving threatening notes at or sending threatening e-mails to (or within) a workplace, or posting threats related to Waterloo Regional Health Network workers or workplaces on social media.
- Shaking a fist or object in a worker's face, or blocking/obstructing their movement.
- Wielding a weapon at work.
- Pounding one's fist on a desk.
- Hitting, punching, shoving, choking, strangling, biting, spitting, groping, grabbing, kicking, pinching, pushing, physically confining, or attempting any of these acts against a Hospital Representative.
- Deliberately injuring or attempting to injure a Hospital Representative.
- Throwing material, an object or spraying liquid at a Hospital Representative.
- Sending threatening text messages, social media communications.
- Sexual violence against a Hospital Representative.

Accidental situations, such as a worker tripping over an object and pushing a co-worker as a result, are not considered "workplace violence."

DEFINITIONS

Bystander: Any Hospital Representative who becomes aware of or who witnesses Disrespect or Prohibited Behaviour, but is not the person engaging in the behaviour.

Complaint: As used in this policy, a complaint is a report of one or more incidents to the Manager, or Labour and Employee Relations, that has been found by the Respectful Workplace Consultant to meet the definition of Prohibited Behaviour under this policy.

Complainant(s): Hospital Representatives making a report under this policy. The complainant need not be the target of the alleged behaviour.

Contractors: Individuals who are conducting work in Waterloo Regional Health Network workplaces, but are not employed by Waterloo Regional Health Network.

Credentialed Professional Employees: A credentialed health professional who holds privileges at the hospital, including physicians, midwives, dentists and credentialed nurse practitioners.

Hospital Representatives: Members of the Waterloo Regional Health Network community, which includes full-time, part-time, temporary, casual or contract employees, including supervisors and managers, all credentialed professional employees, board members, volunteers and any students who perform work or supply services to Waterloo Regional Health Network.

Incident: As used in this policy, refers to a single incident of Disrespect or Prohibited Behaviour.

Protected Grounds: Those personal characteristics protected under the Ontario *Human Rights Code*, specifically: citizenship, race, place of origin, ethnic origin, colour, ancestry, disability, age, creed, sex/pregnancy, family status, marital status, sexual orientation, gender identity, gender expression, receipt of public assistance (in housing) and record of offences for which a pardon has been granted under (in employment).

Report: As used in this policy, a report is when a Hospital Representative or a third party informs a Manager, Labour and Employee Relations or the Whistleblowing Procedure regarding one or more incidents or a complaint of workplace harassment or violence.

Respondent: A person or persons acting in response to a complaint or incident where the person(s) is alleged to have breached the provisions of the Respectful Workplace Policy. The Respondent may be any Hospital Representative or volunteer, patient, visitor or contractor who attends a Waterloo Regional Health Network workplace.

Threshold Assessment: A meeting conducted by a member of the Labour and Employee Relations team with the Complainant(s) to determine whether the complaint rises to the benchmark of Prohibited Behaviour to be dealt with through a formal investigation, or whether it can be dealt with informally.

Visitors: For the purpose of this policy, refers to any individual who is NOT a Hospital Representative, patient, volunteer or contractor and, who is on Waterloo Regional Health

Network property, visiting a patient, or meeting in their work capacity with a Hospital Representative or volunteer (such as a vendor).

Witness(es): A person or persons who may have pertinent knowledge of a situation, incident, scenario or event and/or may be able to verify that it has taken place.

Workplace: For the purposes of this policy, a Waterloo Regional Health Network workplace includes all places where hospital business occurs and includes all:

- hospital buildings (whether owned or leased) and surrounding perimeter including parking lots, walkways, and driveways ("hospital grounds").
- off-site locations where hospital business occurs.
- hospital-sponsored functions and recreational or social events, whether taking place on hospital grounds or elsewhere.
- travel for hospital business.
- conferences and training sessions.
- e-mail, text message and other correspondence.
- social media.
- video calls.
- over the phone including voice mail.
- internet postings.

EDUCATION

A training program on Respect in the Workplace has been developed, established and provided in consultation with the Joint Health and Safety Committees.

The training program will include:

- An overview of the Respectful Workplace Policy and Program.
- What conduct is considered discrimination, harassment, sexual harassment and workplace violence, and how to recognize it.
- How to summon immediate assistance when faced with a situation involving workplace violence.

- How and to whom to report incidents and complaints of Disrespect or Prohibited Behaviour.
- How Waterloo Regional Health Network will investigate and deal with incidents and complaints or reports of Prohibited Behaviour.
- How Waterloo Regional Health Network will report the results of the investigation to the complainant(s) and respondent(s).
- The role of the Respectful Workplace Consultant.

All new Hospital Representatives will be required to participate in training on the Respectful Workplace Policy and Program during their orientation to the hospital. All training conducted must be documented (e.g. electronic records, sign-sheets, etc.).

DOCUMENTATION

Please complete Respectful Workplace Complaint Form

QUALITY MONITORING

This policy shall be reviewed at a minimum, every one (1) year from the policy's effective date, and/or when legislation changes. Any revisions and deletions must be made within three (3) months after the one (1) year mark and must be appropriately communicated to employees.

RELATED DOCUMENTS

Code of Conduct

Conflict of Interest

Critical Injuries

Discipline and Discharge

Domestic Violence

Personal and Panic Alarms

Threat Alert: Flagging of Patients Who Pose a Threat of Violence

Workplace Violence Prevention

APPENDICES

Appendix A: Workplace Investigation Procedural Steps

Appendix B: Respectful Workplace Complaint Form

Appendix C: Respectful Workplace Investigation – Confidentiality Agreement

Appendix D: Patient/Visitor Prohibited Conduct

Appendix E: Contractor Requirements Under the Waterloo Regional Health Network Respectful Workplace Policy

REFERENCES

1. Occupational Health and Safety Act
2. Ontario Human Rights Code
3. Canada Criminal Code
4. Employment Standards Act
5. Public Services Health and Safety Association (PSHSA)

Appendix I – Scent Reduced Environment – **No attachments**

Purpose

This document applies at all Waterloo Regional Health Network campuses.

1. PURPOSE

The purpose of this policy is to reduce scented products in Waterloo Regional Health Network to promote a healthy and safe environment for patients, visitors and employees.

2. POLICY STATEMENT

Waterloo Regional Health Network is committed to reducing the use of scented products. Exposure to certain pollens can trigger or cause asthma symptoms, migraine headaches, skin reactions, nausea, and numerous other effects particularly in individuals that suffer from multiple chemical sensitivities. Sensitivities affect everyone differently ranging from mild and merely annoying symptoms to symptoms severe enough to interfere with daily activities, career and family life; severe sensitivities can be life threatening or fatal. To minimize the impact of exposure within the hospital environment, all employees and hospital affiliates are to refrain from the use of scented products and the delivery of strongly scented flowers.

3. SCOPE

This policy applies to all employees and hospital affiliates of the Waterloo Regional Health Network.

This policy should be interpreted and applied in accordance with the collective agreement(s), if applicable. In the event of any discrepancy between this Policy and an employee's employment contract, and the collective agreement(s) (if applicable), the collective agreement shall take precedence.

4. RESPONSIBILITIES

Manager

- Ensure employees under their supervision comply with the policy.
- Ensure that new products within the unit/department are evaluated for scent.
- Review and investigate all employee or visitors reports, or patient complaints, related to scent exposure.
- Collaborate with Employee Health, Safety and Wellness to determine the need for employee and hospital affiliate education resources (i.e., pamphlets, posters, internal communications, website).
- Communicate the policy to employees and hospital affiliates within their area of responsibility, including the posting of appropriate signage.
- Follow up concerns regarding non-compliance by employees and hospital affiliates, within their area of responsibility.
- Provide support to employees who have a scent sensitivity and work together towards a solution.

Employee Health, Safety and Wellness

- Provide policy education at hospital orientation.
- Develop educational materials such as posters, to provide ongoing communication and reminders to employees and hospital affiliates.
- Review the policy annually, in consultation with the Joint Health and Safety Committee

- Review and follow up all employee incidents associated with exposure to scented products and provide support as needed.

Supply Chain

- The Supply Chain Department will consult with Employee Health, Safety and Wellness regarding scent considerations for new products at Waterloo Regional Health Network (including chemicals and cleaning agents purchased via group purchasing contracts). The hospital will choose fragrant free or fragrant reduced products with all new purchases whenever available. Products with chemical based fragrances are to be replaced or eliminated wherever possible.

Employee and Hospital Affiliates Copy Link

- Refrain from wearing/using any scented products at Waterloo Regional Health Network facilities.
- Promote compliance in a respectful and cordial manner to fellow employees and hospital affiliates.
- If possible, attempt to resolve concerns directly with individuals using scented products, by reminding them of a reduced scent environment.
- If not possible to resolve concerns directly, notify the appropriate contact person of situations of non-compliance.

Joint Health and Safety Committee

- Promote compliance with the policy.
- Review all related employee incident report data.
- Conduct an annual review of the policy.

Procedure

- Signage is posted at Waterloo Regional Health Network notifying all employees, patients, and visitors of reduced scent environment policy.
- Scent reduced signage will be posted throughout the facility.
- An employee that experiences an adverse reaction attributed to scent exposure shall notify their Manager and an incident report shall be completed through the incident

reporting system. The Manager of that unit/department will investigate the incident and complete documentation on the employee incident report.

- A patient or visitor affected by scent exposure, shall notify a nurse or clerk who will then notify the Manager of that unit/department. The Manager will investigate the incident, and a patient incident report should be completed. For in-patients, documentation should be made in their chart.
- Hospital affiliates who experience symptoms of fragrance sensitivity attributed to scented products, are to report the incident to the Contact Person Responsible for Action, who will then complete an Incident Report, as required.
- If the source of the scent is a product used at Waterloo Regional Health Network, every effort will be made to replace this product with an acceptable scent reduced product. If the source is a personal product, the user will be informed in a tactful, respectful manner of the current scent reduced environment policy and advised to refrain from future use.
- Employee Health, Safety and Wellness, Patient Relations, Patient Safety and or Labour and Employee Relations may be consulted for unusual or unresolved situations, including ongoing non- compliance with this policy.

Affected Individual	**Contact Person Responsible for Action**
Employee	Employee's Manager
Student	Student's Supervisor
Volunteer	Manager of Volunteer Services
Physician	Medical Director/Chief of Service
Contracted Service Worker	Manager of Contracted Service

Affected Individual	Contact Person Responsible for Action
Patient	Manager Responsible for Area
Visitor	Manager Responsible for Area
Contractor	Project Coordinator, Facilities

5. DEFINITIONS

Hospital Affiliates: Professionals with hospital privileges, volunteers, students, visitors, patients, board members, contracted service personnel and contractors.

Employee: An individual who is directly employed and paid by the Waterloo Regional Health Network to perform job duties within the organization. Employees are responsible for complying with workplace policies to maintain a safe and healthy environment at the Hospital.

Manager: Individuals directly supervising the work of employees. For the purposes of this policy only, the term manager includes, but is not limited to, supervisor, manager, team lead, chief, director, vice-president, president and CEO.

Scented Products: Scented product(s) are any fragranced product, which may include but are not limited to the following:

- colognes and aftershaves
- perfumes
- scented personal care products such as deodorant, hand creams, body lotions, creams, shampoos, body spray, moisturizers, hair products and cosmetics
- air fresheners and room deodorizers
- cleaning products
- essential oils

- strongly scented flowers such as: Eucalyptus, Freesia, Hyacinth, Lavenders, Lilacs, Lilies (Day, Tiger, Easter, Lily of the Valley and Star gazers), Peony, Poinsettia (due to crossover with latex sensitivity), and Roses.
- laundry detergents and fabric softeners

Symptoms of Fragrance Sensitivity: Headache or migraine, sore throat, runny nose, sinus congestion, wheezing, shortness of breath, dizziness, anxiety, anger, nausea, fatigue, and inability to concentrate.

Work areas: Includes all Hospital property and any area occupied by employees while performing employment duties.

6. EDUCATION

N/A

7. QUALITY MONITORING

This policy shall be reviewed at a minimum, every one (1) year from the policy's effective date, and/or when legislation changes. Any revisions and deletions must be made within three (3) months after the one (1) year mark and must be appropriately communicated to employees.

8. DOCUMENTATION

N/A

9. RELATED DOCUMENTS

N/A

10. APPENDICES

Appendix A: Scent Reduction Signage

11. REFERENCES

1. Ontario Occupational Health and Safety Act, Section 25(2)(h) St. Mary's General Hospital. Scent Reduced Environmental Policy.
2. Timmons & District Hospital. Scent Reduced Policy.
3. Campbell Ford Memorial Hospital. Scent Sensitivity Policy. Hamilton Health Sciences.

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CONTRACTOR HANDBOOK

STATEMENT OF UNDERSTANDING

I, _____ representing _____

has reviewed and understands the Waterloo Regional Health Network's Contractor Handbook and agrees to abide by the requirements of the Handbook.

Non-compliance with any or all of these policies or regulations will result in immediate

Work stoppage. Work will not commence until the WRHN has

determined a resolution.

Signature: _____

Contractor

Date: _____

Signature: _____

Designated WRHN Point of Contact

Date: _____

Waterloo Regional Health Network (WRHN) Logo

Corporate

Title:	**Planned Essential Service Shutdown & Work Request Policy**		
Applies to:	*All Sites*		
Owner:	*Facilities*	**Department:**	Facilities Operations
SLT sponsor:	Director/ Engineering Redevelopment & Plant Maintenance	**Endorsed by:**	Health & Safety Committee
Approval by:	*Approval Group*	**Date:**	2026,05,04
Key words:	Shutdown, Utilities, Maintenance, Safety, Downtime, Infrastructure		
Original effective date: 2026,05,04	**Reviewed date(s):** YYYY, MM, DD	**Revised date(s):** YYYY, MM, DD	
Document type:	☒ Policy	☐ Procedure/Standard Work/SOP	☐ Guideline

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PURPOSE

This policy establishes a standard, safe, and clinically informed process for planning and executing any Planned Essential Service Shutdown or Critical System Impairment that could affect patient care, staff safety, building operations or regulatory compliance.

POLICY STATEMENT

All planned shutdowns must be properly classified, risk assessed, approved, communicated, and executed in accordance with this policy. Non-compliance may result in work stoppage, corrective action, and/or disciplinary action.

SCOPE

Applies to all WRHN sites, staff, and contractors involved in planned shutdown activities. Emergency outages are excluded. If the planned shutdown becomes an Emergency, please follow Appendix B Emergency Shutdown Procedure Flow chart.

RESPONSIBILITIES

WRHN Designated Point of Contact (Accountable)

- Owns go/no-go; schedules and chairs planning meetings, issues meeting minutes, completes risk assessment, develops internal communications “including

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signage" Facilities, confirms post shutdown verification and closes the file with lessons learned.

WRHN Facility Operations (Responsible)

- Validates infrastructure, isolation points, lockout/tagout and shutdown feasibility.
- Leads identification of impacted areas by tracing relevant pipes, circuits etc. Support provided by Contractor.
- Assists Contractor with shutdown support as required.
- Confirms post-shutdown testing / commissioning results and system normalization.

Clinical Operations (Director/Manager) (Consulted as required)

- Leads and ensures clinical continuity planning, patient flow, temporary closures, staffing, work around procedures and equipment contingencies.
- Confirms clinical readiness before start; signals the clinical all-clear after verification testing.

IPAC (Consulted/ Approver where required)

- Reviews HVAC/pressure changes, dust control, clinical space controls, return to service plan etc.
- Communicates PMA measures (physical barriers, negative/positive pressures, cleaning and clearance criteria).

IT/BioMed/Pharmacy/Security/Communications/EVS/Moves (Consulted)

- **IT –** network closets, servers etc.
- **BioMed –** medical devices check
- **Security –** access, patrol and fire watch (if required)
- **Communications –** internal and external communiques / messaging
- **EVS –** Cleaning and post work clearance
- **Moves –** FF&E moves, confirmation of decant space (if required)

Contractor (Responsible)

- Provides drawings (as required), submits shutdown request documentation, Method of Procedure (MOP), sequencing, manpower, permits and AHJ coordination; attends all planning and debrief meetings and complies with WRHN Contractor Handbook, safety and IPAC requirements.
- Contractors will also support WRHN Facilities in the identification of impacted areas by tracing relevant pipes, circuits etc.

Project Executive Sponsor (Approval-Critical)

- Approves Critical Clinical Shutdowns
- Escalation (if required)

Business Continuity & Emergency Management (BCEM) (Consulted as required)

- Assess projects risks for business continuity on Major and Critical shutdowns

PROCEDURE

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Waterloo Regional Health Network (WRHN) Logo

Intake → Feasibility / Risk Review → Planning and Approvals → Pre-Shutdown Review → Execution / Monitoring → Verification and All-Clear.

Shutdown Classification & Minimum Notice Requirements

Minimum notices for emergency repairs and standard maintenance work requests may vary depending on scope of work and at WRHN's sole discretion

Classification	Description	Examples	Minimum Notices	Required Approvals
Independent	Work fully isolated to new construction/unoccupied zones; no impact to live systems.	Includes but not limited to - new tie-ins to dead systems.	5 business days	WRHN designated PC + Facilities
Minor	Limited to non-clinical or single department; short duration.	Includes but not limited to - One panel normal power off-hours, hot work, branch water shutoff, local fire alarm isolation.	10 business days	WRHN designated PC + Facilities + Affected Clinical Manager
Major	Significant operational impact; multi-department or building utility.	Includes but is not limited to- essential/normal/emergency power.	20 business days	WRHN designated PC + Facilities + Affected Clinical Director & Manager, IPAC, Occ Health , BCEM
Critical Clinical	Any impairment impacting OR/procedure rooms, ED, ICU, IPUs, medical gas zones, pressure-controlled spaces, building entrances / exits, life safety.	Includes but is not limited to - medical gases, isolation rooms, water outage on clinical floors, any outage in ED/OR/ICU, emergency power.	30 business days	Executive Project Sponsor, Clinical Director & Manager, WRHN Designated PC, Facilities, IPAC, Occ Health , BCEM

DRAFT

A. Intake

1. Contractor completes the Shutdown Request Form Part A and B **(Appendix B)** and submits to the WRHN designated point of contact.
    a. The Contractor may choose to submit an MOP on company letter head in lieu of filling Part B of the shutdown request form.

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2. WRHN designated point of contact reviews the Shutdown Request Form and MOP for completeness.

B. Feasibility & Risk

1. The Contractor, WRHN designated point of contact, WRHN Facilities meet to confirm MOP and verifies impacted infrastructure, isolation points, confirms resourcing availability, identifies any risks, plans contingencies and reviews timing of the shutdown.

C. Planning & Approvals

1. WRHN designated point of contact schedules a shutdown planning meeting with Project Multi-Disciplinary Team (MDT) and all impacted department leads – meeting purpose to agree to scope, timing, contingencies, communications, resourcing / staffing and go-no go criteria.
2. WRHN designated point of contact obtains all required internal approvals as per the Shutdown Classification Table.
3. WRHN designated point of contact works with Communications & Engagement to issue formal notices and communiques (internal & external) as required.

D. Pre-Shutdown Review

1. Five (5) days prior to a planned shutdown – WRHN designated point of contact confirms all pre-requisites are met and in place (staffing, permits, approvals, materials, contingency plans etc.) and clinical readiness.

E. Execution / Monitoring

1. Day-of-Protocol (prior to shutdown) - *** Timing / scope may be adjusted as per approved MOP***
   a. **T90-120 min –** Project MDT / Contractor "huddle" to verify all pre-requisites to shutdown have been completed.
   b. **T30-T60 min -** WRHN designated point of contact confirms "go or no/go.
2. WRHN Facilities & Contractor performs lockout/tagout and physical isolation. Contractor executes work. WRHN designated point of contact oversees and continues coordination of work in real-time as required.

F. Verification / All Clear

1. Joint Inspection – The Contractor and WRHN Facilities shall jointly inspect the work area to confirm all scope items and system connections have been completed in accordance with approved plans and that no deficiencies are present.
2. System Re-Energization – The Contractor and WRHN Facilities shall remove all locks from main shutoffs.

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   a. Affected systems shall be slowly and methodically re-energized under WRHN Facilities oversight.
3. System Verification – WRHN Facilities shall verify that all affected systems have been restored to normal operation and are functioning as intended.
   a. The Contractor is required to remain on site until full system functionality has been confirmed and all deficiencies, if any, have been addressed.
4. Clinical Area Confirmation – Clinical staff shall round the affected departments, patient rooms etc. to confirm no issues have resulted from the shutdown or associated work.
   a. Any concerns identified shall be reported immediately to WRHN Facilities and designated contact for review and resolution prior to final all-clear.
5. Site Restoration – The Contractor shall ensure the work area is clean, safe and fully restored to its pre-shutdown condition.
   a. WRHN Facilities and designated point of contact shall confirm acceptable site conditions prior to authorizing contractor demobilization.
6. Third-Party Verification (if required) – Where the third-party verification is required, WRHN Facilities or the WRHN designated point of contact shall review and sign all applicable reports or documentation prior to final all-clear.
7. All-Clear Notification – Once WRHN Facilities confirms that systems are fully restored and no outstanding issues remain they will issue the all-clear and if required notify Switchboard to issue an overhead announcement of inform affected areas.
8. Final Authorization and Closeout – Upon completion of all verification steps, the WRHN designated point of contact shall confirm the final all-clear with all parties and authorize contractor demobilization.
   a. Within five (5) business days of the shutdown, the WRHN designated point of contact shall conduct a debrief with the project MDT and document lessons learned to formally close the file.

DEFINITIONS

- **Critical Systems –** Systems dependant on essential services that may affect limited areas but pose clinical/operational risk if impaired (e.g. nurse call, DI/Lab equipment, elevators, access control etc.)
- **Emergency –** A situation, or a situation about to happen, that could cause serious harm to people or major damage to property, whether caused by nature, disease or other health risk, an accident, or an intentional act.

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- **Essential Service –** Utilities whose impairment can impact hospital wide operations including but not limited to; Electrical, Emergency Power, Domestic Water (Hot/Cold), Medical Gases, HVAC/Pressure Control, Fire Protection/Fire Alarm, IT/Communications, Sanitary lines etc.
- **Impairment –** Temporary disabling or bypass of a life safety system (sprinkler, fire alarm etc.).
- **Infection Control Risk Assessment (ICRA):** Part of the Infection Control Project Plan, a process used to identify design elements that increase the risk of microbial transmission in the environment. This assessment reviews the population and program impacted, and what disruptions may result from the project.
- **MDT –** Multidisciplinary Team is a group of professionals brought together to collaborate on a common project or solve a specific problem.
- **Planned Shutdown –** A scheduled interruption to services to install, connect maintain, test of modify infrastructure.
- **Preventive Measures Analysis (PMA):** Part of the Infection Control Project Plan, a documented process of identifying the preventive measures (steps taken to change process, create barriers, or include precautionary measures to reduce contaminant spread) planned to mitigate the risks contained in the Infection Control Risk Assessment (ICRA).

EDUCATION

Training required for involved staff and contractors.

QUALITY MONITORING

Reviewed annually or after major events.

DOCUMENTATION

All approvals, risk assessments, and communications must be recorded.

RELATED DOCUMENTS

Lockout tag out
Hot Work Permit
Code Grey

APPENDICES

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Appendix A - Shutdown Procedure Flow Chart
Appendix B - Emergency Shutdown Procedure Flow Chart
Appendix C - Shutdown Request Form

REFERENCES

DRAFT

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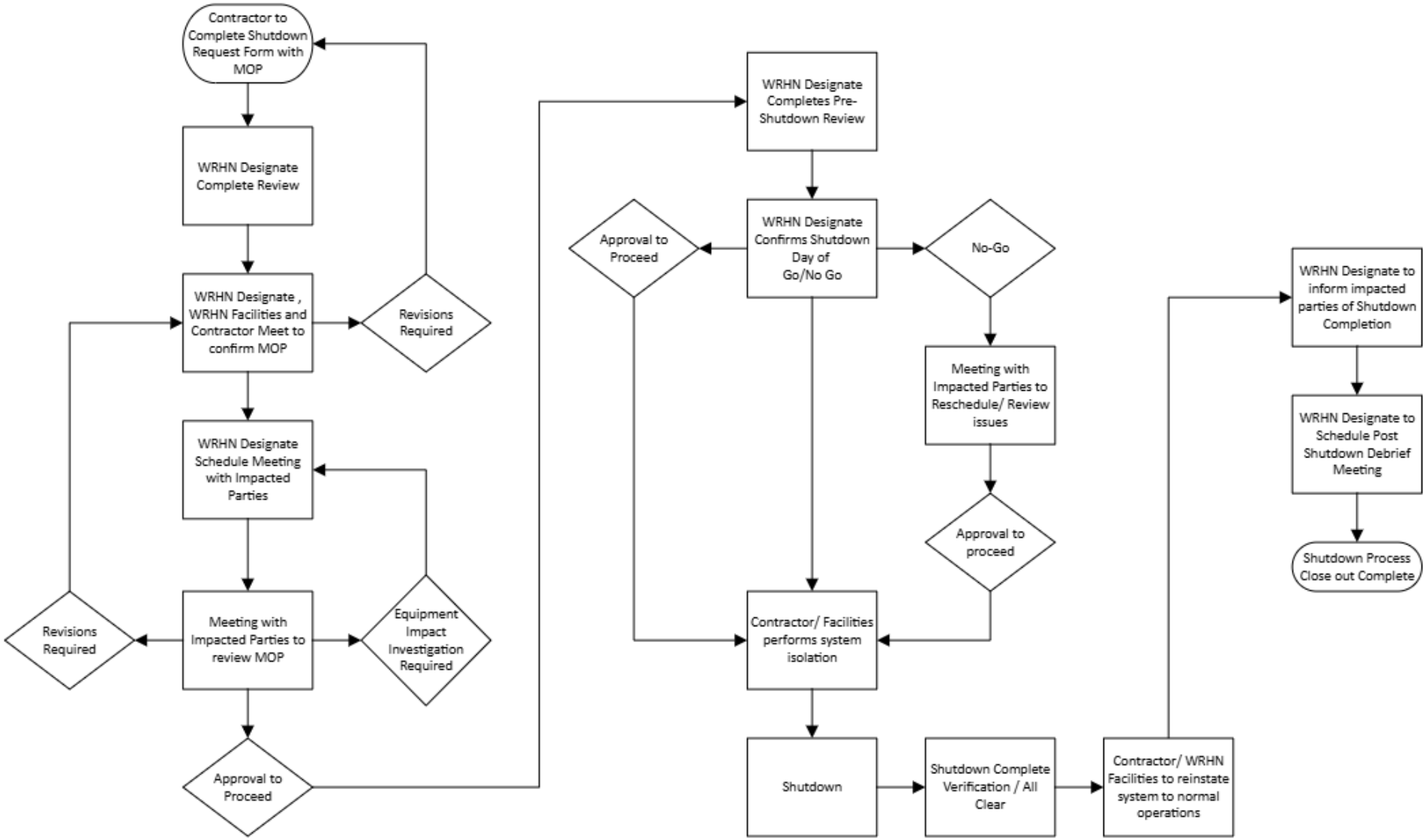
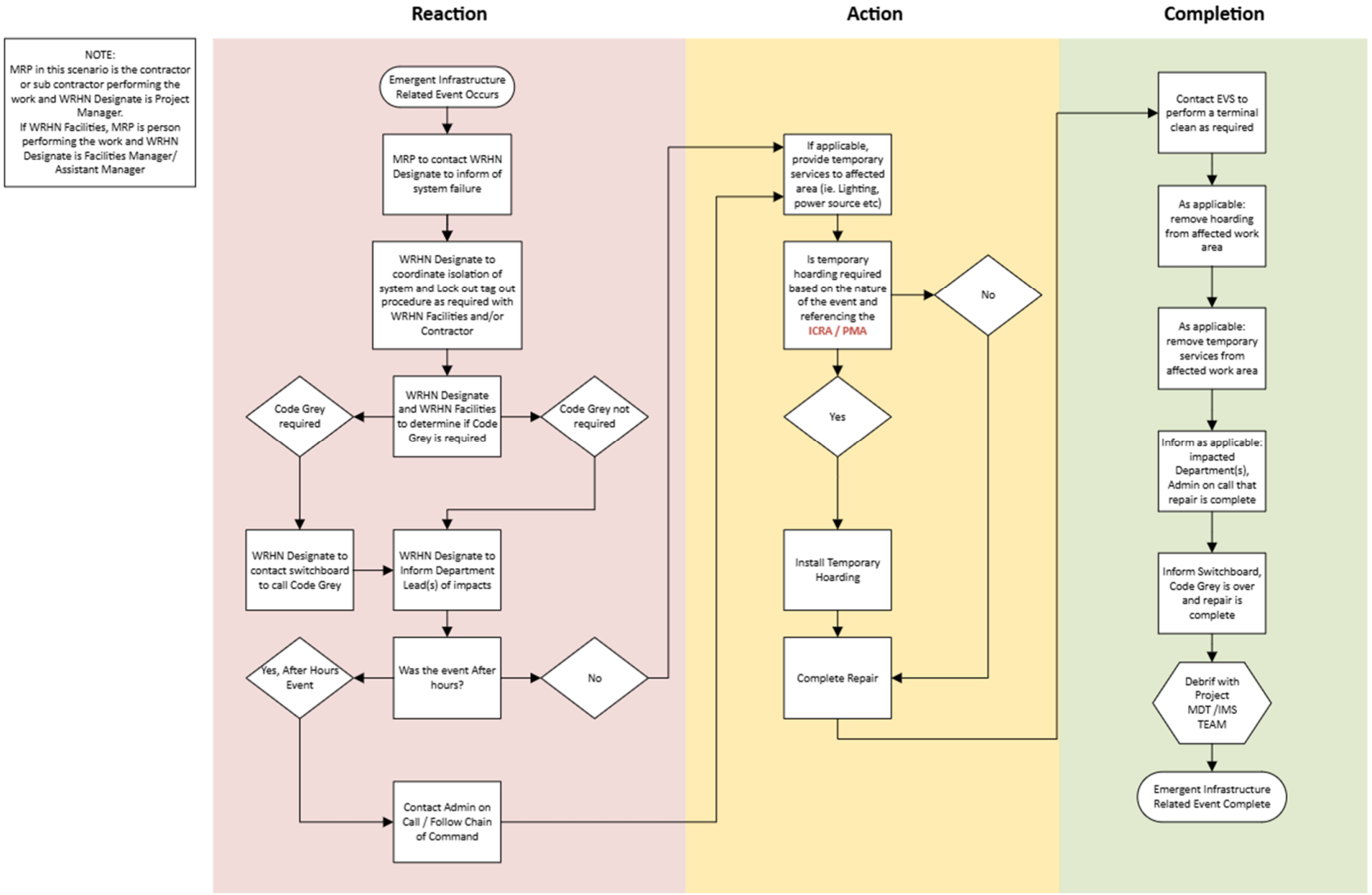
Waterloo Regional Health Network (WHRN)
Planned Essential Services Shutdown and Work Request Policy

Appendix A
Shutdown Procedure Work Flow



Waterloo Regional Health Network (WHRN)
Planned Essential Services Shutdown and Work Request Policy

Appendix B
Emergency Shutdown Procedure Work Flow



Appendix C - Work Shutdown Request Form Part A

Instructions

COMPLETE THIS FORM AND SUBMIT IT TO YOUR DESIGNATED WRHN CONTACT. IF PREFERRED IN LIEU OF PART B CONTRACTORS CAN SUBMIT AN MOP ON A COMPANY LETTER HEAD AS A SEPERATE DOCUMENT.

Project Information

PROJECT NUMBER:_____ PROJECT TITLE:_____

WRHN DESIGNATED CONTACT:_____ PURCHASE ORDER / SERVICE CONTRACT #: _____

PROJECT SITE:_____ PROJECT LOCATION:_____

Contractor Information

CONTRACTING FIRM NAME:_____

REQUESTOR'S NAME:_____ SITE TELEPHONE _____

TELEPHONE #:_____ EMAIL:_____

FAX #:_____ POSITION:_____

Date / Time Required

DATE SUBMITTED:_____ START TIME:_____

START DATE:_____ END TIME:_____

COMPLETION DATE:_____

Work Request Information

WORK DESCRIPTION: _____

SYSTEM	NOTIFICATION (BUS. DAYS)	Major, Minor or Critical Clinical Shutdown	SYSTEM	NOTIFICATION (BUS. DAYS)	Major, Minor or Critical Clinical Shutdown
NATURAL GAS	10	MINOR	GLYCOL	10	MINOR
NATURAL GAS	20	MAJOR	MEDICAL GAS	30	CRITICAL
HOT WATER	10	MINOR	ELEVATORS	20	MAJOR
HOT WATER	20	MAJOR	SANITARY SYSTEM	20	MAJOR
COLD WATER	10	MINOR	BUILDING ENTRANCE	20	MAJOR
COLD WATER	20	MAJOR	STANDPIPE	10	MINOR
COLD WATER	30	CRITICAL	X-RAYING	30	MAJOR
MEDICAL AIR	30	CRITICAL	HYDRO	10	MINOR
MEDICAL VACUUM	30	CRITICAL	HYDRO	20	MAJOR
SPRINKLERS	10	MINOR	HYDRO	30	CRITICAL
SPRINKLERS	20	MAJOR	L.P. STEAM	10	MINOR
HVAC	10	MINOR	H.P. STEAM	10	MINOR
FUELOIL	20	MAJOR	COMPRESSED AIR	10	MINOR
CHILLED WATER	10	MINOR	PNEUMATIC TUBE	10	MINOR
SOFT WATER	10	MINOR	FIRE ALARM	10	MINOR
CORING	20	MAJOR			

For definitions please reference the Planned Essential Services Shutdown & Work Request Policy*

FEE'S MAY BE APPLIED FOR UNSCHEDULED SHUTDOWNS

Minimum notices for emergency repairs and standard maintenance work requests may vary depending on scope of work and at WRHN's sole discretion

Additional Information
PLEASE PROVIDE A DETAILED DESCRIPTION OF THE WORK BEING APPLIED FOR, THE AREAS AFFECTED (INCLUDE APPROPRIATE DRAWINGS) AND ANY OTHER SPECIFIC REQUIREMENTS.

Part B

Scope Of Work

Hours of Work

Safety & Emergency Procedures
WHAT PROVISIONS HAVE BEEN MADE TO REDUCE THE IMPACT OF THE LOSS OF UTILITY; DISASTER RECOVERY PLAN; INCLUDING ESTIMATED TIMES TO RESTORE SERVICES IN THE EVENT OF AN EMERGENCY.

Sequence, Methodology of Work & IPAC Controls

Special Considerations

WRHN DESIGNATED POINT OF CONTACT:

APPROVED BY:_____ SIGNATURE:_____ DATE:_____

WRHN FACILITIES REPRESENTATIVE:

APPROVED BY :_____ SIGNATURE:_____ DATE:_____

Waterloo Regional Health Network (WRHN)

Positron Emission Tomography (PET) CT Scanner

APPENDIX C

COVID-19 Vaccine Policy and Vendor Attestation

September 2026

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TWENTY-FIVE YEARS | ESTABLISHED 1996

Westinghouse HQ, 2nd Floor
286 Sanford Ave. N. Hamilton, ON L8L 6A1
905.526.6700 | mccallumsather.com

POLICY

The COVID-19 immunization program is offered by Grand River Hospital (GRH) to meet the requirements of the Ontario Governments Directive #6 issued under section 77.7 of the *Health Protection and Promotion Act (HPPA)*, R.S.O. 1990, c H.7. The Directive recognizes that healthcare organizations are a higher risk setting for workers and that COVID-19 presents immediate risk to patients who are more vulnerable and susceptible to infection and severe outcomes as a result.

Effective September 7, 2021, in accordance with Directive #6, all Team members are required to provide proof of one of the following:

A. proof of full vaccination against COVID-19; or

B. written proof of a medical reason, provided by a physician or registered nurse in the extended class that sets out: (i) a documented medical reason for not being fully vaccinated against COVID-19, and (ii) the effective time-period for the medical reason; or

C. proof of completing an educational session approved by the Covered Organization about the benefits of COVID-19 vaccination prior to declining vaccination for any reason other than a medical reason.

Team members who meet the criteria as per B. and C. above are required to:

a. submit to regular antigen point of care testing for COVID-19 and provide the hospital with verification of the negative test result, at least twice per week. This frequency may changed based on prevalence in the community.

Effective October 12, 2021 all GRH team members and contractors will be required to have their second dose of vaccine and will need to provide acceptable proof of vaccination to the organization unless the hospital has received and approved a documented medical exemption, or as per applicable legislation.

Contracted Workers
Any organization or individual that is providing services at the hospital must have the most senior individual verify that all and any employees and subcontractors performing work for their organization comply with this policy. Verification will require that the most senior individual signs an official declaration of compliance.

PURPOSE

1. Protect those high-risk clients who receive direct services from workers;
2. Protect the worker;
3. Protect work colleagues and family (including those who, unknown to colleagues, may be in a high-risk category);

4. Protect the ability of GRH to provide critical care and emergency services;
5. Provide leadership on this preventative measure to the community and our community partners;
6. Ensure that all workers make an informed decision about whether or not to receive the COVID-19 vaccine; and
7. Fulfill ethical duties as providers of safe healthcare.

SCOPE

This policy applies to:

All GRH employees, staff, contractors, students, volunteers and any businesses or entities operating on the hospital site. Physicians and residents will also be included in this policy.

All contractors, vendors and individuals who perform work at the hospital.

DEFINITIONS

Team Members: All GRH staff, professional staff (those with privileges to practice in the hospital), volunteers and learners.

Contractors: All other individuals who are performing work and/or delivering goods or services at the hospital including cafeteria vendors and contracted.

Rapid Antigen Test: A point-of-care rapid antigen test for the novel coronavirus known as COVID-19 where the test kit has been obtained from Ontario Health and is taken in accordance with rapid antigen screening guidance.

Fully Vaccinated: Having received the full series of a COVID-19 vaccine or combination of COVID-19 vaccines approved by WHO (e.g., two doses of a two-dose vaccine series, does not need to be the same vaccine as long as 2 doses have been administered, or one dose of a single-dose vaccine series); and having received the final dose of the COVID-19 vaccine at least 14 days ago.

PROCEDURE

Team Members Submitting Proof of Full Vaccination:
Team members must provide proof of full vaccination by September 7, 2021 and submit a copy of their official COVID-19 vaccine receipt from the Ministry of Health to Occupational Health and Safety (OHS) at covid@grhosp.on.ca.

The email must include the team members name, employee number and department along with the COVID-19 vaccine receipt.

NOTE: Volunteers should identify their status accordingly.

All medical documentation that OHS collects is maintained in strict confidence.

Proof of vaccination (i.e. vaccine receipts) can be accessed and download on the provincial website: https://covid19.ontariohealth.ca/. Team members will need their health care number, date of birth and postal code to obtain their vaccine receipts.

For detailed instructions on how to access vaccination receipts online, please refer to Appendix 1 (**ACCESSING YOUR COVID-19 VACCINATION RECEIPT: HOW TO GUIDE**).

Region of Waterloo vaccine clinics will offer COVID-19 vaccine to all GRH team members free of charge.

Team members who do not provide their vaccination status by September 7, 2021 will be required to:

a) **Submit Written Proof of a Medical Reason for Not Being Vaccinated:**
Where applicable, team members will provide written documentation by a physician or registered nurse in the extended class that sets out:
(i) a documented medical reason for not being fully vaccinated against COVID-19, and
(ii) the effective time-period for the medical reason

This documentation will be submitted to Occupational Health and Safety (OHS) at occupational.health@grhosp.on.ca.

The email must include the staff members name, employee number and department along with their written medical documentation.

NOTE: Volunteers should identify their status accordingly.

All medical documentation that OHS collects is maintained in strict confidence.

b) **Proof of Completing an Educational Session:**
Any team member that does not provide proof of full vaccination, excluding team members with substantiated exemptions for not being fully vaccinated, is required to complete a mandatory e-learning module on EDGE by September 14, 2021.

c) **Mandatory Consultation:**
After the completion of the education, if the team member has still decided that they will not get the COVID vaccine, they must book an appointment with the Occupational Health and Safety department by September 21, 2021 to discuss the reason for their decision.

d) **Regular Antigen Point of Care Testing for COVID-19:**
Team members who are not fully vaccinated as of September 7, 2021, will be required to produce a negative rapid antigen test result taken at least twice per week.

Results must be submitted every Tuesday and Friday to Occupational Health and Safety.

Team members who test positive must contact Occupational Health and Safety and proceed to confirmatory PCR testing at the COVID Assessment Centre as per the testing guidance.

The testing kits will be made available for pick up at both the Freeport and KW Campuses for team members who are unvaccinated at no cost.

In addition, all team members will be required to attest during entry screening that:

1) they are asymptomatic; and
2) they are fully vaccinated; or
3) they have completed the rapid antigen test with a negative test result at least twice per week.

Mandatory Vaccination

Team members who have not received their second dose of vaccine as of October 12, 2021, will be placed on an unpaid leave of absence, providing time for staff to reconsider their vaccination status.

Team members who are on unpaid leave due to their vaccination status will have until November 9, 2021 to submit their COVID-19 vaccine receipts to Occupational Health and Safety (OHS) at covid@grhosp.on.ca.

The email must include the team members name, employee number and department along with the COVID-19 vaccine receipt.

NOTE: Volunteers should identify their status accordingly.

New Hire Vaccination Requirement:

New GRH team members (including professional staff, residents, affiliates, volunteers and learners), as a condition of employment, are required to be fully vaccinated and provide proof of their vaccination status to Occupational Health and Safety.

Compliance:

Failure to comply with the COVID-19 policy may result in discipline up to and including termination of employment.

APPENDIX #1

ACCESSING YOUR COVID-19 VACCINATION RECEIPT: HOW TO GUIDE

Staff can download their COVID-19 vaccine receipts by visiting the provincial website at: https://covid19.ontariohealth.ca/

NOTE: Use Google Chrome web browser to access the website. Additional information on appropriate web browsers is accessible at the bottom of the page where it states: "Get details about supported browsers and devices".

Step 1:

- At the bottom of the page, click on the box where it states: "I have read and understand the terms of use".
- Then click on "Continue".

Step 2:

- Complete the Identity verification section including all relevant info: Health Card Number, DOB, Postal Code.
- Then click on "Continue".

Step 3:

- In the section titled "Vaccination receipts, click on "Continue".

Step 4:

- You will then be able to download the receipt for both of your vaccinations.
- With your cursor on the document, right click and select "Save as" and save it to your computer.
- Please save the document using the following file name format with your specific information included: **"First Name, Last Name, COVID Vaccine Receipt, Date".**

Step 5:

- Email the Vaccine Receipt to Occupational Health and Safety at: covid@grhosp.on.ca

NOTE: Medical documentation that OHS collects is maintained in strict confidence.

GRAND RIVER HOSPITAL
Advancing Exceptional Care

June 8, 2023

Dear Valued Partner,

Grand River Hospital (GRH) is committed to providing a safe environment for patients, visitors, staff, physicians, volunteers and our third party Vendors. We continue to closely monitor the evolving COVID-19 situation. Frequent updates are being provided to us from regional, provincial and federal health authorities regarding infection prevention and screening directives.

GRH continues to require all staff, patients and visitors who enter the hospital to passively screen themselves for respiratory and gastrointestinal symptoms. Any individual who is unwell must not come onsite.

In light of provincial directives, the COVID-19 vaccine is a critical component of the global effort to manage this pandemic. On August 17, 2021 all public hospitals in Ontario received provincial direction (set out in the Chief Medical Officer of Health's COVID-19 Directive #6), requiring all persons working in Ontario hospitals, including contractors to (i) be fully vaccinated or (ii) submit to regular antigen testing and provide verification of the negative test result.
At this time, GRH is not allowing for regular antigen testing to be a suitable alternative to the proof of vaccine compliance.

Please see attached to review the GRH Vaccination Policy that complies with this Directive.

Under this Policy, all Vendors are required to submit a signed attestation form forthwith certifying that your staff and sub-contractor policies will abide by this Policy. Together we can start to lessen the transmission of COVID-19 and safeguard the wellbeing of our patients, families and colleagues.

Vendors will ensure any staff coming on hospital premises are either fully vaccinated or have an approved exemption, as per the Policy.

Full compliance is required, and we thank you for your support. By signing this form you are attesting to enforcement of these important and mandatory infection prevention and control directives with your team.

Company Name: _____

Manager/Approver:_____

- I attest that I have reviewed the GRH Vaccination Policy: YES ☐
- I attest to be compliant with the GRH Vaccination Policy and provincial directive #6: YES ☐

Signature:_____

Date:_____

Please submit a signed copy of the form If you have any questions, please contact me at grhvendorattestation@grhosp.on.ca

Sincerely,

Kristen Warden,
Director, Purchasing and Materials Management
Grand River Hospital

Waterloo Regional Health Network (WRHN)

Positron Emission Tomography (PET) CT Scanner

APPENDIX D

Respectful Workplace Policy

September 2026

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WRHN
Waterloo Regional Health Network

Contractor Requirements Under the WRHN Respectful Workplace Policy

This document (Appendix F) is to be followed by contractors, vendors and delivery personnel who attend any Waterloo Regional Health Network (WRHN) workplace.

Contractors, vendors and delivery personnel who wish to report an incident or lodge a complaint involving violence or harassment from WRHN hospital workers will do so under their own organization's workplace violence and harassment program.

WRHN is committed to providing and fostering a positive and respectful workplace free from actual, attempted or threatened violence, and from harassment. WRHN recognizes that workplace violence and harassment are health and safety and human resources issues and will take all reasonable precautions to prevent workplace violence and harassment and to protect workers at the workplace.

WRHN will not tolerate incidents of workplace violence or harassment carried out against any workers at a WRHN workplace, or involved in hospital business. WRHN will take corrective action deemed necessary, up to and including termination of contract, in order to provide a safe and respectful work environment for its workers.

Workplace violence as used in this document is defined as:

- the exercise of physical force by a person against a worker in a workplace, that causes or could cause physical injury;
- an attempt to exercise physical force against a worker in a workplace, that could cause physical injury; or,
- a statement or behaviour, that it is reasonable for a worker to interpret as a threat to exercise physical force, in a workplace, that could cause physical injury to the worker.

Examples of workplace violence include any of the following against, at or towards a worker:

- verbally threatening to attack or harm;
- leaving threatening notes at or sending threatening e-mails to a workplace;
- shaking a fist in a worker's face, or blocking their movement;
- wielding a weapon at work;
- hitting, punching, shoving, choking, strangling, biting, spitting, groping, grabbing, kicking, pinching, pushing, etc., or attempting any of these acts against a worker;

- deliberately injuring or attempting to injure a worker;
- throwing an object at a worker; or,
- sexual violence against a worker;

Workplace harassment as used in this policy means:

- engaging in a course of vexatious comment or conduct against a worker in a workplace that is known or ought reasonably to be known to be unwelcome; or,
- workplace sexual harassment.

Workplace harassment can involve unwelcome words or actions that are known or should be known to be offensive, embarrassing, humiliating or demeaning to a worker or group of workers. Workplace harassment often involves repeated words or actions, or a pattern of behaviours, against individual or groups of workers in the workplace that are unwelcome. However, in some cases the behaviour can be so egregious that one instance would be considered workplace harassment.

Examples of workplace harassment include any of the following against, at or towards a worker:

- making remarks, jokes or innuendos or exhibiting behaviour that demean, ridicule, intimidate, insult, embarrass, belittle, humiliate, discriminate, offend, or isolate a worker;
- displaying or circulating offensive pictures or materials in print or electronic form;
- bullying, yelling at another in anger, shouting, or using obscene and/or foul language;
- spreading rumours, or participating in gossip that may be deemed malicious towards a colleague;
- repeated offensive or intimidating phone calls, mails, or social media messages;
- inappropriate staring;
- harassment or discrimination prohibited under the Ontario Human Rights Code, i.e., based on race, ancestry, place of origin, colour, ethnic origin, citizenship, creed (religion), sex (including pregnancy and gender identity), sexual orientation, disability, age, marital status, family status, receipt of public assistance for accommodation, and record of offences; or
- workplace sexual harassment.

Workplace sexual harassment as used in this policy means:

- engaging in a course of vexatious comment or conduct against a worker in a workplace because of sex, sexual orientation, gender identity or gender expression, where the course of comment or conduct is known or ought reasonably to be known to be unwelcome; or
- making a sexual solicitation or advance where the person making the solicitation or advance is in a position to confer, grant or deny a benefit or advancement to the worker and the person knows or ought reasonably to know that the solicitation or advance is unwelcome.

Some examples of sexual harassment are:

- Unwanted sexual advances;
- Asking for sex in exchange for a benefit or a favour;
- Unwelcome solicitation or advances from a manager/supervisor, or another person who has the power to reward or punish the worker;
- Repeatedly asking for dates, and not taking “no” for an answer;
- Demanding hugs;
- Making unnecessary physical contact, including unwanted touching;
- Leering, using rude or insulting language or making comments of a sexual nature toward others;
- Calling people sex-specific derogatory names;
- Making sex-related comments about a person’s physical characteristics or actions;
- Inappropriate sexual touching, advances, suggestions or requests;
- Posting or sharing pornography, sexual pictures or cartoons, sexually explicit graffiti, or other sexual images (including online);
- Taking and/or sharing sexually inappropriate photographs of a person;
- Making sexual jokes;
- Spreading rumours or making derogatory remarks about a person’s sexuality;
- Bragging about sexual prowess; or
- Isolating, making negative comments or making fun of a person’s gender identity, or because a person does not conform to sex-role stereotypes.

January 24, 2017

Waterloo Regional Health Network (WRHN)

Positron Emission Tomography (PET) CT Scanner

APPENDIX E

Designated Substance Report

September 2026

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Westinghouse HQ, 2nd Floor
286 Sanford Ave. N. Hamilton, ON L8L 6A1
905.526.6700 | mccallumsather.com

WRHN
PET CT Scanner Renovation Project
835 King Street West, Kitchener

Designated Substance Report

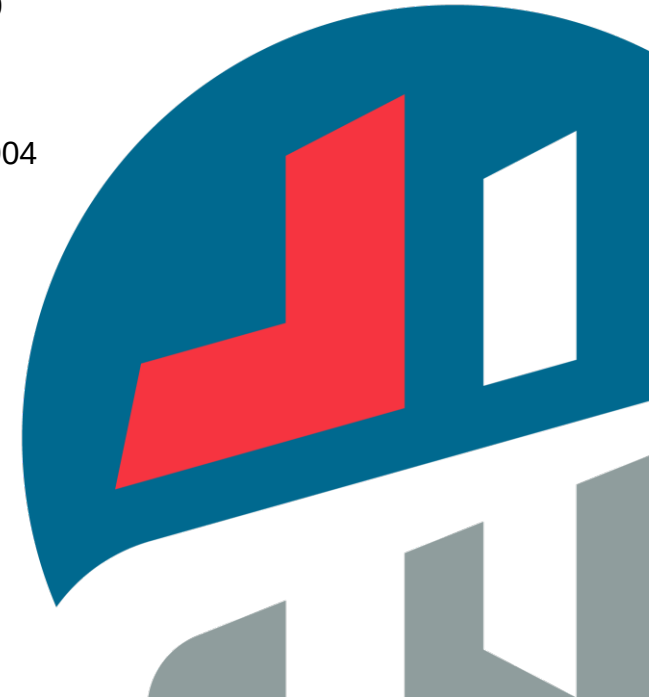
Project Location:
835 King Street West, Kitchener, ON

Prepared for:
Waterloo Regional Health Network
835 King Street West
Kitchener, ON N2G 1G3

Prepared by:
MTE Consultants
520 Bingemans Centre Drive
Kitchener, ON N2B 3X9

August 1, 2025

MTE File No.: 62448_004



Engineers, Scientists, Surveyors.

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1.0 INTRODUCTION 1
2.0 SCOPE OF WORK 1
3.0 METHODOLOGY AND ASSESSMENT CRITERIA 2
4.0 ASSESSMENT AND RESULTS 2
4.1 Findings and Analytical Results 3
4.2 Conclusions and Recommendations 4
5.0 LIMITATIONS 6

Appendices

Appendix A Tables
Appendix B Historical Laboratory Certificates of Analysis

1.0 INTRODUCTION

MTE Consultants Inc. (MTE) was retained by Waterloo Regional Health Network (WRHN) to conduct a Designated Substance for the building located at 835 King Street West in Kitchener, Ontario as part of the GRH- PET CT Scanner Renovation Project.

The purpose of the audit was to identify the presence of Designated Substances within the building (and Project Scope) in accordance with Section 30 of the Occupational Health & Safety Act (OHSA), in advance of renovation work. This report meets the requirements of Section 30 of the OHSA and the requirements of Ontario Regulation (O. Reg.) 278/05.

2.0 SCOPE OF WORK

As requested by the Client, this assessment was limited to the following areas based on McCallum Sather Architects Plans A2.1, A2.2, A3.1, A3.2, A3.1, EX1.1, EX1.2, and EX1.3 including a walkthrough of the project with GRH Facilities Management Redevelopment Team on July 23, 2025:

- Shell Space F236, Storage Room F235.
- CT Scanner and Support Rooms G201, G201-1, G201-2, G201-3 G201-4, G202, G203, G204, G205, G206, G207, G208.
- Staff Washroom and Housekeeping Closet (Level 2 - currently without Seawood FM WSP Room Designations).
- Plumbing Drop Locations Level 1 (speculated – currently no mechanical plans available):
    - F117, F117-1, F117-2, F117-3, F118, F118-1, F118-2, G115, G116, G117, G117-1, G118, G118-1; and
    - Corridors F100-14, F100-14, F100-15 and G100-5.

These areas are referred to in the following sections as the “Subject Areas”.

The Scope of Work for this assessment was completed by MTE and included the following activities:

- Review of existing or historical reports and documentation pertaining to Designated Substances within the building and Subject Areas.
- Visual inspection of all accessible areas within the building and all accessible exterior finishes and elements to identify the following suspect Designated Substances:
    - Asbestos;
    - Lead;
    - Mercury; and
    - Silica.
- The following Designated Substances are not expected to be present due to the building use or in a form that is hazardous: Acrylonitrile, Arsenic, Benzene, Coke Oven Emissions, Ethylene Oxide, Isocyanates, and Vinyl Chloride.
- Preparation of this report of findings and recommendations.

3.0 METHODOLOGY AND ASSESSMENT CRITERIA

This audit was conducted using review of historical reports and historical laboratory data and visual methods for the assessment of materials outlined in Section 2.0 and their corresponding location and use. Materials that are determined to be asbestos-containing materials (ACM) are further classified by their friability and condition. The areas outlined in Section 2.0 were inspected and limited to building components, materials and service connections. Notwithstanding that reasonable attempts were made to identify all Designated Substances; the possibility of concealed substances and material exists and may not become visible until substantial demolition has occurred and therefore are currently undocumented. All work was conducted in accordance with industry accepted methods and MTE Standard Operating Procedures and did not include the following:

- Locations where at-risk patients, materials or equipment may be compromised by dust generating work;
- Materials indicated in this report as “Potentially Concealed”;
- Locations that may be hazardous to the surveyor (located at heights, live electrical equipment, confined spaces);
- Where invasive inspection could cause consequential damage to the property or impair the integrity of the equipment, such as roof system, sealants, exterior finishes, underground services or components of mechanical equipment;
- Locations concealed by building finishes that require substantial demolition or removal for access or determination of quantities (plumbing or electrical lines);
- Non-permanent items or personal contents, furnishings; and
- Settled dust or airborne agents unless otherwise stated.

4.0 ASSESSMENT AND RESULTS

An inspection of the building was conducted by MTE on July 23, 2025. A representative of WRHN Facilities Management Redevelopment Team was present.

The proposed GRH-D333 Lab Re-Processor Renovation Project is expected to disturb existing millwork and wall separations, ceiling grid (to access power and data components) installation of new lab equipment, coring of concrete flooring or above-ceiling wall separations to extend conduits and cables, HVAC ducting, sanitary drain line connections, controls and electrical connections, patching, sanding, priming and painting.

A description of the building and assessed finishes is provided below. Refer to Section 4.1 for a summary of findings.

Building Element	Description
Construction Date	2008-2012 PCD Project, Renovation of Level 2 CT Scanner Rooms 2023-24
Addition Date(s)	-
Levels	2
Exterior Finishes	Concrete Brick veneer and mortar Concrete block and mortar Glass spandrel Flat roof system (2002-2008)

Building Element	Description
Building Structure	Structural steel Concrete Concrete block
Building Insulations	Not inspected
Mechanical Systems/Insulations	Gas fired hot water heating Forced air central heating Central air conditioning Flex (spiral) ducting Fibreglass insulated metal ductwork
	Fibreglass insulation on pipe straights, foil wrapped elbows Fiberglass insulation covered with Polyvinyl Chloride (PVC)
Electrical/Plumbing Systems	Compact fluorescent bulbs, LED bulbs Fluorescent light fixtures with fluorescent light tubes
Floor Finishes	Vinyl sheet flooring Concrete slab below floor finishes
Wall Finishes	Drywall Unpainted poured concrete, floors, walls and deck Concrete block and mortar behind drywall finishes Brick and mortar (exterior)
Ceiling Finishes	2’ x 4’ short fissure pinhole pattern Drywall Metal grid panels, hood vent supports and anchors Poured concrete deck

As part of this assignment MTE reviewed:

- “*2008 Asbestos Audit Update – Grand River Hospital, 835 King Street West, Kitchener Ontario*” dated October 6, 2008, and prepared by MTE Consultants Inc.
- *“Grand River Hospital 2020 Asbestos Audit Update”* dated July 27, 2020, and prepared by MTE Consultants Inc.
- GRH (WRHN) Seawood FM Asbestos Database – WSP.

Review of these reports and Seawood FM (WSP) database indicated that no asbestos-containing materials are present within the Subject Areas. Should the project scope change, the above-listed reports and database should be referenced. Plaster and drywall joint compounds on wall and ceiling finishes have been extensively sampled at GRH over the past 20 years. No asbestos content has been reported in these finishes within the Subject Areas and in the Main Hospital.

4.1 Findings and Analytical Results

A summary of historical sampling locations and analytical results are included in **Appendix A** and includes historical sampling as outlined in Section 4.0.

Historical and current laboratory certificates of analysis are included in **Appendix B**.

A detailed summary of findings and recommended actions is provided in **Table 4.2 of Appendix A.**

Asbestos

Asbestos was used in building materials throughout the years with a peak usage in the 1950s and 1960s. While the manufacture of most ACM, was banned in the 1970s, buildings constructed in the 1980s have the potential for ACM as well. In 1986 legislation limiting the use of asbestos in consumer products was introduced. Based on the age of construction (Patient Care Development Project - 2008-2012) no asbestos-containing materials are present within the Subject Areas.

Lead

Lead was historically used in mortar pigments, ceramic glazing; plumbing solder, electrical equipment and electronics solder, in pipe gaskets as packing in cast iron bell and spigot joints of sanitary drains, flexible plumbing connections, flashing panels, acoustical dampeners, phone cable casing and some architectural applications. In buildings constructed after 1990, these applications are no longer applicable outside of specialized uses (shielding for medical imaging etc.).

A review of historically sampled paints was conducted for lead content review. It should be noted that many finishes were painted as part of the REMCC or Patient Care Development Project dating back to 2002-2008 and no lead-based paints are anticipated.

Based on the review of historical data and visual inspections, low-level lead-containing paint products are anticipated within the Subject Areas.

Mercury

Mercury is typically used in building service applications such as fluorescent light tubes, compact fluorescent bulbs, metal halide (sodium halide) lamp bulbs, and neon lights as a vapour. Mercury may exist in thermostats and pipe or mechanical equipment thermometers as a liquid. Mercury is presumed to be present in the above materials.

Mercury-containing materials were visually identified at the time of the inspection.

Silica

Silica is present in rock, stone, soil, and sand. Masonry products such as concrete block, brick, and mortar, as well as concrete and associated products contain silica. Due to its ubiquitous nature, silica was historically used in a wide variety of building materials and is still used today in new construction.

Building materials that are presumed to contain silica were visually identified at the time of the inspection.

4.2 Conclusions and Recommendations

A detailed summary of recommended actions is provided in **Table 4.2 of Appendix A**.

In accordance with Section 30 of OHSA and Section 8 of O. Reg. 278/05 the owner must provide a copy of this report to all contractors doing work at the building. The owner must also provide a copy of this report to all prospective contractors.

Should any additional suspect Designated Substances be discovered during building renovation demolition, work in the vicinity should cease and the materials should not be disturbed until proper notification, testing and abatement instructions are provided. All waste generated as a result of any and all work at the Site must be handled, transported and disposed of in accordance with Ontario Regulation 347 made under the Environmental Protection Act and local by-laws. Based on the assessment findings and analytical results, the following abatement measures are presented. It should be noted that the recommended actions are the minimum

required actions, as prescribed by the appropriate Acts, regulations, guidelines, standards, codes and general best practice measures.

Asbestos

Based on the laboratory results, historical documents review, age of construction and visual identification no ACMs are suspected to be present.

Should any suspect ACM be discovered during the course of construction, renovation, alteration, or maintenance activities, work which disturbs the material must cease immediately. Suspect ACM must be treated as asbestos-containing or sampled prior to disturbance to assess the presence of asbestos.

There are no requirements under current legislation to remove ACM from a building simply because it is present. However, O. Reg. 278/05 requires that an Asbestos Management Program be implemented and maintained by the owner/employer where ACM is identified or suspected present.

Lead

Lead-containing materials in the form of lead shielding and lead glazing for the existing CT Scanner Rooms (G202 & G204) and Control Room (G203) was confirmed through discussions with WRHN Facilities Management.

Low level lead-containing paints were also confirmed present through historical sampling events and the following general procedures are recommended as a precautionary measure as per the Environmental Abatement Council of Canada's (EACC) Lead Guideline for Construction, Renovation, Maintenance or Repair (October 2014):

- General dust control;
- The washing of hands and face at on-site facilities;
- No smoking, eating, chewing gum or drinking in the work area; and
- No removal of painted surfaces by means of abrasive blasting.

Mercury

Mercury-containing materials were identified. All mercury containing materials or sources should be removed, intact, prior to any work which may disturb or damage them and cause worker exposure to mercury liquid and/or vapour.

On-site crushing of mercury-containing materials should not occur. Care should be taken to ensure safe storage of the above until recycling or disposal can be coordinated. Under current legislation, mercury waste requires handling and disposal in accordance with Ontario Regulation 490/09 of the OHSA and Ontario Regulation 347 of the Environmental Protection Act.

Silica

Silica is presumed to be present; therefore, special requirements for management and handing are required. The contractor should also consult MOL Occupational Health and Safety Branch's Guideline: *Silica on Construction Projects* (April 2011) for the procedures and methods required to remove and dispose of silica-containing materials.

5.0 LIMITATIONS

Services performed by **MTE Consultants Inc.** (MTE) were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the Environmental Engineering & Consulting profession. No other representation expressed or implied as to the accuracy of the information, conclusions or recommendations is included or intended in this report.

This report was completed for the sole use of MTE and the Client. It was completed in accordance with the approved Scope of Work referred to in Section 2.0. As such, this report may not deal with all issues potentially applicable to the site and may omit issues that are or may be of interest to the reader. MTE makes no representation that the present report has dealt with all-important environmental features, except as provided in the Scope of Work. All findings and conclusions presented in this report are based on site conditions, as they existed during the time period of the investigation. This report is not intended to be exhaustive in scope or to imply a risk-free facility.

Any use which a third party makes of this report, or any reliance on, or decisions to be made based upon it, are the responsibility of such third parties. MTE accepts no responsibility for liabilities incurred by or damages, if any, suffered by any third party as a result of decisions made or actions taken, based upon this report. Others with interest in the site should undertake their own investigations and studies to determine how or if the condition affects them or their plans.

It should be recognized that the passage of time might affect the views, conclusions and recommendations (if any) provided in this report because environmental conditions of a property can change. Should additional or new information become available, MTE recommends that it be brought to our attention in order that we may re-assess the contents of this report.

All of which is respectfully submitted,

MTE Consultants Inc.

Martin Mielke, B.Sc.
Technical Practice Leader, Indoor Environments
519-743-6500
mmielke@mte85.com

MJM: smk
https://mte85.sharepoint.com/sites/62448_004/Shared Documents/03- Reports/DSA/62448_004_2025-08-01_rpt_DSA-WRHN-GRH-PET CT ScannerRenovationProject.docx

Appendix A

Tables

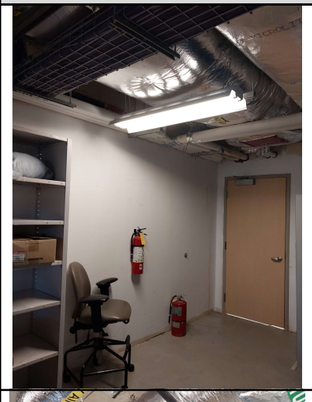
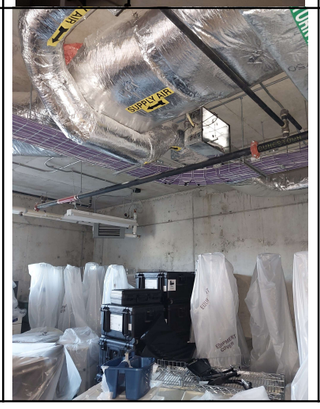
TABLE 4.1: HISTORICAL LEAD IN PAINT SAMPLE SUMMARY TABLE					
Sample #	**Location**	**Colour**	**Material**	**Lead Content (µg/g)**	**Classification**
2013 - Level 5 & 6 PIC Project - D Wings					
LP01	D WING CORRIDORS	BEIGE	DRYWALL	<5	LOW LEVEL LEAD-CONTAINING
LP02	D WING CORRIDORS	TURQUOISE	DRYWALL	<5	LOW LEVEL LEAD-CONTAINING
LP03	D WING CORRIDORS	GREY GREEN	DRYWALL	<5	LOW LEVEL LEAD-CONTAINING
LP04	D WING CORRIDORS	LIGHT GREEN	DRYWALL	30	LOW LEVEL LEAD-CONTAINING
LP05	D WING CORRIDORS	**BEIGE**	**METAL DOOR TRIM**	**2,960**	**LEAD-CONTAINING**
2015 - PACU - D226					
LP1	D226	PINK SALMON	DRYWALL	<5	LOW LEVEL LEAD-CONTAINING
2019 - Fluoroscopy - D2104					
LP8	D2104	GREEN	DRYWALL	<20	LOW LEVEL LEAD-CONTAINING
November 16, 2022 - X-ray Rooms E261, E261-1 and E261-2 Renovation Project					
LP01	E261-2	PALE GREEN	DRYWALL	<5	LOW LEVEL LEAD-CONTAINING
LP02	E261-1	OFF-WHITE	DRYWALL	7	LOW LEVEL LEAD-CONTAINING
January 20, 2025 - D333 Lab Re-Processor Renovation Project					
LP01	D333	BEIGE	PLASTER	33	LOW LEVEL LEAD-CONTAINING

"<": The samples analysed reported concentrations of lead to be less than 1000 µg/g and are therefore classified as low level lead-containing.

As outlined in EACC's Lead Guideline for Construction, Renovation, Maintenance or Repair (October 2014), for the purpose of classifying surface coatings and mortars by laboratory analysis, any material containing lead at a concentration:

- Greater than 0.5% by weight (5,000 µg/g, mg/kg, ppm) is considered lead-based;
- Between 0.1 % and 0.5% by weight (1,000 to 5,000 µg/g, mg/kg, ppm) is considered lead-containing; or
- Less than 0.1% (1,000 µg/g, mg/kg, ppm) is considered low level lead-containing.

Table 4.2 - Summary of Designated Substances, Hazardous Materials and Recommended Actions						
WRHN - PET CT Scanner Renovation Project						
Material	**Location**	**Material Description**	**Approximate Quantity**	**Photograph**	**Management Requirements If No Impacts to Material**	**Recommended Actions If Material Will Be Or Likely Be Impacted By Maintenance, Renovation, Construction or Demolition Activities**
Lead	CT Scanner Rooms G202, G204, Control Room G203	Lead Shielding in Wall cavities and in Control Room Glazing	1,215 ft^2 (113 m^2)	-	None	Removal prior to renovation/demolition activities in accordance with EACC's Lead Guideline as a: Class 1 Operation - No hot work to remove
Low Level Lead-Containing Paint	Throughout Subject Areas	Beige, Pale Green wall paint on drywall	-		None	In accordance with EACC's Lead Guideline general hygiene procedures during renovation activities: - General dust control, - Washing of hands and face at on-site facilities, - No smoking, eating, chewing gum or drinking in the work area, - No abrasive blasting
Mercury	Throughout Subject Areas	Compact Fluorescent Bulbs in pot light fixtures	10+		None	Intact removal and storage with no on-site crushing and disposal of materials to a licensed facility

Table 4.2 - Summary of Designated Substances, Hazardous Materials and Recommended Actions						
WRHN - PET CT Scanner Renovation Project						
Material	**Location**	**Material Description**	**Approximate Quantity**	**Photograph**	**Management Requirements If No Impacts to Material**	**Recommended Actions If Material Will Be Or Likely Be Impacted By Maintenance, Renovation, Construction or Demolition Activities**
Mercury	Throughout Subject Areas	Flourescent tubes (T4s/T8s) in light fixtures	60+		None	Intact removal and storage with no on-site crushing and disposal of materials to a licensed facility
Silica	Throughout Subject Area	Brick and mortar, concrete block and mortar present behind select walls. Poured concrete walls and presumed present below vinyl sheet flooring. Poured concrete is present at the deck above the false ceilings	-		None	Conduct any work during renovation, demolition activities in accordance with the Ministry of Labour Guideline Silica on Construction Projects

Notes:
1) A copy of this report should be provided to all prospective contractors prior to quotation, in accordance with Section 30 of the Occupational Health and Safety Act.
2) Recommended actions are the minimum required actions, as prescribed by the appropriate Acts, regulations, guidelines, standards, codes and general best practice measures. Prior to demolition, the Contractor may choose to alter the approach and combine or break out sections of work. This is acceptable provided that the appropriate Acts, regulations, guidelines, standards and codes are followed and afford protection for the health and safety of workers, occupants and the public that is at least equal to the protection that would be provided by complying with the minimum requirements.
3) All waste generated is subject to characterization and disposal in accordance with Ontario Regulation 347.

Appendix B

Historical Laboratory Certificates of Analysis

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Hamilton, ON L8H 7P4
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www.paracellabs.com

Certificate of Analysis

MTE Consultants Inc. (Kitchener)

520 Bingemans Centre Dr.
Kitchener, ON N2B 3X9
Attn: Martin Mielke

Client PO: 60885_001
Project: 60885_001 GRH Lab Reprocessor Renovation
Custody:

Report Date: 24-Jan-2025
Order Date: 23-Jan-2025

Order #: 2504283

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2504283-01	LP01

Approved By: Mark Foto

Mark Foto, M.Sc.
Laboratory Director

Any use of these results implies your agreement that our total liabilty in connection with this work, however arising shall be limited to the amount paid by you for this work, and that our employees or agents shall not under circumstances be liable to you in connection with this work

Certificate of Analysis

Report Date: 24-Jan-2025

Client: MTE Consultants Inc. (Kitchener)

Order Date: 23-Jan-2025

Client PO: 60885_001

Project Description: 60885_001 GRH Lab Reprocessor Renovation

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Metals, ICP-MS	EPA 6020 - Digestion - ICP-MS	23-Jan-25	23-Jan-25

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions/Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

Certificate of Analysis

Report Date: 24-Jan-2025

Client: MTE Consultants Inc. (Kitchener)

Order Date: 23-Jan-2025

Client PO: 60885_001

Project Description: 60885_001 GRH Lab Reprocessor Renovation

Sample Results

Lead

Matrix: Paint

Paracel ID	Client ID	Sample Date	Units	MDL	Result
2504283-01	LP01	20-Jan-25	ug/g	5	33

Laboratory Internal QA/QC

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Matrix Blank									
Lead	**ND**	**5**	**ug/g**						
Matrix Duplicate									
Lead	**824**	**5**	**ug/g**	**1060**			**25.50**	**50**	
Matrix Spike									
Lead	83.6	5.00	ug/g	42.6	82.0	70-130			

PARACEL LABORATORIES LTD.

Paracel ID: 2504283

Paracel Order Number (Lab Use Only)	Chain Of Custody (Lab Use Only)
2504283	

Client Name:	MTE Consultants Inc.	Project Ref:	60885_001 GRH Lab Reprocessor Renovation
Contact Name:	Martin Mielke, Paul Semeniuk	Quote #:	22-084 MTE Standing Offer
Address:	520 Bingmans Centre Drive Kitchener ON N2B 3X9	PO #:	
Telephone:	519-743-6500 ext 1318	E-mail:	mmielke@mte85.com psemeniuk@mte85.com mbennett@mte85.com

Page 1 of 1

Turnaround Time

☐ 1 day ☐ 3 day
☒ 2 day ☐ Regular
Date Required:

Regulation 153/04

☐ Table 1 ☐ Res/Park ☐ Med/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other
☐ Table ___
For RSC: ☐ Yes ☐ No

Other Regulation

☐ REG 558 ☐ PWQO
☐ CCME ☐ MISA
☐ SU - Sani ☐ SU - Storm
Mun:
☐ Other:

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analysis

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken: Date	Sample Taken: Time	LEAD in Paint	TCLP - LEAD
1	60885_001-GRH D333-LP01 - Beige Wall Paint on Plaster	P			Jan-20-25	2:00 PM	✔	
2								
3								
4								
5								
6								
7								
8								
9								
10								

Comments:

Method of Delivery: Purolator

Relinquished By (Sign):	Received By Driver/Depot:	Received at Lab: SD	Verified By:
Relinquished By (Print): Martin Mielke	Date/Time:	Date/Time: Jan 23 2025 8:45 AM	Date/Time: Jan. 23 9:06
Date/Time: Jan-22-25 2:30 PM	Temperature: °C	Temperature:	pH Verified: ☐ By:

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B13-31050

Report To:

EMC Scientific Inc.
5800 Ambler Dr. #100,
Mississauga ON L4W 4J4 Canada
Attention: Alister Haddad

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 29-Nov-13
DATE REPORTED: 02-Dec-13
SAMPLE MATRIX: Paint Chips

JOB/PROJECT NO.: Grand River Hospital
P.O. NUMBER: 33566-143
WATERWORKS NO.

	Parameter		Lead				
	Units		µg/g				
	M.D.L.		5				
	Reference Method		EPA 6010				
	Date Analyzed/Site		29-Nov-13/O				
Client I.D.	**Sample I.D.**	**Date Collected**					
LP1-Paint-Beige-C122	B13-31050-1	20-Nov-13	454				
LP2-Paint-Teal-C124	B13-31050-2	20-Nov-13	< 5				
LP3-Paint-Beige-C126	B13-31050-3	20-Nov-13	500				
LP4-Paint-Light Teal-C124	B13-31050-4	20-Nov-13	5				

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

M.D.L. = Method Detection Limit
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

The analytical results reported herein refer to the samples as received. Reproduction of this analytical report in full or in part is prohibited without prior consent from Caduceon Environmental Laboratories.

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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B15-30345

Report To:

EMC Scientific Inc.
5800 Ambler Dr. #100,
Mississauga ON L4W 4J4 Canada
Attention: Alister Haddad

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 19-Nov-15
DATE REPORTED: 20-Nov-15
SAMPLE MATRIX: Paint Chips

JOB/PROJECT NO.: GRH Patient Recovery-D226
P.O. NUMBER: 33566-152
WATERWORKS NO.

	Parameter		Lead				
	Units		µg/g				
	R.L.		5				
	Reference Method		EPA 6010				
	Date Analyzed/Site		20-Nov-15/O				
Client I.D.	**Sample I.D.**	**Date Collected**					
LP1-Pale Pink Salmon-Wall	B15-30345-1	17-Nov-15	< 5				

R.L. = Reporting LImit
Site Analyzed: K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill
Uncertainty Values available upon request

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

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Certificate of Analysis

MTE Consultants Inc. (Kitchener)

520 Bingemans Centre Dr.
Kitchener, ON N2B 3X9
Attn: Martin Mielke

Client PO:
Project: 33566-176 GRH Fluoroscopy
Custody:

Report Date: 26-Nov-2019
Order Date: 22-Nov-2019

Order #: 1947576

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1947576-01	LP1-D2104-Green Wall Paint

Approved By:

Dale Robertson, BSc
Laboratory Director

Any use of these results implies your agreement that our total liabilty in connection with this work, however arising shall be limited to the amount paid by you for this work, and that our employees or agents shall not under circumstances be liable to you in connection with this work

Certificate of Analysis
Client: MTE Consultants Inc. (Kitchener)
Client PO:

Report Date: 26-Nov-2019
Order Date: 22-Nov-2019
Project Description: 33566-176 GRH Fluoroscopy

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Metals, ICP-OES	based on MOE E3470, ICP-OES	25-Nov-19	25-Nov-19

Sample Data Revisions

None

Work Order Revisions/Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

PARACEL LABORATORIES LTD.

Order #: 1947576

Certificate of Analysis
Client: MTE Consultants Inc. (Kitchener)
Client PO:

Report Date: 26-Nov-2019
Order Date: 22-Nov-2019
Project Description: 33566-176 GRH Fluoroscopy

Sample Results

Lead

Matrix: Paint
Sample Date: 20-Nov-19

Paracel ID	Client ID	Units	MDL	Result
1947576-01	LP1-D2104-Green Wall Paint	ug/g	20	<20

Laboratory Internal QA/QC

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Matrix Blank									
Lead	**ND**	**20**	**ug/g**						
Matrix Duplicate									
Lead	**1340**	**20**	**ug/g**	**1300**			**3.3**	**30**	
Matrix Spike									
Lead	923		ug/L	650	109	70-130			

CADUCEON ENVIRONMENTAL LABORATORIES
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CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B13-07784

Report To:

EMC Scientific Inc.
5800 Amber Dr. #100,
Missisuaga ON L4W 4J4 Canada
Attention: Alister Haddad

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 09-Apr-13
DATE REPORTED: 10-Apr-13
SAMPLE MATRIX: Paint Chips

JOB/PROJECT NO.: GRH 5D 6D NIC
P.O. NUMBER: 33566-135
WATERWORKS NO.

Parameter			Lead				
Units			µg/g				
M.D.L.			5				
Reference Method			EPA 6010				
Date Analyzed/Site			09-Apr-13/O				
Client I.D.	**Sample I.D.**	**Date Collected**					
LP01 - Beige Wall Paint	B13-07784-1	05-Apr-13	< 5				
LP02 - Turquoise Wall Paint	B13-07784-2	05-Apr-13	< 5				
LP03 - Grey Green Wall Paint	B13-07784-3	05-Apr-13	< 5				
LP04 - Light Green Wall Paint	B13-07784-4	05-Apr-13	30				
LP05 - Beige Door Trim Paint	B13-07784-5	05-Apr-13	2960				

M.D.L. = Method Detection Limit
Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

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Certificate of Analysis

MTE Consultants Inc. (Kitchener)

520 Bingemans Centre Dr.
Kitchener, ON N2B 3X9
Attn: Martin Mielke

Client PO: 33566-190
Project: 33566-190 GRH - X-Ray Project
Custody:

Report Date: 24-Nov-2022
Order Date: 23-Nov-2022

Order #: 2248217

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2248217-01	LP01
2248217-02	LP02

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Any use of these results implies your agreement that our total liabilty in connection with this work, however arising shall be limited to the amount paid by you for this work, and that our employees or agents shall not under circumstances be liable to you in connection with this work

Certificate of Analysis

Report Date: 24-Nov-2022

Client: MTE Consultants Inc. (Kitchener)

Order Date: 23-Nov-2022

Client PO: 33566-190

Project Description: 33566-190 GRH - X-Ray Project

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Metals, ICP-MS	EPA 6020 - Digestion - ICP-MS	23-Nov-22	24-Nov-22

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions/Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

Certificate of Analysis

Report Date: 24-Nov-2022

Client: MTE Consultants Inc. (Kitchener)

Order Date: 23-Nov-2022

Client PO: 33566-190

Project Description: 33566-190 GRH - X-Ray Project

Sample Results

Lead

Matrix: Paint

Paracel ID	Client ID	Sample Date	Units	MDL	Result
2248217-01	LP01	16-Nov-22	ug/g	5	<5
2248217-02	LP02	16-Nov-22	ug/g	5	7

Laboratory Internal QA/QC

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Matrix Blank									
Lead	**ND**	**5**	**ug/g**						
Matrix Duplicate									
Lead	**7.4**	**5**	**ug/g**	**6.6**			**10.30**	**50**	
Matrix Spike									
Lead	55.1	5.00	ug/g	ND	110	70-130			

Paracel ID: 2248217

PARACE LABORATORIES LT

Laurent Blvd
ario K1G 4J8
9-1947
paracellabs.com
ellabs.com

Paracel Order Number (Lab Use Only)	Chain Of Custody (Lab Use Only)
2248217	

Client Name:	MTE Consultants Inc.	Project Ref: 33566-190 GRH - X-Ray Project	Page 1 of 1
Contact Name:	Martin Mielke, Paul Semeniuk	Quote #: 20-106 MTE Standing Offer	Turnaround Time
Address:	520 Bingmans Centre Drive Kitchener ON N2B 3X9	PO #:	☐ 1 day ☐ 3 day
		E-mail:	☒ 2 day ☐ Regular
Telephone:	519-743-6500	mmielke@mte85.com, psemeniuk@mte85.com	Date Required:

Regulation 153/04	Other Regulation
☐ Table 1 ☐ Res/Park ☐ Med/Fine	☐ REG 558 ☐ PWQO
☐ Table 2 ☐ Ind/Comm ☐ Coarse	☐ CCME ☐ MISA
☐ Table 3 ☐ Agri/Other	☐ SU - Sani ☐ SU - Storm
☐ Table ___	Mun:
For RSC: ☐ Yes ☐ No	☐ Other:

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analysis

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	LEAD in Paint	TCLP - LEAD										
1	LP01 - E261-2 - Pale Green Wall Paint on drywall	P			Nov-16-22	3:30 PM	✔											
2	LP02 - E261-1 - Off-white Wall Paint on drywall	P			Nov-16-22	3:30 PM	✔											
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		

Comments:			Method of Delivery: Purolator
Relinquished By (Sign):	Received By Driver/Depot:	Received at Lab: Jimeepam Bohman	Verified By:
Relinquished By (Print): Martin Mielke	Date/Time:	Date/Time: Nov 23, 2022 08:50	Date/Time: Aug 23 2022 1946
Date/Time: Nov-22-22 8:36 AM	Temperature: °C	Temperature:	pH Verified: ☐ By: NA

Waterloo Regional Health Network (WRHN)

Positron Emission Tomography (PET) CT Scanner

APPENDIX F

WRHN Milestone Schedule

September 2026

mcCallumSather
TWENTY-FIVE YEARS | ESTABLISHED 1996

Westinghouse HQ, 2nd Floor
286 Sanford Ave. N. Hamilton, ON L8L 6A1
905.526.6700 | mccallumsather.com

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		**PET CT - Project Schedule**	**764 days**	**Mon 25-01-27**	**Wed 28-03-01**	
2		**Ministry Capital Submissions**	**579 days**	**Mon 25-01-27**	**Thu 27-06-10**	
3		Stage 1.1 - Pre Capital	579 days	Mon 25-01-27	Thu 27-06-10	
4		Stage 1.1 Submission to MOH	1 day	Tue 25-02-25	Tue 25-02-25	
5		MOH Review	558 days	Wed 25-02-26	Thu 27-06-10	4
6		Issuance of Project Agreement	0 days	Mon 25-01-27	Mon 25-01-27	
8		Stage 1.2/1.3	20 days	Fri 25-07-11	Fri 25-08-08	6
13		Stage 2.1 - Block Schematic	0 days	Tue 25-02-25	Tue 25-02-25	
17		Stage 2.2 - Sketch Plan	61 days	Fri 25-11-28	Mon 26-03-09	
21		Stage 2.3 - Contract Documents	68 days	Mon 26-06-15	Mon 26-09-21	
22		Stage 2.3 Submission to MOH	0 days	Mon 26-06-15	Mon 26-06-15	51FS+2 wks
23		MOH Review	13.6 wks	Mon 26-06-15	Mon 26-09-21	22
24		MOHApproval to Tender	0 days	Mon 26-09-21	Mon 26-09-21	23
25		Stage 3.1 - FEC and Award	21 days	Fri 26-10-30	Fri 26-11-27	
26		Stage 3.1 Submission to MOH	1 day	Fri 26-10-30	Fri 26-10-30	57FS+1 day
27		MOH Review	4 wks	Mon 26-11-02	Fri 26-11-27	26
28		MOH Approval to Award GC	0 days	Fri 26-11-27	Fri 26-11-27	27
29		Stage 3.2 Construction (Refer to Construction Activities - Line 58)	0 days	Fri 26-11-27	Fri 26-11-27	28
30		**OH Equipment Procurement / Requirements**	**704 days**	**Thu 25-04-24**	**Wed 28-03-01**	
31		OH - Approval to Purchase Equipment	0 days	Thu 25-04-24	Thu 25-04-24	
32		Equipment Selection Reporting Deadline	0 days	Wed 25-10-01	Wed 25-10-01	
33		Equipment Delivery Deadline	1 day	Wed 27-03-31	Wed 27-03-31	
34		Equipment Go-Live Deadline	0 days	Wed 28-03-01	Wed 28-03-01	
35		**Planning, Design & Costing**	**341 days**	**Fri 25-07-11**	**Mon 26-11-30**	
44		30% Design Development	4 wks	Fri 25-07-11	Fri 25-08-08	9
45		*Class C Estimate*	*0 days*	*Fri 25-08-08*	*Fri 25-08-08*	*44*
46		60% Design Development	4 wks	Mon 25-08-11	Mon 25-09-08	44
47		100% Design Development	4 wks	Tue 25-09-09	Mon 25-10-06	46
48		*Class B Estimate*	*3 wks*	*Tue 25-10-07*	*Tue 25-10-28*	*47*
49		80% Construction Documents	1 day	Fri 25-11-28	Fri 25-11-28	
50		Issued for Tender Documents	65 days	Fri 25-12-12	Fri 26-03-27	
51		*Class A Estimate*	*9 wks*	*Wed 26-03-18*	*Fri 26-05-22*	
52		Permit Submission	1 day	Thu 25-11-06	Thu 25-11-06	
53		Permit Issuance	18.6 wks	Thu 25-11-06	Tue 26-03-31	52SS
54		Construction Tender Issuance	0 days	Mon 26-09-28	Mon 26-09-28	24FS+5 days
55		Construction Tender Close	15 days	Mon 26-09-28	Mon 26-10-19	54
56		WRHN Internal Tender Review	5 days	Tue 26-10-20	Mon 26-10-26	55
57		Board Motion for 3.1 Submission	2 days	Tue 26-10-27	Wed 26-10-28	56

Project: PET CT Final Project Sch
Date: Wed 26-09-23

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
58		Issued for Construction Documents	176 days	Thu 26-03-19	Mon 26-11-30	29FF+1 day
59		**Long Lead Times (Equipment)**	**100 days**	**Mon 26-12-14**	**Wed 27-05-19**	
60		RTU (Daikin Units)	14 wks	Mon 26-12-14	Wed 27-04-07	64
61		Radio Isotope Fume Hood (for Hot Lab)	20 wks	Mon 26-12-14	Wed 27-05-19	64
62		**Construction**	**457 days**	**Tue 25-10-14**	**Tue 27-08-31**	
63		General Contractor Award	5 days	Mon 26-11-30	Fri 26-12-04	28
64		Site Mobilization	5 days	Mon 26-12-07	Fri 26-12-11	63
65		**PET CT Scanner Room**	**73 days**	**Mon 26-12-14**	**Mon 27-04-12**	
66		IPAC Compliance Review	3 days	Mon 26-12-14	Wed 26-12-16	64
67		PETCT Scanner Room Demolition	2 wks	Thu 26-12-17	Wed 27-01-13	66
68		PET CT Scanner Room Interior Framing	1 wk	Thu 27-01-14	Wed 27-01-20	67
69		PET CT Scanner Room M&E Rough-in	3 wks	Thu 27-01-21	Wed 27-02-10	68
70		PET CT Scanner Room Lead Lining Installation and Verification	5 days	Thu 27-02-11	Thu 27-02-18	69
71		PET CT Scanner Room boarding installation	5 days	Fri 27-02-19	Thu 27-02-25	70
72		PET CT Scanner Room Interior Finishes & Fixtures	20 days	Fri 27-02-26	Thu 27-03-25	71
73		PET CT Scanner Room Deficiency	5 days	Tue 27-03-30	Mon 27-04-05	72
74		PET CT Scanner Room Commissioning	2 wks	Tue 27-03-30	Mon 27-04-12	72
75		Consultant, Equipment Vendor and Hospital Reviews and Acceptance	5 days	Tue 27-03-30	Mon 27-04-05	73FS-5 days
76		Partial Occupancy PetCT Scanner Room	0 days	Mon 27-04-12	Mon 27-04-12	74
77		**Injection Room Space**	**128 days**	**Fri 27-02-26**	**Tue 27-08-31**	
78		IPAC Compliance Review	3 days	Fri 27-02-26	Tue 27-03-02	71
79		Injection Room Area Demolition	2 wks	Wed 27-03-03	Tue 27-03-16	78
80		Injection Room Area Interior Framing	5 wks	Wed 27-03-17	Thu 27-04-22	79
81		Injection Room Area M&E Rough-In	5 wks	Fri 27-04-23	Fri 27-05-28	80
82		Injection Room Area Lead Lining installation	10 days	Mon 27-05-31	Fri 27-06-11	81
83		Injection Room Area boarding installation	10 days	Mon 27-06-14	Fri 27-06-25	82
84		Injection Room Area Interior Finishes and Fixtures	30 days	Mon 27-06-28	Tue 27-08-10	83
85		Injection Room Area Deficiency	2 wks	Wed 27-08-11	Tue 27-08-24	84
86		Injection Room Area Commissioning	3 wks	Wed 27-08-11	Tue 27-08-31	84
87		Consultant, Equipment Vendor and Hospital Reviews and Acceptance	5 days	Wed 27-08-18	Tue 27-08-24	85FS-5 days
88		Substantial Completion	0 days	Tue 27-08-24	Tue 27-08-24	87
89		Occupancy Permit	5 days	Wed 27-08-25	Tue 27-08-31	87
90		**PET CT Equipment**	**396 days**	**Tue 25-10-14**	**Thu 27-06-03**	
91		PET CT Purchase Confirmation	1 day	Tue 25-10-14	Tue 25-10-14	
92		Equipment Lead Time	90 days	Wed 26-11-04	Thu 27-03-25	91,93SF

Project: PET CT Final Project Sch
Date: Wed 26-09-23

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
93		**PET CT Equipment Delivery**	**1 day**	**Thu 27-03-25**	**Thu 27-03-25**	
94		PET CT Equipment Mechanical Install	10 days	Mon 27-03-29	Fri 27-04-09	93FS+4 days
95		PET CT Testing and Commissioning	5 days	Mon 27-04-12	Fri 27-04-16	94
96		PET CT Acceptance Testing	5 days	Mon 27-04-19	Fri 27-04-23	95
97		PET CT Live Apps Training	5 days	Mon 27-04-26	Fri 27-04-30	96
98		Siemens Acceptance Period	23 days	Mon 27-05-03	Thu 27-06-03	97
99		WRHN PET CT Operational Readiness	4 wks	Mon 27-05-03	Mon 27-05-31	97
100		**PET CT Go-Live**	**0 days**	**Mon 27-05-31**	**Mon 27-05-31**	**99**

Project: PET CT Final Project Sch
Date: Wed 26-09-23

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	